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- Silicone oil usage in hand rehabilitation
- Postural measurement in cerebral palsy
- Osteoarthritis model of care in New Zealand
- Telehealth wheelchair assessment readiness
- Self-reported depression, anxiety, and disability in Parkinson's disease

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Cochrane Rehabilitation – Connecting Rehabilitation Professionals to Evidence

Cochrane is a global independent network that exists to help funders, providers, and consumers make better decision about healthcare. Cochrane is best known for its highly trustworthy and fiercely independent systematic reviews, which it publishes through the Cochrane Library. Importantly, access to all resources in the Cochrane Library is free for all people in Aotearoa New Zealand (https://www.health.govt.nz/our-work/cochrane-library). For physiotherapists in New Zealand, the Cochrane Library provides a practically endless resource for continued professional development.

Last year marked the fourth anniversary of Cochrane Rehabilitation – a field within Cochrane that was launched in December 2016 to connect the organisation to the rehabilitation community, that is, consumers, providers, researchers, funders, and policy makers of rehabilitation services (Arienti et al., in press). Cochrane Rehabilitation is a two-way bridge, in that it functions both to make Cochrane's extensive resources accessible to rehabilitation stakeholders and to inform the work of Cochrane from the perspective of these stakeholders and their everyday needs (Negrini et al., 2018).

Over the past four years, Cochrane Rehabilitation has become a large organisation with over 15,000 active users in 174 countries. In addition to its Executive Committee, Advisory Committee, and Advisory Board, Cochrane Rehabilitation has five working areas that focus on activities that need regular updates and maintenance: review, publication, education, methodology, and communication. A common misunderstanding is that Cochrane Rehabilitation publishes its own systematic reviews: it does not. The production of systematic reviews is left to Cochrane's many review groups. As a "field", Cochrane Rehabilitation's main job is translational: making the work of review groups more relevant, more accessible, and more applicable to the everyday activities of people involved in rehabilitation. For instance, the Review Working Group has now electronically "tagged" over 10,000 systematic reviews in the Cochrane Library to identify those most relevant to the practice of rehabilitation (Levack et al., 2019). This work has then been used to identify topics for summarisation and dissemination via Cochrane Corners, and these have now been published in 14 rehabilitation journals internationally (Arienti et al., in press); 53 were published in 2020 alone. The Review Working Group is now engaging with the Cochrane Library to make "rehabilitation" a quick filter to add to its search engine, based on this existing tagging work.

In addition to these working areas, Cochrane Rehabilitation also undertakes special projects. In 2020, a project was launched to improve access to evidence on rehabilitation for people with Covid-19. Called the "Rehabilitation – COVID-19 Evidence-based Response" (REH-COVER), the project has been organised around five main activities related to Covid-19 rehabilitation: production of rapid living systematic reviews, production of an interactive living evidence map, prioritisation of research topics on rehabilitation and Covid-19 in collaboration with the World Health Organization (WHO), production of a Cochrane Library Special Collection on Covid-19 and rehabilitation for patients with functional consequences of acute illness, and lastly, collaboration with the COVID-19 Evidence Network to support decision-making (https://rehabilitation.cochrane.org/resources/cochrane-rehabilitation-versus-covid-19).

Cochrane Rehabilitation also works extensively with the WHO on its Rehabilitation 2030 strategy. This work has involved the development of a "package of intervention" for 16 of the most commonly disabling conditions (Rauch et al., 2019). These packages aim to set a benchmark for basic rehabilitation services for these conditions in all countries globally. Cochrane Rehabilitation is doing the work to collate the best evidence for rehabilitation to inform these packages.

A number of international projects have also been undertaken to further the development of research methods to improve the quality of evidence in rehabilitation. Guided by the Methods Working Area, this work began with a two-day symposium, funded in part by the Royal Society Te Āparangi, which resulted in the production of a special issue of the *European Journal of Physical & Rehabilitation Medicine* on systematic review methods for rehabilitation topics (Levack et al., 2019). More recently, the Methods Working Area has been developing a rehabilitation extension to the Consolidated Standards of Reporting Trials (CONSORT) statement, with the working title, Randomized Controlled Trial Rehabilitation Checklist (RCTRACK) (Negrini et al., 2020). The CONSORT statement is a list of criteria endorsed by all leading health science journals, including the *New Zealand Journal of Physiotherapy*, that describes a minimum level of reporting required in any published article on a clinical trial. The CONSORT statement ensures that when researchers publish findings from randomised controlled trials, all key information needed to evaluate the quality of the study and to apply it to clinical practice has been included in the report. The CONSORT statement has resulted in a measurable improvement in the quality of published research since it was first launched (Kane et al., 2007). However, this statement was initially created with medical and pharmaceutical research in mind, and it does not include all the standards that we need to produce informative, trustworthy, reproducible rehabilitation research. The work towards RCTRACK has been undertaken to address this gap – to improve the quality of reporting of rehabilitation trials and systematic reviews in order to produce better evidence to guide clinical practice.

Cochrane Rehabilitation has undertaken many other activities in many other areas (Arienti et al., in press): the production of a free online e-book on best evidence in rehabilitation; the publication of "blogshots" – short, rapid-fire posts about evidence in areas of rehabilitation practice disseminated in multiple languages via social media; the delivery of training in evidence-based rehabilitation at multiple conferences around the world; and the development of international consensus on an operational definition of "rehabilitation" to apply to all of our work. If you want to know more about any of these projects or get involved in the work of Cochrane Rehabilitation, visit the Cochrane Rehabilitation website (https://rehabilitation.cochrane.org/), sign up for the newsletter, or follow Cochrane Rehabilitation on its Twitter, Facebook, Instagram, LinkedIn, or YouTube news feeds.

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William Levack is a professor of rehabilitation, and is dean and head of campus for University of Otago Wellington (UOW) . He is president of the New Zealand Rehabilitation Association and affiliated with the Rehabilitation Teaching & Research Unit at UOW. William got involved in Cochrane Rehabilitation when it was first established in 2016, and he is currently chair of its Review Working Area and a member of its Executive Board.

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Usage and Clinical Perspectives of Silicone Oil as a Therapeutic Adjunct in Hand Rehabilitation: A Survey of New Zealand and Australian Therapists

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ABSTRACT

This study aimed to quantify current silicone oil usage by therapists in New Zealand and Australia, and gauge clinician perceptions regarding the therapeutic properties of silicone oil. To ascertain clinical beliefs, a questionnaire containing Likert scales was custom designed. Therapists attending a combined hand conference held in Melbourne, Australia, in 2013 were surveyed, with a 50.4% response rate. One-quarter of therapists surveyed (*n* = 126) reported current usage of silicone oil. Therapists' perceptions were that silicone oil impacted positively on wound healing (Likert scale agreement score, 4.6/5) and finger movement, with less pain reported (Likert scale agreement score, 3.8/5). Silicone oil was used specifically after Dupuytren's palmar contracture release surgery. Non-use of silicone oil was mainly attributable to unavailability in the clinical setting. Results indicate that silicone oil is currently used and valued due to its pain-relieving and movement-promoting properties in combination with facilitation of wound healing.

Donaldson, G., Johnson, G. M., Sole, G. & Perry, M. (2021). Usage and clinical perspectives of silicone oil as a therapeutic adjunct in hand rehabilitation: A survey of New Zealand and Australian therapists. *New Zealand Journal of Physiotherapy, 49*(1), 7–14. https://doi.org/10.15619/NZJP/49.1.02

Key Words: Hand, Pain, Physical Therapy, Silicone Oil, Wound Healing

INTRODUCTION

The hand, by virtue of its functional interaction with the environment, frequently sustains trauma that disrupts the integrity of the skin (Kwan et al., 2009). Traumatic hand injuries, such as burns, lacerations, and abrasions, are common and frequently require acute medical interventions and ongoing care to achieve wound healing (Lazarus et al., 1994). Substantial wounds of the hand are often challenging to manage, as the multiple joints, and underlying tissues and tendons require controlled motion during healing to prevent the formations of unwanted adhesions (Merritt, 1998). Concurrently, the outer surface of the hand needs to re-establish skin integrity as the wound closes, but still have sufficient laxity to allow all joints full motion (Yang et al., 2014).

Since the 1960s, medical grade silicone oil (SiO) has been proposed as a therapeutic adjunct for open hand wounds, burns, and post-operative hand rehabilitation (Helal et al., 1982; Spira et al., 1967). Medical grade SiO is clear and odourless, with a viscosity of 350 centistokes (cS), which is similar to olive oil. In comparison water, has a viscosity of 1 cS at 20°C (Braley, 1970).

Anecdotal evidence suggests that SiO encourages early gains in finger motion with less associated pain (Helal et al., 1982; Spira et al., 1967) and increases the speed of wound healing, i.e., time taken to complete epithelisation (Weeder et al., 1967). Laboratory-based research has shown that SiO has antimicrobial properties, particularly against staphylococcal pathogens (Arici et al., 2016; Chrapek et al., 2012; Ozdamar et al., 1999). However, there is limited clinical research relating directly to hand wounds.

Despite historical case studies detailing the use of SiO for hand injuries (Helal et al., 1982; Maciejczyk, 1961; Spira et al., 1967; Weeder et al., 1967) and more recent ophthalmic studies (Dave et al., 2019), there has been no literature published during the last 18 years detailing the use of SiO in hand rehabilitation. In Australasia there are anecdotal reports of hand therapists using SiO, but it is unclear whether therapists regularly use SiO as an adjunct in hand rehabilitation. The purpose of this paper was to clarify SiO use in New Zealand and Australia and, if used, to gauge clinician's perceptions about its properties and effectiveness.

METHODS

This study is survey based, using a custom-designed questionnaire. A schematic overview of the study design is provided in Figure 1.

Questionnaire development

The University of Otago Human Ethics Committee granted ethical approval for this study (reference number D13/346). The questionnaire development included an initial literature search, an interview with two hand therapists, and a pilot test, from which five initial questions were identified:

1. Is SiO acceptable as an adjunct for open wound rehabilitation?
2. Are there adverse effects or risks associated with SiO usage?
3. What is the possible impact of SiO on pain experienced during exercise?
4. What impact does SiO have on finger range of motion?
5. What perceptions do therapists have regarding infection and wound healing with SiO usage?

The primary author (GD) conducted focus interviews with two hand therapists experienced in SiO use to gauge their opinion regarding the utility and overall scope of the questionnaire. Following these interviews, the cost of SiO and the impact on wound dressing changes were included in the questionnaire. Pilot testing on a convenience sample of five hand therapists during a regional hand therapy meeting determined minor formatting changes required to improve the questionnaire's clarity.

The silicone oil questionnaire

The final version of the questionnaire, entitled "The Silicone Oil in Hand Rehabilitation Questionnaire" (SiOQ) (Appendix A), contained 18 questions. Questions 1 to 6 entailed respondents' professional demographic and professional registration status data. Question 7 asked whether the respondent used SiO, followed by two open-ended questions asking therapists' reasons for using or not using SiO. Questions 10 to 16 were completed by users of SiO to examine professional viewpoints of SiO use relating to finger range of motion, pain levels, impact on dressing changes, adverse effects, and risks of infection. Respondents rated their agreement with the statements on a 5-point Likert scale, which was anchored by the reference points "disagree", "unsure" (centred), and "agree". Finally, questions 17 and 18 were open-ended and related to therapists' perceptions of the benefits and disadvantages of SiO.

Administration of the SiOQ

To qualify for inclusion in the SiOQ, participants had to be a hand therapist registered with either a New Zealand or Australian parent body; had to be an attendee at the combined conference of Hand Therapy New Zealand (HTNZ) and the Australian Hand Therapy Association (AHTA) that was held in Melbourne, Australia in October 2013; and had to provide formal consent.

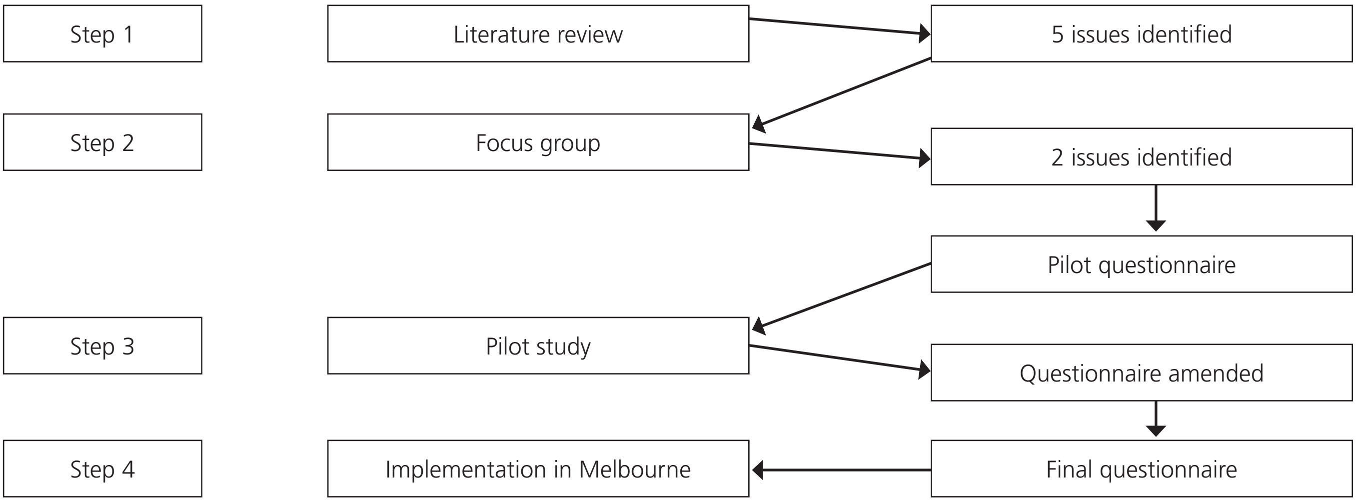
In 2013, the collective membership of HTNZ and AHTA therapists was estimated to be 450. Recruitment of conference attendees (*n* = 250) was via a poster in the registration area and announcements made at the conference. Respondents who completed hard copies of the participant information sheet, consent form, and SiOQ went into a draw to win an iPad mini.

Data analysis

Data were entered into Microsoft Excel for analysis. Respondent demographics and Likert scale responses were analysed using frequency counts. Likert response categories were ranked numerically and then multiplied by the frequencies. This weighted analysis (Norman, 2010) gave an overall combined score out of 5 points. This score, termed "level of agreement", reflected the respondent's viewpoint of each statement on the

Figure 1

Overview of Study Design



Likert scale. Zero agreement is reflected by a 0 score, whereas strong agreement has 5 points. Written responses to open-ended questions were grouped according to thematic content by GD, with frequency counts performed for reporting purposes.

RESULTS

Demographics

The response rate from the hand therapists attending the combined conference was 50.4% (*n* = 126). All respondents were qualified therapists, who had either completed occupational therapy (*n* = 72) or physiotherapy (*n* = 51) training. All but three respondents provided hand therapy professional membership status and country of registration. The respondents reported a wide range of hand therapy experience (1-40 years), with a mean of 12 years (SD = 9). Of the respondents, 22 held postgraduate qualifications of either a master's degree or above, with three holding doctorates.

SiO usage

In regard to SiO usage, 43% (*n* = 54/126) of respondents reported using SiO in their clinical practice. However, only 24% (*n* = 30/126) currently used SiO. A third of respondents (*n* = 42/126) were unaware of the existence of SiO as a therapeutic adjunct for hand therapy (Figure 2). The demographics of the SiO users (*n* = 54) compared to those who had never used SiO (*n* = 72) were similar (Table 1). A greater number of hand therapists with physiotherapy training (62%, *n* = 34/54) reported use of SiO in their clinical practice compared to those with an occupational therapy background (37%, *n* = 20/54).

Agreement on clinical attributes of SiO

The highest overall level of agreement for all respondents (*n* = 54) that had used SiO was that immersion was an acceptable and appropriate therapeutic adjunct for the management of open hand wounds (level of agreement score, 4.1/5). The second area of strong respondent agreement concerned the

Figure 2

Summary of Respondent Awareness and Usage of Silicone Oil

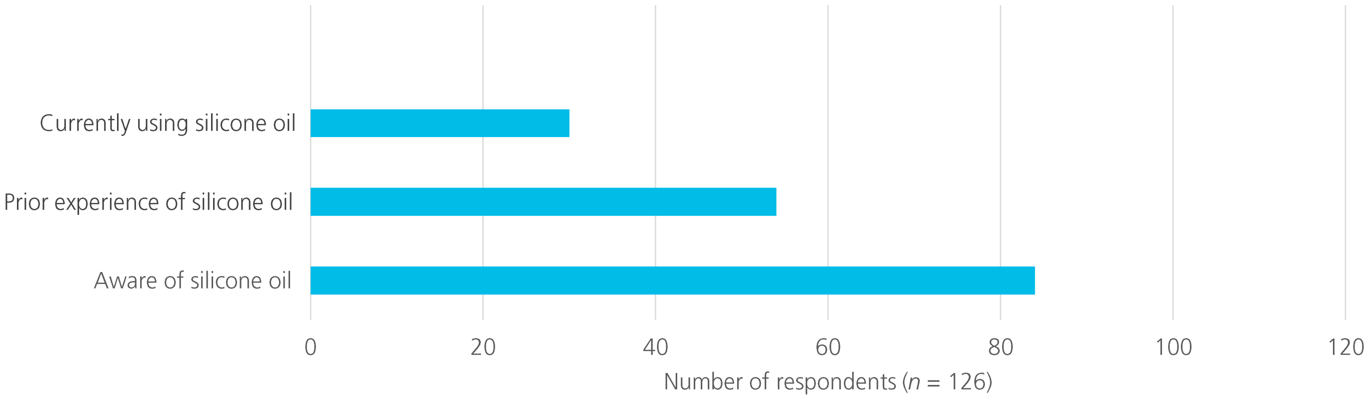


Table 1

Demographics of Respondents Separated by Silicone Oil Use

Total respondents in survey (*n* = 126)	Silicone oil users (*n* = 54)	Never used silicone oil (*n* = 72)
Response rate (total 50.4%)	43%	57%
Physiotherapist	34	17
Occupational therapist	20	55
Average years worked	14	11
Range of years worked	1–40	0–32
Private practice	41	48
Public practice	13	24
Master's degree or doctorate	11	11
New Zealand registered	30	4
Australian registered	10	32
Registration not stated	14	36

positive impact of SiO on wound dressing changes, with the perception that dressing changes were atraumatic after SiO use (level of agreement score, 4.6/5). Respondents agreed that SiO allowed hand movement with less pain (level of agreement score, 3.8/5). The lowest level of agreement between SiO users (level of agreement score, 3.6/5) related to the risk of infection associated with SiO use (Table 2).

Reasons for non-usage of SiO

The most frequent reason for non-usage of SiO was its nonavailability in the clinic (*n* = 13) (Figure 3). Additional reasons included a lack of product knowledge combined with perceived limited clinical evidence for SiO use, and concerns over cleanliness and hygiene. Cost and the requirement for a doctor's referral were also reasons for nonuse. The free text responses regarding SiO disadvantages included responses about the "complex" and "messy" nature of the intervention, which has a "risk of spillage" (Appendix A, question 18). In addition, SiO was reported as "requiring a high level of cooperation and commitment from patients when used at home".

Reasons for use of SiO

Therapists reported SiO for specific use in the post-surgical management of Dupuytren's contracture release (26%, *n* = 14) (Figure 4). Reasons for clinical use included "wound care" and "improved wound healing time", which together equalled 35% (*n* = 19); gaining range of movement (11%, *n* = 6); at the surgeon's request (9%, *n* = 5); and for scar management (9%, *n* = 5). Respondents comments about perceived benefits included terms such as "soothing", "pain-free effect", and "less tightness when moving". The most cited observations related to the enhancement of wound healing: "faster wound healing" and "softer dead skin allowing for simpler debridement" (Appendix A, question 17).

DISCUSSION

A quarter of the therapists surveyed used SiO, and strongly agreed that SiO was effective for open wound hand rehabilitation as it made movement less painful. Therapists stated that SiO was used specifically for post-surgical

Table 2

Level of Agreement Scores for Therapeutic Implications of Silicone Oil

Therapeutic implications	Level of agreement [a]	
	Have used SiO (*n* = 54)	Current user of SiO (*n* = 30)
Can be used for open wounds	4.1	4.2
Assists with atraumatic dressing changes	4.0	4.1
Less pain with motion	3.8	4.0
No adverse effects	3.8	4.1
Assists with gaining motion	3.7	3.4
Additional cost	3.7	3.7
Decreased risk of infection	3.6	4.4

Note. SiO = silicone oil.

[a] Answers scored on a 5-point Likert scale; an overall "level of agreement" score of 0 indicates no agreement, with 5 indicating total agreement.

Figure 3

Reasons for No Longer Using Silicone Oil

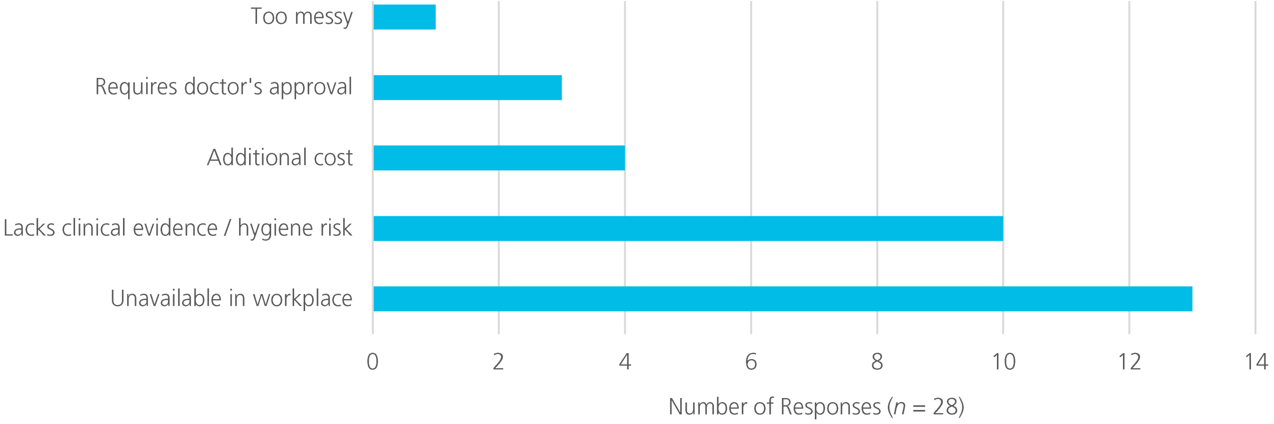
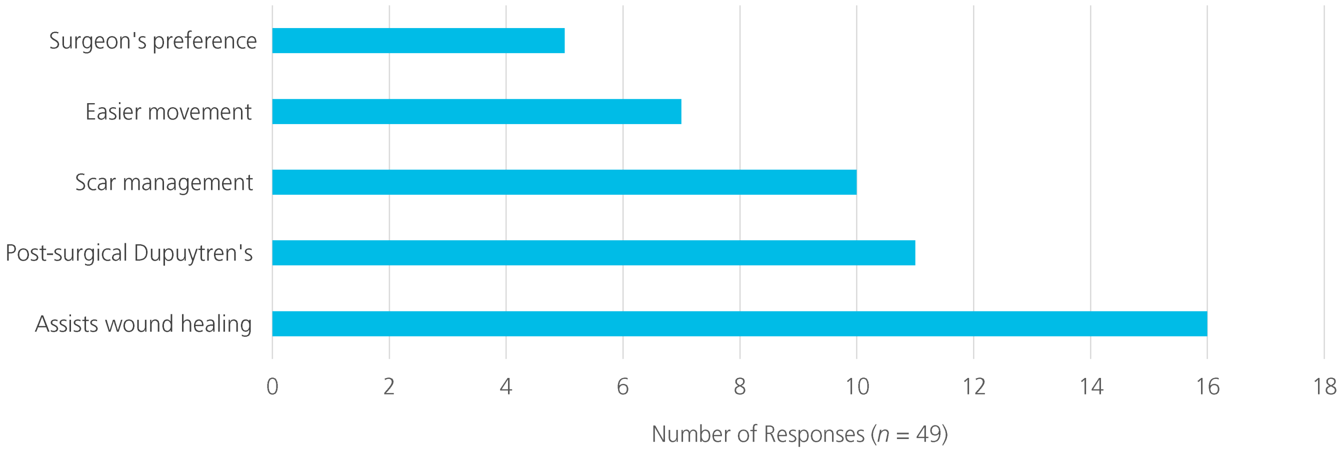


Figure 4

Reasons for Current Use of Silicone Oil



Dupuytren's rehabilitation. However, a third of therapists surveyed were unaware of SiO usage as an adjunct in hand rehabilitation.

The survey identified a range of clinical issues. Nonavailability of SiO at hospitals and clinics was one reason preventing therapists from incorporating SiO into rehabilitation programmes. Another factor impacting therapists' usage was that, at the time of administration of this questionnaire, SiO required a doctor's prescription. However, the New Zealand Government changed the medical classification of SiO to a medical device in 2014 (New Zealand Government, 2013), which means it can now be incorporated into a care plan by a therapist based upon clinical reasoning.

From the results of this study, we can hypothesise that therapists with limited product knowledge are less likely to use SiO. However, this was not tested using statistical methods. Some respondents expressed concern regarding the risks of infection, cleanliness, and a lack of clinical evidence for SiO use. These concerns are valid as there is a paucity of literature in this area of hand therapy. Nevertheless, literature that does exist suggests that infection is not a concern. For example, the study of Thurston and McChesney (2002) examined SiO use for hand-wound rehabilitation and found that SiO did not support the growth of bacteria, despite the wound testing positive for bacterial growth.

Furthermore, while not in the field of hand research, there has been extensive investigation of SiO and infection in ophthalmic laboratory research. This body of work has identified strong antimicrobial properties associated with SiO, particularly against staphylococcal pathogens (Arici et al., 2016; Chrapek et al., 2012; Ozdamar et al., 1999). Intraocular injections of antibiotics with and without SiO found treatment with SiO rapidly controlled infection and achieved better visual acuity when compared to intraocular injection of antibiotics alone (Bali et al., 2003). The research documenting antimicrobial and anti-inflammatory properties of SiO is limited to ophthalmic research (Aras et al., 2001; Bali et al., 2003; Chrapek et al., 2012).

Conversely, therapists may be cognisant of literature detailing Swanson's silicone arthroplasty implants, used for finger joint replacements in arthritis (Bales et al., 2014; Swanson, 1972). Early publications reported complications with implanted silicone joint replacements, such as particulate synovitis, lymphadenopathy, and the formation of granuloma tissue (Christie et al., 1977; DeHeer et al., 1995; Kircher, 1980). However, Thurston (1997) reviewed 116 hand wounds mobilised in SiO over a 12-year period and did not find any of the adverse effects associated with implanted silicone such as granuloma, areas of inflammation or abnormal scar formation.

In contrast to the wide range of traumatic injuries and diagnoses associated with SiO usage in the earlier literature, the current study found post-surgical Dupuytren's commonly cited as the reason for SiO use. Hand therapists frequently see traumatic injuries, such as burns, de-gloving injuries, and tendon lacerations, and these share similar therapeutic goals to post-surgical Dupuytren's (Warwick, 2015), such as restoring motion with the least pain possible during wound healing. In the current study, therapists' perceptions regarding less pain with motion are consistent with previous authors who state, "The hand can be exercised with less pain than otherwise would occur" (Helal et al., 1982). Given this consistency, the rare citing of traumatic injuries as the reason for SiO use is surprising. The absence of published protocols that recommend SiO use for traumatic injuries may be a factor. Tendon repair rehabilitation, for example, is guided by very prescribed criteria, such as Kleinart (Hundozi et al 2013), Washington (Dovelle & Heeter, 1989) and Saint John (Higgins & Lalonde, 2016), but none suggest SiO use. In the absence of published protocols that specify SiO use, therapists may be reluctant to modify their current practice. Thurston (1997) details SiO use in post-surgical Dupuytren's, which may explain the use of SiO for this specific pathology.

Therapists in this study strongly agreed (4/5) on the utility of SiO in the daily replacement of wound dressings, where patients report less pain during dressing changes after SiO use. Spira and colleagues (1967) pioneered the use of SiO in plastic bags for the treatment of burned hands. The bag containing SiO acts as a form of dressing, while the sealed space within the bag allows unrestricted finger motion, which is advantageous during rehabilitation. Subsequently, silicone impregnated dressings were developed (Cutting et al., 2009; Platt et al., 1996). Silicone dressings adhere readily to intact skin, but do not stick to the moist wound surface. Subsequently, a lesser nociceptive stimulus occurs when the dressings are removed (White, 2005). Less pain and stress improve the speed of wound healing (Broadbent et al., 2003; Matsuzaki & Upton, 2013; McGuire et al., 2006; Upton & Solowiej, 2010), and these findings are consistent with therapists' perceptions that SiO usage heals hand wounds faster, with less pain experienced during range of motion exercises and atraumatic wound dressing changes.

The literature lacks studies on patient perceptions of SiO. Therefore, future studies should evaluate both the efficacy of SiO and qualitative investigation with the use of patient-rated outcome measures.

The strengths of this study include careful development of the questionnaire using Likert scales to ascertain therapists' opinions on SiO, and the trial and refinement of the questionnaire before it was administered. The response rate achieved was acceptable (Richardson, 2005), although 60% would have been desirable to reduce sample error and bias.

Study limitations include the use of a local regional sample for pilot testing and the absence of a working definition of SiO on the questionnaire. A clear definition of SiO may have eliminated possible respondent confusion. Seven respondents alluded to the point that SiO was helpful for scar management although it is silicone gel sheets that are explicitly designed and routinely used by therapists for scar care (Sawada & Sone, 1990). Furthermore, the results of the study cannot be generalised beyond the conference attendees, and data collection was undertaken over seven years ago. Therefore, the views expressed are not representative of hand therapists worldwide.

CONCLUSION

This study found that 43% of therapists surveyed had used SiO as an adjunct in hand rehabilitation for the management of open hand wounds within New Zealand and Australia. Therapists surveyed agreed that SiO use permitted movement with less pain. Furthermore, therapists perceived that SiO use contributed to faster healing and atraumatic wound dressing changes.

The practical implications of this study include recognition of the low level of therapists' product knowledge and research relating to SiO. Therapists need easy access to recent evidence to support their clinical use of this adjunct. Surgical release of Dupuytren's hand joint contracture is a common surgery in New Zealand and a specific reason for clinical use of SiO. Addressing the nonavailability of SiO in the clinic could make this simple adjunct to hand rehabilitation more common in clinical practice where indicated.

This research highlights beliefs commonly held by New Zealand and Australian therapists regarding SiO, and raises the profile of SiO as an adjunct therapy for hand wounds. Investigation of the effectiveness of SiO to improve wound healing, for example, in post-operative Dupuytren's contracture release wounds, is needed to improve clinical practice. Future research should first evaluate the feasibility and acceptability of treatment regimens, for example, using SiO in a home-based exercise programme, taking into account both clinicians' and patients' perspectives.

KEY POINTS

1. A quarter of hand therapists surveyed reported SiO use.
2. Therapists strongly agreed that SiO used in wound care permits movement with less pain.
3. Therapists agreed that SiO use impacted positively on wound dressing changes.
4. SiO is used specifically for post-surgical Dupuytren's rehabilitation.

DISCLOSURES

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

PERMISSIONS

Ethical approval was obtained from the University of Otago Human Ethics Committee (reference number D13/346).

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Appendix A

THE SILICONE OIL IN HAND REHABILITATION QUESTIONNAIRE

This survey is being conducted by Gail Donaldson as part of her doctoral study being conducted at the University of Otago. This is a confidential survey which is being conducted to ascertain the level of usage and professional opinion of silicone oil held by New Zealand and Australian hand therapists.

Instructions: Please mark each question with a tick.
Provide answers when prompted and grade your responses as applicable.

1. Your professional registration status is:
   ☐ Physiotherapist ☐ Occupational therapist
   ☐ New Zealand registered ☐ Australian registered

2. Your highest academic degree is:
   ☐ Registered/certified hand therapist
   ☐ Master's degree
   ☐ PhD

3. How many years of hand therapy experience do you have?
   ____________ years

4. The predominant area of your professional hand therapy practice is:
   ☐ Private practice ☐ Public sector

5. Are you aware of the use of silicone oil in relation to hand therapy rehabilitation?
   ☐ Yes ☐ No

6. Have you ever used silicone oil for your patients in hand rehabilitation?
   ☐ Yes ☐ No

7. Do you currently use silicone oil for your patients in hand rehabilitation?
   ☐ Yes ☐ No

8. If you currently use silicone oil, please state your reason for doing so.
   ____
   ____
   ____
   ____

9. If you do not currently use silicone oil or have done so in the past, please state your reason for not doing so now.
   ____
   ____
   ____
   ____

Please mark on the line the point that best describes your opinion regarding the therapeutic implications of silicone oil in the following statements.

10. Silicone oil immersion can be used in the presence of open wounds
    Disagree Not sure Agree

11. Silicone oil immersion helps improve range of motion of the hand
    Disagree Not sure Agree

12. Silicone oil immersion allows movement with less pain
    Disagree Not sure Agree

13. Silicone oil immersion assists with atraumatic dressing changes
    Disagree Not sure Agree

14. Silicone oil has adverse effects
    Disagree Not sure Agree

15. Silicone oil is costly
    Disagree Not sure Agree

16. There is increased risk of infection with use of silicone oil
    Disagree Not sure Agree

17. Do you want to add any additional comments about the perceived benefits of silicone oil in regard to hand rehabilitation?
    ____
    ____

18. Do you want to add any additional comments about the disadvantages of silicone oil?
    ____
    ____

The Relationship Between Radiographic and Anthropomorphic Measurements of Deformity of the Thorax, Hips, and Pelvis in Adults with Cerebral Palsy

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ABSTRACT

Non-ambulant adults with cerebral palsy (CP) are commonly affected by progressive secondary debilitating musculoskeletal issues, which may be clinically measured using the Goldsmith Indices of Body Symmetry (GIofBS). The primary aim of this study was to explore relationships between clinical outcomes and relevant radiographic measures in non-ambulant adults with CP. Thoracic shape and symmetry, pelvic orientation, and hip range were measured using the GIofBS. Radiographs of the pelvis and spine were reviewed. The Pearson correlation (r) or Pearson's r was used to assess the relationships between clinical and radiographic measures. The positioning and readability of radiographic data in 30 non-ambulant adults with CP were variable. Minimal to no correlation between paired measures of radiographic and clinical data for trunk, pelvis, and hips were found, ranging from the lowest correlation of $r(15) = -0.09$, $p = 0.620$ (left migration percentage and hip range) to the highest of $r(15) = -0.25$, $p = 0.200$ (right hip morphology scale and hip range). The complex three-dimensional nature of asymmetries of the thorax, pelvis, and hips, measured clinically with the GIofBS, provides valuable, yet different, postural information to that obtained by radiographs. Inclusion of both radiographs and the GIofBS would enable a comprehensive lifespan assessment for postural management of adults with CP.

Holmes, C., Brock, K. & Morgan, P. (2021). The relationship between radiographic and anthropomorphic measurements of deformity of the thorax, hips, and pelvis in adults with cerebral palsy. *New Zealand Journal of Physiotherapy, 49*(1), 15–23. https://doi.org/10.15619/NZJP/49.1.03

Key Words: Cerebral Palsy, Posture, Radiograph, Scoliosis, Windswept Hips

INTRODUCTION

The secondary musculoskeletal consequences of cerebral palsy (CP), a permanent, life-long condition acquired before, during, or after birth, are progressive and often debilitating. The arising postural asymmetries affecting the spine, pelvis, and hips may result in further adverse consequences, such as pain and pressure injuries (Gudjonsdottir & Mercer, 1997), especially for non-ambulant adults with CP. The risk of mortality due to respiratory disease in adults with CP is much greater than the general population (Ryan et al., 2019), with postural asymmetry of the thoracic cage contributing to increased risk in the most severely affected adults (Horimoto et al., 2012). Postural asymmetry involving limited hip flexion, pelvic obliquity, trunk asymmetry, scoliosis, and windswept hip posture is common in adults with CP with low motor function (Ágústsson et al., 2018), described on the Gross Motor Function Classification System (GMFCS) as levels IV and V (Palisano, et al., 1997). These asymmetries typically occur alongside pain and spasticity, further adversely affecting function and participation (Benner et al., 2019).

The identification, monitoring, and management of secondary postural complications for adults with CP is critical, given the impact on many domains of health and functioning alongside carer burden and economic impacts. The specific requirements for non-ambulant adults with CP results in the need for specialised equipment, support workers, hospital admissions and reliance on crisis services (Collis et al., 2008; Gudjonsdottir & Mercer, 1997). This presents particular challenges for non-ambulant adults with CP who frequently have limitations in communication and cognition. Despite their potential importance, there is a lack of standardised measurement techniques beyond radiographs to record postural asymmetry in this population (Benner et al., 2019; Holmes et al., 2018). In addition, capturing the complex three-dimensional asymmetry of the thoracic cage and windswept hips with a reliable measurement tool can prove even more challenging. Physiotherapists are well placed to fill this critical surveillance role within both standard and advanced scope of practice roles (World Physiotherapy, 2019).

When radiographic surveillance is possible, there are limitations in interpretation of objective findings for those with significant postural asymmetry. The Cobb angle and migration percentage (MP) are recommended radiographic measurements used to assess status of scoliosis and hip displacement respectively in those with CP. The Cobb angle is a radiographic objective measure of the extent of spinal curvature (Cobb, 1948), reported in degrees, with scoliosis defined as a Cobb angle ≥ 10° (Oda et al., 2017). The MP is a radiographic measure (in percentage form) of the amount of ossified femoral head not covered by the ossified acetabulum (Reimers, 1980). The Australian Hip Surveillance Guidelines considers MP of ≤ 10% to be normal and MP ≥ 30% as abnormal or "at risk" (Wynter et al., 2014). The Cobb angle and MP represent two-dimensional measures of complex three-dimensional skeletal deformities, and may be limited in effectively documenting functional postural deformity. The rotary components of thoracic asymmetry and windswept hips are thus difficult to ascertain with radiographic studies alone in non-ambulant adults with CP. Due to the potential for progression of scoliosis and hip displacement in this vulnerable population, and the aforementioned limitations with radiographic monitoring, there is a need for an additional valid and reliable clinical measurement tool that can capture three-dimensional elements of posture to be used alongside radiographs to assist in functional management.

The Goldsmith Indices of Body Symmetry (GIofBS) is a clinical measurement tool providing a systematic, objective and three-dimensional approach for the identification of asymmetry of the chest, pelvis, and hips (Goldsmith et al., 1992). The chest measurements provide a component of axial rotation and the hip and pelvic measurements occur across more than one plane of movement, as compared to the views obtained from plain radiographs and goniometer measures, which only provide anterior/posterior or lateral measures. The GIofBS was chosen as a clinical measurement tool potentially suited for adults with severe neuromuscular disability, due to the scarcity of alternative tools that can reliably capture three-dimensional aspects of complex postural asymmetry in this population. The constructs captured with the GIofBS have noted relevance to seated and sleeping positions, impacting on pain, pressure risks, and function. Satisfactory intra- and inter-rater reliability of the GIofBS have recently been determined in non-ambulant adults with CP, and control data have been established (Holmes et al., 2020).

Exploration of the relationships between radiographic and anthropomorphic measurements of postural deformity in adults with CP may provide valuable information to assist clinical management of adults with complex disabilities, and suggest effective assessment tools to identify specific elements of postural asymmetry. Continuity of care and specialist knowledge are two of the identified barriers to effective transitioning of young adults from paediatric to adult healthcare services (Burns et al., 2014), which may be addressed with use of the GIofBS across the lifespan.

The objectives of this study were to establish the relationship between radiographic and anthropomorphic measurements of postural deformity in adults with CP, such as described with the GIofBS. Specifically, this study aimed to explore any relationship between GIofBS measures and radiographs in adults with CP classified as GMFCS levels IV or V.

METHODS

This cross-sectional study used data arising from 30 adults with CP, some of whom participated in a measurement tool reliability study to undertake secondary analysis of previously unreported radiographic data (Holmes et al., 2020).

Participants and setting

All patients referred to the Young Adult Complex Disability Service between February 2017 and December 2018 were considered for inclusion. Patients with a diagnosis of CP classified as GMFCS level IV or V were eligible for inclusion in the study. Patients were excluded if they had a severe movement disorder or behavioural issues that placed either themselves or the raters at risk during measurement, or if they were pregnant. Ethical approval was gained from St Vincent's Hospital, Melbourne, Human Research Ethics Committee (HREC/16/SVHM/148). All participants (or their next of kin) signed informed consent forms.

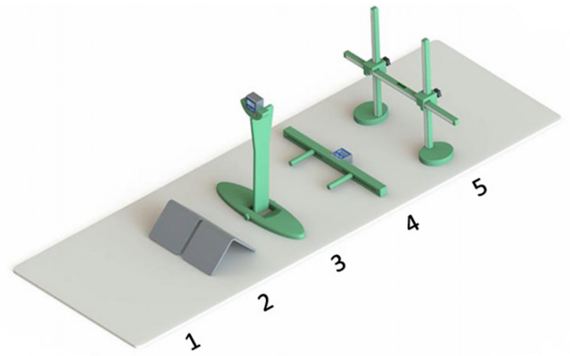
Outcome measures

GIofBS

As per standard testing protocol, the relevant GIofBS outcome measures collected for analysis were (a) chest right left ratio (indicative of chest rotation), (b) combined hip external rotation/abduction (left and right), and (c) the Windswept Index (indicative of the degree of asymmetry between the left and right pelvis/lower limbs) (Goldsmith et al., 1992; Goldsmith & Goldsmith, 2013). These measures have previously been shown to have excellent inter- and intra-rater reliability in this population (Holmes et al., 2020). The components of the GIofBS anatomical measurement instrument are illustrated in Figure 1, with further illustrations of the measurement process provided in Figure 2.

Figure 1

Anatomical Measurement Instrument



Note. Anatomical measurement instrument with equipment listed from left to right: 1 = non-slip mat; 2 = foot brackets; 3 = leg paddle with level box angle sensor; 4 = pelvic bridge with level box angle sensor; 5 = chest frame (Goldsmith & Goldsmith, 2013).

Hip/spine radiographs

Antero-posterior (AP) radiographs of the pelvis and spine obtained within 12 months of the collection of the GIofBS data were reviewed. The Australian Hip Surveillance Guidelines for Children with Cerebral Palsy recommend surveillance every 12 months beyond skeletal maturity in the presence of abnormal MP, progressive scoliosis, or significant pelvic obliquity (Wynter et al., 2014), thus a 12-month time frame was considered acceptable for this study. All radiographic measurements were completed using tools within a picture archiving and

Figure 2

Goldsmith Indices of Body Symmetry Measurement Process

Note. Depiction of the Goldsmith Indices of Body Symmetry measurement processes: (a) chest frame to gain chest right left ratio and chest depth width ratio; (b) pelvic bridge and leg paddle to gain measures used to calculate Windswept Index; (c) leg paddle to gain right hip external rotation/abduction.

communication system (PACS) (Synapse™, Fujifilm Corp., Tokyo, Japan).

Procedures

GlofBS measurements were performed by an experienced therapist (rater) having undergone additional training in administration of the GlofBS Anatomical Measurement Indices as per a standard testing protocol (Goldsmith & Goldsmith, 2013). A testing session typically lasted 45 min.

Radiographic evaluation and measurement for each participant was undertaken by a senior orthopaedic physiotherapist, who is a postgraduate research fellow with 10 years' experience, and responsible for radiographic evaluation and measurement in a clinical musculoskeletal surveillance service. Measurement of MP, Cobb angle and pelvic obliquity, and grading of hip status according to the Melbourne Cerebral Palsy Hip Classification Scale (MCPHCS) (Robin et al., 2009) were undertaken. The MCPHCS is a six-level radiographic ordinal scale used to classify morphology of the skeletally mature hip. The classification covers a wide range of radiographic features, from Grade I (normal hip) through to Grade V (dislocated hip) and Grade VI (dislocated hip that required salvage surgery). The classification includes sub-classifications for femoral head deformity, acetabular deformity, and pelvic obliquity (Robin et al., 2009; Shrader et al., 2017). Pelvic obliquity was measured as the angle between the inter-teardrop line and a horizontal reference line parallel to the frame of the radiograph (Heidt et al., 2015). If the inter-teardrop line was obscured by gonadal shielding, the inter-ischial or inter-iliac crest line was used (Heidt et al., 2015). A quality rating was provided for each radiograph (not readable/readable/challenging to read), and the position in which the spine radiograph was obtained was recorded (supine/sitting/not reported). Any limitations in evaluating the radiograph and obtaining valid measurements were recorded, along with any reason for missing data (e.g. inadequate participant position invalidating measurement). If more than one spinal curve was present, the largest Cobb angle was selected. The highest MP (left or right hip) was noted. The researcher was blinded to GlofBS results for each participant.

The following paired data were selected for exploration of any relationship between GlofBS and radiographic measures based on similarity of investigation of a specific skeletal area (i.e. spine, hip).

1. Chest right left ratio compared to Cobb angle (largest angle if >1 curve).
2. Combined hip external rotation and abduction compared to MP (right and left).
3. Combined hip external rotation and abduction compared to the MCPHCS (right and left).
4. Windswept Index compared to the highest MP (either right or left).

Statistical analyses

The SPSS statistical software version 24 (SPSS Inc., Chicago, Illinois) was used for all quantitative analyses. Normality of all data was evaluated using visual inspection of the histograms and evaluation of the Kolmogorov-Smirnov statistic, with $p > 0.05$ satisfying normal distribution. Mean scores and SDs for each variable were calculated once normative data was confirmed. The following adjustments to the data were made if required to facilitate analyses. The GlofBS chest right-left ratio was adjusted to reflect the magnitude of the measure rather than a positive or negative value (indicative of rotation in a clockwise or anticlockwise direction). The Windswept Index was adjusted to reflect absolute values rather than positive and negative values either side of zero.

Parametric analysis was undertaken using Pearson's correlation (r) to assess correlation between paired GIofBS outcomes against radiographic measures (Cobb angle, MP and MCPHCS). The strength and direction of any relationships (r) were established according to Cohen (1988), where 0.1 to 0.29 = small, 0.30 to 0.49 = medium and 0.50 to 1.0 = large effect size. Significance was set at $p < 0.05$.

Scatterplots were constructed to visualise relationships between GIofBS variables and key radiographic data. Individual cases were identified that were outside the cut-offs previously established from the literature for the Cobb angle and MP (Oda et al., 2017; Wynter et al., 2014). For GIofBS measures, an *a priori* decision was made to use control data to calculate cut-off cases sitting above or below 2 SD (95% of cases) from the mean (Holmes et al., 2020), described as very high or very low scores.

RESULTS

After screening 165 potential participants, 30 adults participated in the study, with a median age of 19 years (range 17-38). Of the 135 excluded, 36 declined, 34 did not have a diagnosis of CP, 46 did not have function classified at GMFCS level IV or V, five had a severe movement disorder (dystonia), nine had significant cognitive/behavioural challenges, and five did not have radiographs available. Of the 30 participants, 29 had CP sub-type quadriplegia and one had diplegia, 10 had received previous surgery for scoliosis, 20 had no consistent communication methods, two used communication devices, and eight were verbal communicators.

Positioning for spinal radiographs was variable: nine of 30 spinal radiographs were performed in a supine position and 13 in a sitting position, while six did not have a documented position; two participants were missing spinal radiographs. The quality of the spinal radiographs also varied, with five of 30 not readable and five reported as challenging to read. Only two of the 30 hip radiographs were not readable in a valid and reliable manner due to extreme positioning of the hip into fixed abduction and abduction/external rotation (Figure 3).

Demographic and postural data for the cohort are presented in Tables 1 and 2. The total number of participants included in the spinal and hip radiograph data was 28 and 30, respectively. Of note, from the radiographs, 10 hips were reported as "at risk", eight hips were considered within normal limits (MP$\leq$ 10%), 19 participants had a documented scoliosis, and 27 participants had pelvic obliquity. Cobb angles as high as 93° were identified, and pelvic obliquity ranged from 0° (two participants) to 29° (two participants). The majority of hips (15 right 16 left) were described as Grade III using the MCPHCS (Table 2).

Table 1

Participant Demographics

Demographic	n^a
Gender	
Male	17
Female	13
Age (years)	Median 19, range 17–38
GMFCS level	
IV	3
V	27

Note. GMFCS = Gross Motor Function Classification System.

[a] Except where indicated.

Any association between radiographic and GIofBS outcomes for trunk, pelvis, and hips was explored. Minimal to no correlation between paired measures of radiographic and GIofBS data was found ranging from lowest correlation: $r\,(15) = –0.09$, $p = 0.620$ (left MP and left external rotation/abduction) to highest: $r\,(15) = –0.25$, $p = 0.200$ (right MCPHCS and right external rotation/abduction) (Table 3).

Scatterplots were constructed to illustrate the relationship between the Windswept Index and highest MP (Figure 4), right MP and right abduction/external rotation (Figure 5), and the highest Cobb angle and chest right left ratio (Figure 6). Scatterplots of these comparisons demonstrate that the majority of participants had Cobb angles and MP values above control cut-off values. In comparison, for GIofBS values, more people with CP fell within the control range (+/- 2 SD).

Figure 3.

Example of Radiographic View of Pelvis and Hips From Which Migration Percentage is Calculated

Note. Right hip migration percentage: 100%. Left hip migration percentage: unable to complete valid and reliable assessment and measurement (Reimers, 1980) due to hip positioning in extreme abduction and external rotation.

Table 2

Participant Postural Data

GIofBS [a]	Mean (SD)	Range
Chest right left ratio (magnitude)	0.16 (0.13)	0.01–0.56
Windswept Index (absolute values)	19.02 (22.74)	0.75–81.00
Right external rotation/abduction (°)	43.79 (19.57)	7.80–79.00
Left external rotation/abduction (°)	46.19 (16.43)	2.25–70.00
Radiographic data	Mean (SD) Range	Incidence, *n*
Highest migration percentage (%) [b]	31 (22) 0–100	< 10, 8 10–30, 38 31–99, 8 100, 2
Largest Cobb angle (°) [c]	32 (24) 7–93	< 10, 3 10–30, 10 30–60, 6 > 60, 3
Pelvic obliquity (°) [d]	8 (9) 0–29	< 10, 21 11–20, 5 21–30, 3
MCPHCS [e]	Right/left hip, *n*	
Grade I	2/0	
Grade II	6/7	
Grade III	15/16	
Grade IV	3/4	
Grade V	1/	
Grade VI	1/0	

Note. GIofBS = Goldsmith Indices of Body Symmetry; MCPHCS = Melbourne Cerebral Palsy Hip Classification Scale.

[a] *n* = 60; 4 unreadable quality, [b] *n* = 2 missing spinal radiographs, *n* = 6 unreadable quality; [c] *n* = 1 unreadable quality; [d] 2 participants unable to be graded due to poor radiograph quality.

Control data for comparison: Mean (SD), range: Chest right left ratio (magnitude): 0.07 (0.05), 0.00–0.27; Windswept Index (absolute values): 3.59 (3.21), 0.00–14.25; Right external rotation/abduction 53.61° (6.19°), 35.00°–65.50°; Left external rotation/abduction 55.79° (6.84°), 41.75°–69.00° (Holmes et al., 2020).

Table 3

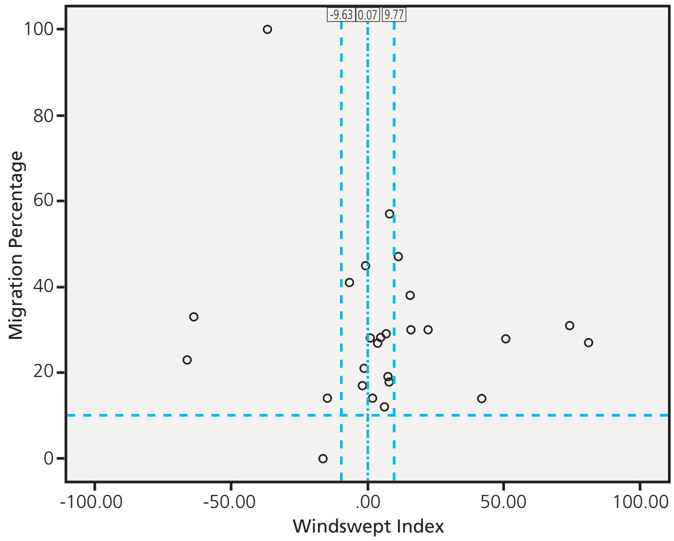
Correlations between Goldsmith Indices of Body Symmetry and Radiographic Data

Variable	Pearson's *r*	*p*
Cobb angle and chest right left ratio	0.13	0.580
Left MP and left external rotation/abduction	–0.09	0.620
Right MP and right external rotation/abduction	–0.19	0.330
MP and Windswept Index	–0.23	0.240
Right MCPHCS and right external rotation/abduction	–0.25	0.200
Left MCPHCS and left external rotation/abduction	–0.19	0.350

Note. MCPHCS = Melbourne Cerebral Palsy Hip Classification Scale; MP = migration percentage.

Figure 4

Scatter Plot Depicting the Relationship Between the Windswept Index and the Highest Migration Percentage

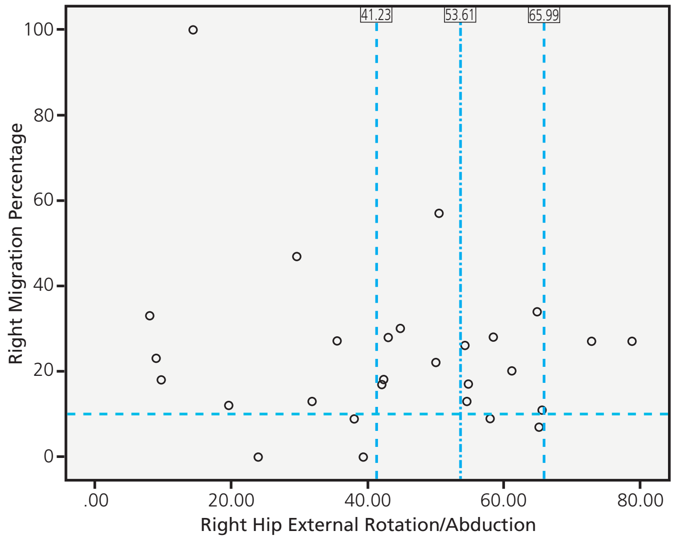


Note. The vertical dotted lines represent the mean ± 2 SD. The horizontal dots represent 10° migration percentage.

Figure 4 depicts the relationship between the Windswept Index and the highest MP. It illustrates that 28 of 29 participants had an MP of concern (MP ≥ 10°), yet only 12 participants had a Windswept Index of concern (outside 2 SD of control data).

Figure 5

Scatter Plot Depicting the Relationship Between the Right Migration Percentage and Right Hip External Rotation/Abduction

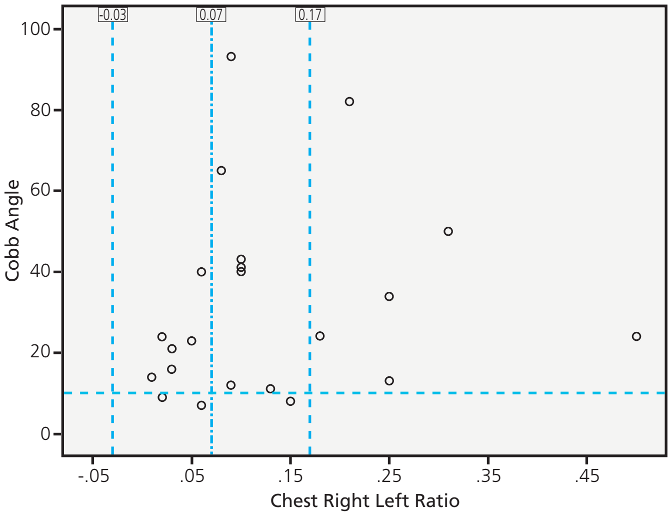


Note. The vertical dotted lines represent the mean ± 2 SD. The horizontal dots represent 10°migration percentage.

Figure 5 depicts the relationship between right MP and right hip external rotation/abduction. It illustrates that 23 of 28 participants had a right MP of concern (MP ≥ 10°), yet only 10 of these also had a hip range of concern (outside 2 SD of control data).

Figure 6

Scatter Plot Depicting the Relationship Between the Highest Cobb Angle and Chest Right Left Ratio



Note. The vertical dotted lines represent the mean ± 2 SD. The horizontal dots represent 10° Cobb angle.

Figure 6 depicts the relationship between the highest Cobb angle and the chest right left ratio. It illustrates that while 19 participants had a Cobb angle of concern (≥10°) only six also had a chest right left ratio of concern (outside 2 SD of normative data).

DISCUSSION

This study is the first to explore relationships between an anthropometric measurement tool (GIofBS) for thoracic shape and symmetry, pelvis, and hips, and similar radiographic measures in a sample of non-ambulant young adults with CP attending a large metropolitan healthcare service. As found in a previous study (Holmes et al., 2018), the incidence of hip displacement and scoliosis was high, with 19 of 22 participants demonstrating a scoliosis ≥ 10° and 48 hips demonstrating an MP ≥ 10°. All correlations between paired GIofBS variables and radiograph outcomes were small and not significant, suggesting that these tools measure two different constructs.

The study findings highlighted that measures of the Windswept Index alone (using the GIofBS) cannot be used to predict the presence or absence of hip displacement (MP). Similarly, hip MP is not related to hip mobility range in this cohort, as those with higher MP values demonstrated hip range values both higher and lower than hip external rotation/abduction range observed in control comparisons. The radiographic MCPHCS also bore minimal relationship to anthropometric constructs as measured with the GIofBS. Previous studies have also found that physical examination of joint range of motion via goniometry cannot replace information gleaned from radiographs in children with CP (Hägglund et al., 2007; Pruszczynski et al., 2016; Soo et al., 2006), as physical examination of hip range in a paediatric study was a poor indicator of risk of hip displacement (Hägglund et al., 2007). In this study, excess hip movement range was typically unilateral, associated with windswept hips and fixed postural deformity, often of an extreme nature in most participants. It is therefore not surprising that the MCPHCS and the GIofBS hip external rotation/abduction showed little relationship considering the MCPHCS is used to describe hip morphology as opposed to the GIofBS measure of hip mobility (GIofBS hip external rotation/abduction).

GIofBS measures of chest asymmetry (rotation) in this study also showed little correlation with radiographic measures of Cobb angles, suggesting the GlofBS is measuring a different spinal construct. Only six of 22 participants demonstrated both clinically significant Cobb angles (scoliosis) and extreme chest asymmetry. Previous studies exploring parameters correlated with the Cobb angle have demonstrated varying results (Sato et al., 2016; Suzuki et al., 1993), possibly indicative of the complex nature of the thoracic cage deformity. For example, three-dimensional aspects of scoliosis involving lateral deviation and spinal rotation measured with ultrasound were found to have only a small (but significant) correlation to the Cobb angle in a cohort of 11 children with CP (Suzuki et al., 1993). Frequent documentation of the three-dimensional nature of the rotational postural deformity of the thoracic cage will thus require additional clinical tools beyond radiographs and ultrasound, such as the GIofBS, to provide a comprehensive understanding of the stability of the thoracic asymmetry and any responsiveness to interventions.

A recent scoping review on postural asymmetry in adults with CP noted that non-standardisation of radiographic positioning is common in this population (Holmes et al., 2018). The Australian Hip Surveillance Guidelines for Children with Cerebral Palsy (Wynter et al., 2014) recommend a standardised position for AP pelvis radiographs (supine with neutral pelvic tilt, and neutral hip rotation and abduction), yet this is not always achievable. As noted in this study, the feasibility of obtaining a standardised position for imaging is often compromised in the complex adult CP population due to contracture, and cognitive and movement disorder challenges. In this study, the spinal radiograph positioning was variable with supine recorded for nine and sitting recorded for 13 participants. The Cobb angles from five spinal radiographs were unable to be measured at all, and five were noted to be challenging to accurately measure because of image quality issues. Positioning of participants for AP pelvis radiographs was similarly variable, decreasing validity of an MP measurement on some radiographs. A valid MP measurement was unable to be obtained at all for either hip for two of the participants due to significant windswept positioning for one and wide hip abduction positioning (“frog leg” image) for another. Error may occur in radiographs due to positioning error and/or measurement error (Schmid et al., 2016), with measurement error +/- 5% for MP measurement (Schmid et al., 2016) and 4% to 8 % for Cobb angle measurement (Gstoettner et al., 2007). The positioning error is largely unknown, with suggestions that it may be up to 30% (Schmid et al., 2016). Mandatory recording of variance from the standard radiographic position for hip surveillance and spinal monitoring would facilitate greater accuracy in ongoing management of adults with CP, as the required quality and accuracy of radiographs for standardised and accurate measurement is not always possible in this population. An additional measurement tool with established reliability (Holmes et al., 2020), such as the GIofBS, would be of value.

A greater understanding of the observed rotary postural elements of the spine and hip/pelvis can be gleaned with the addition of the GIofBS to appropriate radiographic studies where feasible, adding to optimal functional management of non-ambulant adults with CP. This enables treating therapists to regularly monitor effectiveness of non-surgical interventions, such as tailored sleep systems (Public Health England, 2018). There is also the potential to use the GIofBS to monitor postural asymmetry in other populations with significant neuromuscular dysfunction, such as muscular dystrophy or multiple sclerosis. However, measurement of asymmetry of the spine, hips, and pelvis remains particularly challenging for those patients with severe cognitive or extreme movement disorders who may not tolerate either radiographs or bedside measurement using GIofBS. Further research is required in this area to explore the potential for digital photography monitoring or shape capture methods, such as three-dimensional laser scanning systems for fabrication of customised seating systems (Tasker et al., 2011) or dual energy x-ray absorptiometry, commonly used in athletic populations (Nana et al., 2016) and for those with eating disorders (Stewart et al., 2012) to track changes in body composition. Biomedical imaging, despite its many diagnostic, prognostic, and therapeutic applications (Farahani et al., 2017), remains unexplored in the measurement of postural asymmetry.

With the recent introduction of the National Disability Insurance Agency (National Disability Insurance Agency, 2019) in Australia enabling funding for those with significant and permanent disability, the rigour of assessment and efficacy of interventions is paramount. Clinicians who have previously had little experience managing adults with CP are now providing much needed therapeutic interventions to this population. Study findings will provide a greater understanding of the impact of postural asymmetry and clinical measurement in non-ambulant adults with CP, thus guiding interventions. Clinician knowledge of the lifespan care requirements is of extreme importance, ensuring adults with CP receive the best possible healthcare outcomes.

Limitations

A limitation of this study was a reliance on radiographs taken within one year of the GIofBS measurement, which assumes postural stability within the year or a very slow rate of change. However, given the often > 20-year history of abnormal forces impacting on postural symmetry in the cohort, we would argue a one-year timeframe was justified. The recently published National Institute for Health and Care Excellence (NICE) guidance on the management of adults with CP recognises the requirement for regular assessment, including the posture of adults with CP (Bromham et al., 2019). It has been well established that musculoskeletal complications are progressive (Tosi et al., 2009), yet due to a dearth of longitudinal studies, the rate of change is unknown. Until longitudinal evidence regarding the rate of change can be established, annual reviews as recommended by hip surveillance and NICE guidelines should be considered (Bromham et al., 2019; Wynter et al., 2014). It is for these reasons that a 12-month period between GIofBS measures and radiographs was considered appropriate.

Another limitation was the relatively high number of radiographs that were unable to be accurately read. This meant that missing data were evident for 17% (spine) and 10% (hips) of the cohort, which may have influenced the interpretation of the relationship between radiographic and anthropometric data.

Figure 3 highlights that radiographs alone may not be adequate to document posture due to adults with complex disabilities and contractures being unable to achieve standardised positioning, variation in participant's position for radiographs, and potentially variation of expertise and knowledge amongst radiographers in attempting to obtain standardised alignment for valid and reliable measurements. As previously indicated, strategies for optimising the documented start position in radiographs in this population may enhance future radiographic quality and interpretation.

Participants in this study were non-ambulant adults with CP (GMFCS levels IV and V), managed by a specialist multidisciplinary team for complex medical issues and co-morbidities, and findings may not be representative of those with less severe postural asymmetry (GMFCS Levels I–III).

Effective management of posture in non-ambulant adults with CP is extremely challenging due to the combination of skeletal, muscular, and soft tissue distortion over a lifetime. Further, elements contributing to complex three-dimensional postural asymmetry of the thoracic cage, spine, pelvis, and hips, frequently encountered in adults with severe CP are difficult to quantify by standard two-dimensional methods, such as radiographs, alone.

Use of the GIofBS highlights the nature of postural asymmetry complementary to that obtained by radiographs, and may be useful in guiding interventions while ensuring relevant objectivity of clinical assessment is met for this challenging and complex group of adults. Inclusion of both radiographs and GIofBS could facilitate comprehensive clinical assessment for lifetime postural care of non-ambulant adults with CP.

CONCLUSION

This study showed there was minimal to no relationship between GIofBS measures and radiographic data for similar body areas in clinical measurement posture metrics in non-ambulant adults with CP.

KEY POINTS

1. Non-ambulant adults with cerebral palsy (CP) are commonly affected by progressive secondary musculoskeletal issues which are challenging to manage.
2. The three-dimensional rotary nature of postural asymmetry is difficult to quantify by radiographs alone.
3. Postural asymmetry of the chest, pelvis, and windswept hips is objectively measured using Goldsmith Indices of Body Symmetry (GIofBS).
4. Use of radiographs and GIofBS facilitates lifespan care of non-ambulant adults with CP.

DISCLOSURES

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

PERMISSIONS

Ethical approval was gained from St. Vincent's Hospital, Melbourne, Human Research Ethics Committee (HREC/16/SVHM/148). All participants (or their next of kin) provided informed consent.

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An Evidence-Informed Model of Care for People with Lower Limb Osteoarthritis in New Zealand

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ABSTRACT

Osteoarthritis (OA) is a prevalent and costly condition. Evidence-based clinical guidelines recommend three core treatments for OA: education, exercise, and weight loss (as appropriate). However, the translation of evidence into practice is limited. Clinical guidelines do not provide information on how to implement recommendations in local care settings. In New Zealand, management of people with OA in primary care is inconsistent and fragmented. Clinicians and researchers have made a call for a New Zealand OA model of care to close this evidence-practice gap and optimise primary care OA management nationwide. A model of care is a condition-specific implementation strategy that outlines what care should be funded and delivered, who should provide it, and where and how care should be addressed. Various models of care for OA have been implemented with promising results in Australia, the United Kingdom (UK) and Europe. One programme that is translating guidelines into practice is the Model OsteoArthritis Consultation (MOAC). Empirical evaluations of the MOAC in the UK and Europe have demonstrated greater delivery of core treatments, better service quality, and improved patient outcomes. This article makes a case for piloting the MOAC in New Zealand as an implementation strategy to optimise primary care management of OA.

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Key Words: Osteoarthritis, Model of Care, New Zealand

BACKGROUND: THE CURRENT IMPACT OF OSTEOARTHRITIS IN NEW ZEALAND

Osteoarthritis (OA) is a common musculoskeletal disorder that affects 303.1 million people globally, accounting for 9.6 million years lost due to disability (James et al., 2018). In New Zealand, approximately 10% (386,000) of adults live with OA (Ministry of Health, 2017). Population ageing means the prevalence of OA in New Zealand is expected to rise to 12.7% by 2040 (Arthritis New Zealand, 2018). OA is associated with considerable cost to the economy. It was estimated that arthritis (of which OA is the most common form) cost New Zealand $12.2 billion in 2018, including $7.9 billion in lost well-being, $3.3 billion in lost productivity, and $993 million in health sector costs

(Arthritis New Zealand, 2018). Furthermore, the healthcare costs of knee OA in New Zealand are projected to increase from $199 million in 2013 to $370 million in 2038 (Wilson & Abbott, 2019). Total hip joint replacements and total knee joint replacements for OA are increasing throughout the developed world, including in New Zealand. By 2026, the number of total hip joint replacements and knee joint replacements performed per year in New Zealand is predicted to increase by 84% and 183%, respectively (Hooper et al., 2014). These are concerning projections considering the high cost of such surgeries. Furthermore, this growing cost highlights the importance of exhausting all non-surgical treatment approaches (i.e., education, exercise, and weight loss) to improve outcomes and potentially reduce the need for surgery (Allen, Bongiorni, et al., 2016).

EVIDENCE–PRACTICE GAP

Various international evidence-based guidelines exist to inform the management of OA. For example, the National Institute for Health and Care Excellence (NICE) guideline for OA care and management was developed based on the best available evidence and consultation with key stakeholders (National Institute for Health and Care Excellence [NICE], 2021). The NICE standards recommend that treatment emphasises self-management and is progressive depending on the person's needs, and that all people with OA should receive three core treatments: education, exercise, and weight loss interventions (as appropriate) (Table 1) (NICE, 2021).

Table 1

National Institute for Health and Clinical Excellence Recommendations for Osteoarthritis Treatment

Core osteoarthritis treatment recommendations for all individuals	Access to appropriate information (verbal and written). Enhance understanding of the condition and its management. Counter misconceptions (e.g., inevitable progression, un-treatable condition). Ensure information sharing is ongoing rather than a single event.
	Offer advice on activity and exercise. Advice to exercise as a core treatment irrespective of age, comorbidity, pain severity, or disability. Should include local muscle strengthening AND general aerobic fitness.
	Interventions to achieve weight loss if the person is overweight or obese. Clinic should offer interventions to achieve weight loss as a core treatment.
Education and self-management	Agree on individualised self-management strategies with the person with osteoarthritis. Ensure self-management programmes emphasise recommended core treatments.
Referral for consideration of joint surgery	Referring clinicians should ensure the individual has at least been offered the core non-surgical treatment options before referral for surgical consideration. Base decision of referral thresholds on discussions among patient, clinicians, and surgeons. Refer for consideration of joint surgery before prolonged and established functional limitation and severe pain occurs.
Follow-up and review	Offer regular review to all people with symptomatic osteoarthritis. Monitor symptoms and the impact on everyday activities and quality of life. Discuss the person's knowledge of osteoarthritis, and their concerns and preferences. Review the effectiveness and tolerability of all treatments. Support for self-management.

Note. Recommendations adapted from Conaghan et al. (2008).

Despite the robust evidence upon which these guidelines are based, research shows a gap between guideline recommendations and the clinical management of OA, both in New Zealand and internationally (Abbott et al., 2019; Brand et al., 2011; Poitras et al., 2010). In New Zealand, most people with OA first consult their general practitioner (GP) regarding their condition. However, research suggests that recommended treatments following this initial GP visit are inconsistent (Jolly et al., 2017; Larmer et al., 2019). Evidence from the United Kingdom (UK) and Europe also demonstrates limited uptake of clinical guidelines in practice, especially guidelines concerning non-surgical and non-pharmacological treatments for OA (Healey et al., 2018; Porcheret et al., 2013). In light of this evidence-practice gap, a paradigm shift is needed to optimise non-pharmacological management and delay (or avoid) surgical intervention (Allen, Bongiorni, et al., 2016; Hunter, 2011, 2017).

ASSESSMENT OF THE PROBLEM: DOES NEW ZEALAND NEED A MODEL OF CARE FOR OA?

In New Zealand, management of OA in primary care is fragmented, and no clear implementation strategy exists to translate guidelines into clinical practice (Baldwin et al., 2017; Jolly et al., 2017; Reid et al., 2014). Community Health Pathways is a New Zealand online resource available primarily to

GPs to plan patient care (Goddard-Nash et al., 2020; McGeoch et al., 2015). Still, it is unclear to what extent these pathways influence clinical practice. A call has been made by primary care clinicians and researchers for the development of a New Zealand model of care for OA (Baldwin et al., 2017). A model of care is a condition-specific management pathway that aims to close the gap between guideline recommendations and clinical management (Briggs et al., 2016). A critical limitation of clinical practice guidelines is that they fail to provide information on implementing valuable evidence-based recommendations in clinical practice. A model of care addresses *what* care should be delivered, *who* should deliver it, *where* it should be delivered, and *how* it should be delivered (Allen, Bongiorni, et al., 2016).

New Zealand has a unique funding arrangement involving the Accident Compensation Corporation/Te Kaporeihana āwhina Hunga Whara (ACC) that only covers accident-induced injuries. ACC also provides significant funding for the care of New Zealanders with accident-induced injuries (Accident Compensation Corporation/Te Kaporeihana āwhina Hunga Whara, 2020). Still, it presents a challenge for managing chronic conditions such as OA, as care for these conditions is not typically covered by ACC, as often they do not meet the funding criteria of being caused by an accident. Between 2015 and 2019, the New Zealand Ministry of Health established the Mobility Action Programme (MAP), with the specific purpose of developing clinical services for people living with chronic musculoskeletal conditions (Ministry of Health, 2019). The MAP was designed to fund a range of community-based, multidisciplinary programmes aimed at improving primary care management of musculoskeletal conditions. The broader aim of the MAP was to identify service delivery models that provide the greatest benefits for people with musculoskeletal disorders, while also providing value for money in terms of resources invested (Ministry of Health, 2019). Anecdotally, the MAP has supported several successful projects, but the final project analysis report is yet to be released by the Ministry of Health.

LOOKING INTERNATIONALLY FOR AN OA MODEL OF CARE FOR NEW ZEALAND

Models of care for OA have been implemented in the UK, Europe, and Australia, hence it is appropriate to examine these international examples when considering what a New Zealand OA model of care could look like (Allen, Choong, et al., 2016; Briggs et al., 2014; Dziedzic et al., 2018). The Model OsteoArthritis Consultation (MOAC) is an example of an implementation strategy applied and robustly evaluated in the UK, delivering promising preliminary results (Quicke et al., 2019). The MOAC aims to achieve the core recommendations from the NICE guidelines in primary care. The programme focuses on supporting self-management for people with OA, with enhanced linkages among health professionals involved in delivering care. Figure 1 presents an example of a MOAC-based clinical pathway for a person with OA.

Several large projects across the UK and Europe have evaluated the effectiveness of the MOAC in terms of OA outcomes and the uptake of the NICE core recommendations (Figure 2) (Keele University, n.d.). In these projects, elements of the MOAC were adapted to the local context; namely, the healthcare professionals involved in delivering the service, the setting, service buy-in, and staff availability.

The Managing OSteoArthritis In ConsultationS (MOSAICS) study was a large, robust cluster randomised controlled trial conducted in the UK (Dziedzic et al., 2018). The trial involved 525 participants with OA across eight general practices. In the MOSAICS study, implementation of the MOAC followed several key steps that promoted the core treatments outlined in the NICE guidelines (Dziedzic et al., 2018). In particular, the MOSAICS study used four care innovations:

- the MOAC (Figure 1);
- an OA guidebook (co-designed with patients and the public);
- recording OA care quality in an electronic medical records template matched against the NICE guidelines;
- training for healthcare staff (GPs, practice nurses, and physiotherapists).

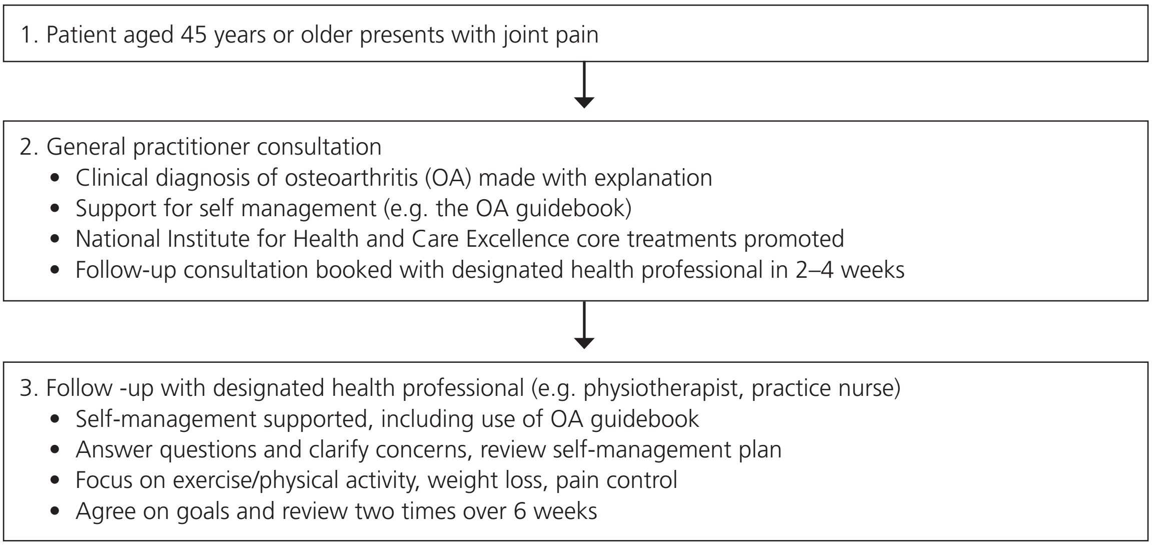
In addition to the MOSAICS study, the MOAC was recently implemented and evaluated in two further studies: the Joint Implementation of Osteoarthritis Guidelines in the West Midlands (JIGSAW) in the UK, and a European version (JIGSAW-E), which is being piloted across Western Europe (Keele University, n.d.). The JIGSAW-E study involved the systematic implementation of previously tested innovations from the JIGSAW project in five European regions (the UK, the Netherlands, Norway, Denmark, and Portugal). The JIGSAW and JIGSAW-E studies adopted the same MOAC principles, emphasising self-management and integrated primary care. For example, the JIGSAW and JIGSAW-E projects indicated care could be delivered by a GP and practice nurse, or by other staff (e.g., physiotherapists, healthy lifestyle advisors, or pharmacists) working alongside GPs. The JIGSAW and JIGSAW-E projects also demonstrated that the fundamental MOAC principles could be pragmatically and flexibly implemented in different healthcare settings to improve care quality for people with OA.

Evaluation of the MOAC in the MOSAICS, JIGSAW and JIGSAW-E studies has yielded promising results. Implementation of the MOAC increased the delivery of core treatments recommended in the NICE guidelines; namely, increased written and verbal information on OA and advice regarding exercise, as well as greater prescription of strengthening exercises (Dziedzic et al., 2018; Healey et al., 2018; Porcheret et al., 2018). The MOAC also led to an increase in the diagnosis of "OA" rather than "joint pain", more frequent recording of a patient's weight, an increased number of physiotherapy referrals, a decrease in the reliance on radiographs for assessment and diagnosis, and a reduction in the use of oral nonsteroidal anti-inflammatory drugs and walking aids by people with OA (Jordan et al., 2017).

Qualitative assessment of the MOAC showed that it was considered acceptable by GPs, nurses, and people with OA (Morden et al., 2014; Porcheret et al., 2018). GP attendance at MOAC training workshops resulted in improved consulting behaviour and a self-reported shift in the perception of OA from being an untreatable condition to one where effective conservative treatments are available (Morden et al., 2015;

Figure 1

Example Patient Pathway Based on the Model OsteoArthritis Consultation



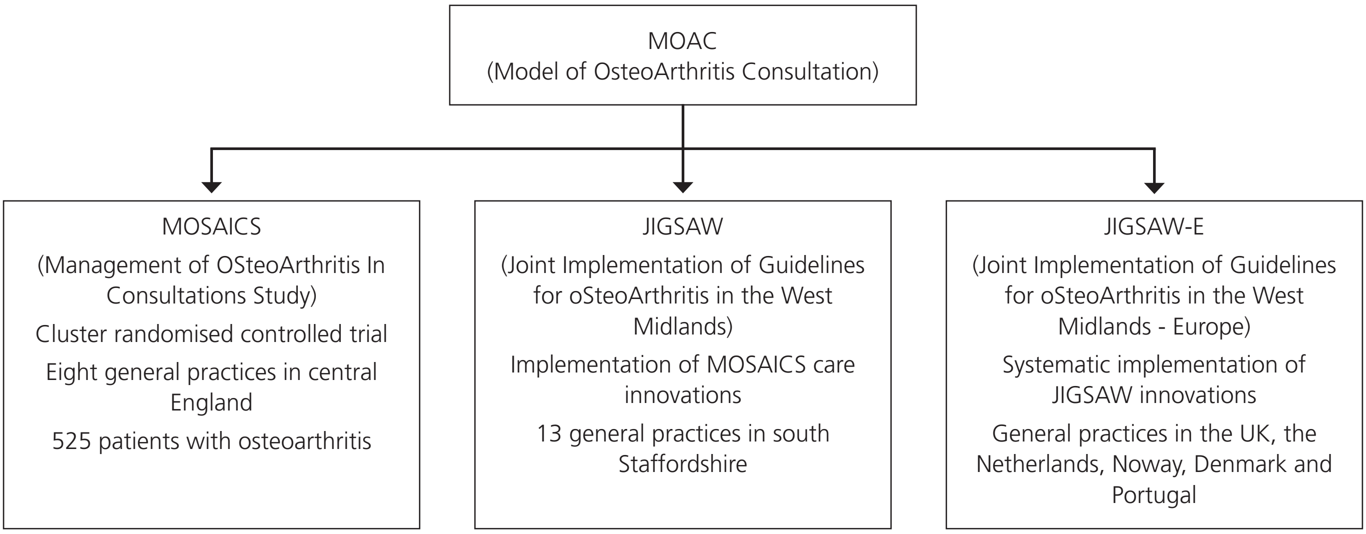
1. Patient aged 45 years or older presents with joint pain

2. General practitioner consultation
   - Clinical diagnosis of osteoarthritis (OA) made with explanation
   - Support for self management (e.g. the OA guidebook)
   - National Institute for Health and Care Excellence core treatments promoted
   - Follow-up consultation booked with designated health professional in 2–4 weeks

3. Follow -up with designated health professional (e.g. physiotherapist, practice nurse)
   - Self-management supported, including use of OA guidebook
   - Answer questions and clarify concerns, review self-management plan
   - Focus on exercise/physical activity, weight loss, pain control
   - Agree on goals and review two times over 6 weeks

Figure 2

Linked Series of Projects from Initial Research Through Local Implementation of Innovations to International Pilots



MOAC
(Model of OsteoArthritis Consultation)

MOSAICS
(Management of OSteoArthritis In Consultations Study)
Cluster randomised controlled trial
Eight general practices in central England
525 patients with osteoarthritis

JIGSAW
(Joint Implementation of Guidelines for oSteoArthritis in the West Midlands)
Implementation of MOSAICS care innovations
13 general practices in south Staffordshire

JIGSAW-E
(Joint Implementation of Guidelines for oSteoArthritis in the West Midlands - Europe)
Systematic implementation of JIGSAW innovations
General practices in the UK, the Netherlands, Noway, Denmark and Portugal

Porcheret et al., 2018). Furthermore, GPs believed that closing a consultation with the "OA booklet" and referral to a health professional led to improved patient satisfaction (Morden et al., 2014). Nurses' adherence to the NICE guidelines was also improved after the MOAC training, with nurses reporting increased confidence in managing people with OA and less need to refer back to the GP (Morden et al., 2015). People with OA reported having a clearer understanding of the cause, prognosis, and treatment of OA, and appreciation for receiving personalised advice (Morden et al., 2014). Additionally, they reported feeling that their condition was "legitimised" (Morden et al., 2014). Overall, GPs, nurses, and people with OA reported an improved ability to manage the condition (Morden et al., 2014).

COULD THE MOAC IMPROVE PRIMARY CARE MANAGEMENT OF OA IN NEW ZEALAND?

Given that the healthcare systems in New Zealand and the UK share some similarities (e.g., most primary care is GP based, and much of the secondary and tertiary care is publicly funded and hospital based), the successful implementation of the MOAC in the UK suggests there is scope to pilot the MOAC in New Zealand. Like the UK, people with OA in New Zealand tend to present to GP clinics as their primary management providers (Jolly et al., 2017, Larmer et al., 2019). This implementation strategy would likely facilitate shared care for OA between GPs and other primary care professionals, consistent with clinical guidelines that recommend an inter-professional management approach for OA. Implementation of the MOAC in New Zealand, focusing on the core treatments (education, exercise, and weight loss) delivered through primary care could alleviate the pressure on secondary and tertiary care by preventing or delaying the need for joint replacement surgery. However, formal evaluation of the cost-effectiveness of the MOAC is necessary.

NEXT STEPS

Based on the evidence reviewed, it seems feasible that the MOAC could be implemented in New Zealand, following in the footsteps of the MOSAICS, JIGSAW, and JIGSAW-E projects. The next step would be to pilot a MOAC programme in New Zealand. Implementation of a pilot MOAC in New Zealand would need to align with the 2016 Health Strategy, involve key stakeholders, and consider local structures and resources (Ministry of Health, 2016). In each country where the MOAC has been piloted, the programme has been adapted to match the needs of the population and health context. Should the MOAC be piloted in New Zealand, a similar adaptation process would be needed to ensure that it is culturally responsive and reduces the inequity of care for people living with OA. This adaption process would require significant, meaningful input from key stakeholders, such as (but not limited to) iwi, Arthritis New Zealand, Primary Health Organisations, District Health Boards, the New Zealand College of GPs, and Physiotherapy New Zealand. Ongoing data collection and evaluation would need to be embedded in the design of a pilot MOAC to clarify improvements in service quality. However, a framework already exists that can be used to critically evaluate outcomes from the model of care (Briggs et al., 2016). This process should include a patient reported outcome measure capturing the quality of care for OA in accordance with clinical guidelines (Østerås et al., 2013). If the pilot was successful, specific policy would be needed to support the scale up of the MOAC (Allen, Choong, et al., 2016).

Physiotherapists are ideally placed to lead the implementation of a pilot MOAC in New Zealand. Physiotherapists can manage many people with musculoskeletal conditions in the primary care setting, and patients have high confidence in information, assessment and management provided by physiotherapists (Desmeules et al., 2012; Ludvigsson & Enthoven, 2012). Physiotherapy-led OA programmes have resulted in improved patient outcomes (in terms of pain, function, and weight loss) as well as reducing the need for GP visits and the demand for joint replacement surgery (Claes et al., 2015; Deslauriers et al., 2017; Dziedzic et al., 2018; Hay et al., 2006; Ludvigsson & Enthoven, 2012; Svege et al., 2015; Teoh et al., 2017). Currently, physiotherapists in Australia and Sweden are involved as primary care leaders in models of care for people with OA (Hunter et al., 2018; Jönsson et al., 2019). Similarly, physiotherapists in New Zealand could work closely with GPs as part of a multidisciplinary team to coordinate and improve care for people with OA.

KEY POINTS

What is already known?

1. Osteoarthritis (OA) is a prevalent and costly condition.
2. In New Zealand, management of OA in primary care is fragmented and no clear implementation strategy exists that translates guidelines into clinical practice.

What this paper adds

3. This article makes a case for piloting the Model OsteoArthritis Consultation in New Zealand as an implementation strategy to optimise primary care management of OA.

DISCLOSURES

No funding was received. There are no conflicts of interest which may be perceived to interfere with or bias this study.

PERMISSIONS

None.

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Social and Technical Readiness for a Telehealth Assessment Service for Adults With Complex Wheelchair and Seating Needs: A National Survey of Stakeholders

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ABSTRACT

Wheelchairs can significantly improve quality of life for those who need them, yet access to physiotherapists or occupational therapists specialising in wheelchair and seating assessment can be difficult, especially for Māori. This paper reports on a national online survey that was undertaken as phase 1 of a mixed methods study of key stakeholders of the perceived social and technical requirements of a telehealth wheelchair assessment service for people with complex mobility needs. Key stakeholders included wheelchair users and their families, specialist and non-specialist assessors, technicians, and service managers. Responses (n = 114) indicated perceived shortcomings with current in-person assessment. Telehealth assessment was anticipated to improve service quality, particularly the timeliness of services (52/92, 57%) and prioritisation of the urgency of assessment (71/92, 77%). Preferences were for use of existing software rather than bespoke systems. Training in conducting assessment via telehealth was considered essential by most assessors (29/41, 71%). Internet connectivity was in place for most wheelchair users (43/47, 92%) but was inadequate for 29% (14/49) of assessors (pre-COVID-19). Māori wheelchair users largely had infrastructure in place for telehealth assessment (10/11, 91%) and held positive expectations of it. Telehealth wheelchair and seating assessment is anticipated to improve the quality of care for wheelchair users with complex needs. Upgraded technical capability of public health services and robust training in conducting assessment via telehealth will be critical to successful uptake of this service. Specific needs for Māori wheelchair users warrant further investigation.

Graham, F., Boland, P., Wallace, S., Taylor, W. J., Jones, B., Maggo, J. & Grainger, R. (2021). Social and technical readiness for a telehealth assessment service for adults with complex wheelchair and seating needs: A national survey of stakeholders. *New Zealand Journal of Physiotherapy, 49*(1), 31–39. https://doi.org/10.15619/NZJP/49.1.05

Key Words: Indigenous Peoples, New Zealand, Seating, Telerehabilitation, Wheelchairs

INTRODUCTION

Wheelchairs are one of the most used and highly valued assistive devices for people who require them for personal mobility (Boland et al., 2018), and with mobility a central concern of physiotherapists (Wikström-Grotell & Eriksson, 2012). Well-designed and carefully fitted wheelchairs and integrated seating systems are often essential for inclusion and participation in society for people with mobility-related disabilities (World Health Organization, 2008). Wheelchairs can rapidly enable a person to achieve their mobility goals, maintain employment (Minis et al., 2014), and alleviate pain (Hunt et al., 2016). Yet, despite this, the disability community reports widespread unmet needs for adaptive equipment, including wheelchairs, both internationally (World Health Organization, 2020) and within New Zealand, where unmet need is substantially higher for Māori compared to non-Māori (Health Quality and Safety Commission, 2019).

Wheelchair and seating provision is publicly funded in New Zealand through either the Ministry of Health (MOH) or the Accident Compensation Corporation (ACC) for accident-related wheelchair needs. ACC is a compulsory national insurance scheme administered by the New Zealand Government. Criteria for funding and the funding scope differs between these two entities. It is unclear if these differences impact on varying levels of current service satisfaction.

For people with neuromuscular health conditions (NMC), wheelchair and seating assessments are often "complex", given progressive changes in multiple body functions of wheelchair users, and variable physical, social, and economic environments (De Souza & Frank, 2016). NMC include conditions such as muscular dystrophies and motor neuron disease, and traumatic origins, such spinal cord injury. To optimise seating and/or wheelchair configurations, complex wheelchair assessments involve interviewing wheelchair users about their goals; taking accurate measurements of their body position; the evaluation of their home, community and/or work environments; and extensive product knowledge (Borg et al., 2012; Martin et al, 2011; Rousseau-Harrison & Rochette, 2013). Complex wheelchair assessments require the skills of highly specialised assessors (physiotherapists or occupational therapists) with advanced clinical training. Regular, ongoing application of assessment skills is widely recognised as critical to maintaining competence in complex wheelchair assessments, given the complex clinical reasoning required and continually evolving product solutions. Consequently, in New Zealand where both population (5 million) and population density (14:1 km^2) (Stats NZ, 2020) are relatively low, specialist assessors are few and located in urban centres. In New Zealand, complex assessments typically occur in wheelchair users' homes or workplaces, with significant others present, and with a local non-specialist therapist accompanying the remote specialist assessor. Alternatively, wheelchair users travel to regional specialist clinics. Access to specialist assessors is, therefore, a substantial barrier to timely wheelchair assessment for people with complex needs. Travel to specialist clinics is difficult for many people with NMC, given the associated fatigue and expense of travel. A telehealth wheelchair assessment service (TWAS) for people with complex wheelchair and seating needs may provide a more timely and accessible service than in-person services.

TWAS involves the use of technology (e.g., video-conferencing) to connect a wheelchair-user and local non-specialist therapist with a remote specialist assessor. Bespoke and software-as-a-service (SaaS) systems have been proposed previously for TWAS (Graham et al., 2019), varying considerably in cost, functionality, bandwidth and device requirements, data privacy, and security functions. In New Zealand, various SaaS technologies have been used in an ad hoc manner with anecdotal success. TWAS was the exception rather than the rule until non-contact servicing was required to reduce the risk of community transmission of COVID-19, prompting the rapid switch to telehealth solutions. However, there remains no national policy, training, or infrastructure to support safe and widespread use of TWAS, and there is limited international research or sector-specific information on which to robustly plan for such a service.

Our scoping review on the perceptions and use of TWAS and evidence of its effectiveness has identified that studies to date are limited and of low methodological quality (Graham et al., 2019). Findings from non-randomised, case-controlled studies indicate that TWAS can be cost-effective, with clinical outcomes equivalent to in-person assessment by trained assessors (Barlow et al., 2009; Schein, Schmeler, Holm et al., 2010). Satisfaction with TWAS is generally high for wheelchair users (Barlow et al., 2009). Most significantly, TWAS facilitated access to services for wheelchair users when travel to assessment services was not possible (Schein, Schmeler, Saptono et al., 2010). While time efficiencies and some educational advantages have been reported, many therapists are hesitant to adopt TWAS, citing concerns about clinical errors (Atwa et al., 2013; Khoja et al., 2005). It is unclear if this concern reflects a broader anxiety about change to clinical practice when adopting technology or a warranted concern about clinical risk. No studies to date have specifically examined the effect of TWAS for people with complex wheelchair needs, who have the most to gain from appropriate and timely assessment, and specialist equipment provision. Nor have prior studies explored the perspectives of minority and/or indigenous populations, who may have distinct needs.

Constructs, such as health, disability, and participation in society, which are known to vary in meaning between cultures (Bickenbach, 2009; Cram et al., 2003, Washbourn et al., 2016), are critical to a successful match of wheelchair users with wheelchair technology solutions (MacLachlan & Scherer, 2018). Differences in unmet needs for adaptive equipment for Māori compared to non-Māori (Health Quality and Safety Commission, 2019) indicate the reality of these cultural distinctions. Therefore, New Zealand specific research is needed to inform TWAS delivery that is clinically safe, optimised for service efficiency, appropriate for people with complex wheelchair needs, and most importantly, is designed to address health inequities that exist for Māori and people with disabilities.

Change of service delivery has historically often occurred without due consideration of implications and potential unintended consequences (Sligo et al., 2017). Significant changes, like moving from in-person to remote, video-based care, will require careful implementation to ensure success. Social and technical factors (Sittig & Singh, 2010) underpin the success of end user uptake of new technologies. Social factors that influence the adoption of technology include personal, professional and organisational culture. Technical factors include the software and hardware requirements of a system. According to the universal theory of acceptance and use of technology (Venkatesh & Davis, 2000), key social factors that determine the adoption of new technology include perceived ease of use and perceived usefulness (Davis, 1986). Expectations of effort (e.g., to learn a new system), social influences (e.g., perceived competence by peers), and facilitating conditions (i.e., technology functions that enhance ease of use) (Venkatesh et al, 2003) further explain technology uptake and enhance the likelihood of technology adoption when considered and addressed in early design stages. This study sought stakeholders' perceptions of the social (e.g., perceived ease of use and perceived usefulness) and technical facilitating conditions (e.g., hardware, software, and other infrastructural resources), with particular analysis of the culturally specific needs of Māori. To understand the context of these perspectives, stakeholders' satisfaction with the current system was first established. Specifically, the research questions were:

1. How satisfied are stakeholders with current in-person wheelchair and seating services?
2. What are the anticipated social and technical requirements of TWAS from the perspectives of wheelchair users with NMC; specialist and non-specialist assessors; and managers, funders and policy developers?
3. What are the culturally specific perspectives and needs of Māori wheelchair users with NMC of TWAS?

METHODS

Design

A survey method was the first phase of a two-phase convergent (quan-QUAL) mixed methods study (Creswell & Plano Clark, 2011) to determine the socio-technical design requirements for TWAS in New Zealand. Survey methods enabled maximal reach in identifying the socio-technical landscape of stakeholders of TWAS and informing the data collection for a subsequent qualitative study. Ethical approval was obtained from the University of Otago Ethics Committee (Health) (reference number H19/046) alongside locality approval and Māori consultation from each recruitment site. The study was guided by regular discussions with an advisory group comprising Māori, wheelchair users, physiotherapists, allied health students and educators, and technology specialists.

Participants were eligible to be included if they had been involved in complex wheelchair assessment (in-person or via telehealth) within the last 2 years, or were currently involved in the management, funding or design of wheelchair services. This included wheelchair users aged >18 years with NMC (Morrison, 2016); specialist or non-specialist (i.e., local to the wheelchair user) assessors, including technicians and service managers; and carers and significant others if they were present at a complex wheelchair and seating assessment within the last 2 years. Wheelchair users were included if they self-reported a wheelchair as their main means of mobility inside the home. This was used as an indicator of "complexity", on the basis that if people with NMC require a wheelchair for indoor mobility, their wheelchair mobility needs will involve physical, social, and environmental assessment consistent with definitions of "complex" as described in the introduction.

Exclusion criteria

We excluded children and youth <18 years because we felt that they and their families would have a distinctive and different set of needs.

Recruitment

Invitations were distributed electronically to all publicly funded health authorities that approved study participation (13/20), and 11 independent consumer and professional organisations. The sampling frame could not be determined because of privacy concerns from district health boards. The survey was distributed using the REDCap platform (Harris et al., 2009) via a hyperlink in an email to each organisation. Study invitations were then disseminated using the communication systems already in place (i.e., email, social media, and printed newsletters) for each organisation. Māori participation was encouraged by targeting health authorities in regions with high Māori populations.

Instruments

Data collection tools included a survey and, for wheelchair users, the Quebec User Evaluation of Satisfaction with Technology (QUEST) (Demers et al., 2002), discussed below. Survey design was informed by the socio-technical health information technology model (Sittig & Singh, 2010) and the universal theory of acceptance and use of technology model. Questions informed by the socio-technical health information technology model asked respondents about the expected effort involved with and benefit of using TWAS, and social influences on expected uptake (including personal, professional and organisational culture). Survey questions (*n* = 20) also included a Likert rating (e.g., degree of necessity, importance, or confidence), categorical choice (e.g., preferred hardware features), and yes/no questions (e.g., prior use of telehealth), resulting in ordinal and categorical data. The survey was refined through multiple iterations of cognitive interviewing (Willis, 2005) with members of each stakeholder group drawn from co-authors and advisory group members (*n* = 13), including Māori (*n* = 2) and wheelchair users (*n* = 2). Wording was modified slightly for each stakeholder group to reflect the context of their engagement in wheelchair and seating assessment. Demographic questions for all stakeholders included age (years), gender, (male/female/gender diverse), ethnicity (as per New Zealand Census ethnicity options), years of involvement in wheelchair and seating assessment, and a self-identified stakeholder category. Additional questions for consumers related to their health, educational and employment status; and the type of wheelchair they used. Questions which directly addressed the research questions in this study were: the perceived impact of TWAS on quality and efficiency of care, and confidence; training needs (in relation to undertaking TWAS); and the technical (software and hardware) requirements of TWAS. The full survey is available from the corresponding author upon request.

To provide further context to the responses of wheelchair users, the QUEST was embedded within the survey to indicate current wheelchair and service satisfaction. The QUEST is a 12-item self-reported measure of consumer satisfaction with assistive technology (8 items) and services (4 items), indicated on a 5-point Likert scale. The QUEST has been widely validated (Demers et al., 2002) and is considered the gold standard for the measure of assistive technology satisfaction. Service-related questions do not specify the mode of service delivery (in-person or tele-delivered), and thus are applicable to both/either modes.

Data collection and analysis

Survey responses were entered into REDCap by participants (June-September 2019, pre-COVID-19) and analysed using SPSS v25 (IBM Corp, 2013) and R, version 4.0 (R Core Team, 2018) using descriptive statistics. Surveys with one or more responses were included in the analysis, hence specific response numbers (*n*) are reported per question. QUEST findings and questions relating to the impact on care are presented as stacked horizontal bar charts. Categories of less than five participants are reported in text only.

RESULTS

Surveys (*n* = 114) were returned by wheelchair users (*n* = 47); assessors (*n* = 49), comprising occupational therapists (*n* = 39) and physiotherapists (*n* = 10); family members (*n* = 9); technicians (*n* = 6); and service managers (*n* = 3). No funders or policy developers responded. Complete responses were received for 84 surveys. Where an item/question response was incomplete, the denominator may be less than the number of respondents in the stakeholder category.

Most respondents were female (66/90, 73%), identifying as New Zealand European (77/94, 82%), with half aged between 46 and 65 years (51/99, 52%). Responses from Māori (11/94, 12%) reflected less than population proportions of Māori with disability (Stats NZ, 2013) (Table 1). Most Māori participants were wheelchair users (7/11, 64%). Respondents represented all geographic regions of New Zealand. For the 36 wheelchair users who reported their wheelchair funding source, 72% (26/36) were funded by the MOH, 19% (7/36) by ACC, and 8% (3/36) privately.

Education level was high among wheelchair users, with over half (25/47, 53%) having postgraduate or tertiary qualifications. Wheelchair users' general health was high with only 6% (3/47) reporting poor health. Only 28% (13/47) of wheelchair users were in paid employment and 12% (6/47) were able to drive themselves to hospital appointments. Most wheelchair users (31/47, 66%) were less than 60 min drive from their nearest major hospital.

About half of wheelchair users (25/47, 53%) used a powered wheelchair and had used a wheelchair for more than 2 years, indicating significant levels of physical disability and considerable experience with current wheelchair assessment services; 18 wheelchair users had experienced greater than nine assessments.

Just over half of wheelchair users reported being "quite" to "very satisfied" with their current wheelchairs and recent wheelchair services (see QUEST responses in Figure 1). Patterns in satisfaction with wheelchairs and services were similar irrespective of the wheelchair funder or ethnicity of the user. Many wheelchair users reported waiting more than 6 months for their first wheelchair (14/37, 38%), with one in five (8/37, 22%) waiting longer than 12 months. Proportions were similar for reviews of wheelchairs. In contrast, most assessors estimated that the first wheelchairs and reviews were in place within 1 to 6 months (33/41, 81%).

Table 1

Participant Demographics (n = 114)

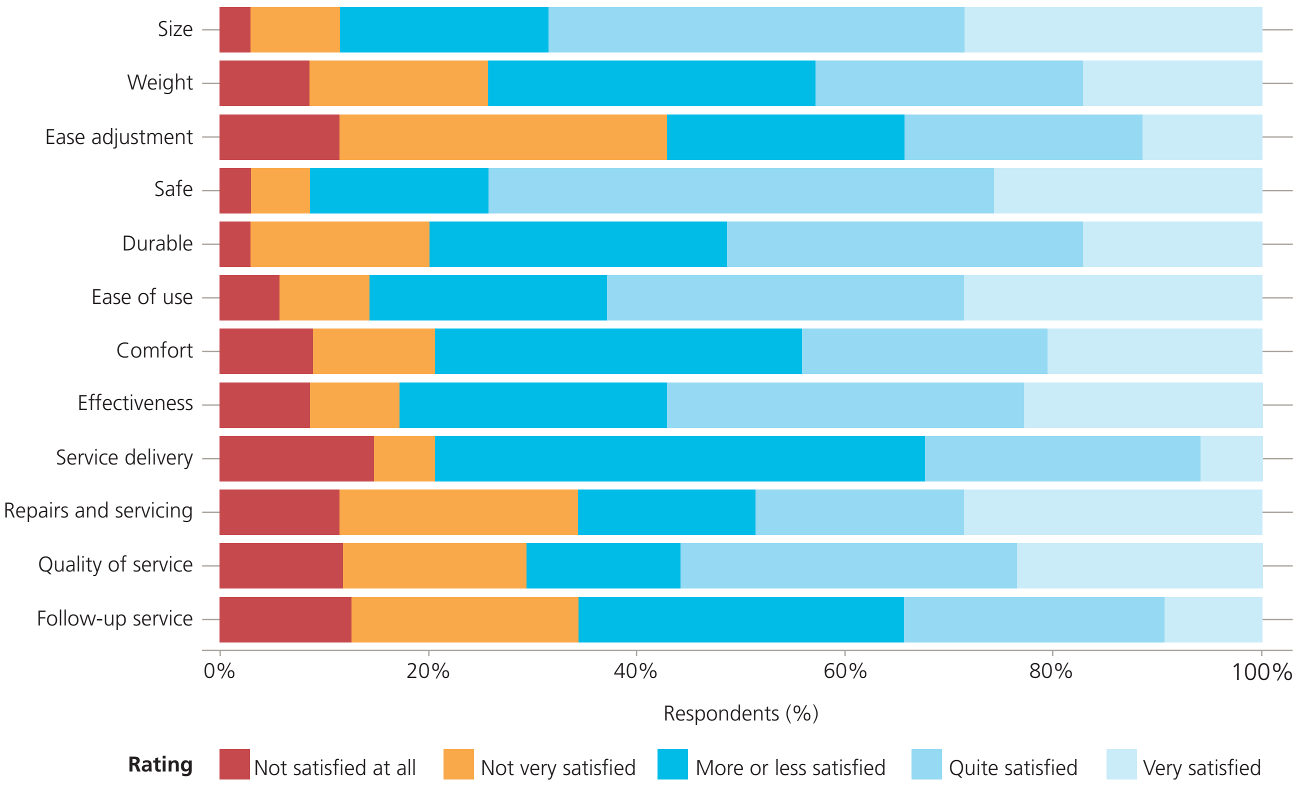
Characteristics	Wheelchair users *n*	Assessors *n*	All *n* (%)
Age (years)	–	–	99 [a]
16–25	4	9	13 (9)
26–35	4	1	6 (6)
36–45	4	4	15 (15)
46–55	11	16	28 (28)
56–65	6	14	23 (23)
> 66	7	5	14 (14)
Gender	–	–	90 [a]
Male	15	1	21 (23)
Female	19	38	66 (73)
Gender diverse	2	1	3 (3)
Ethnicity [b]	–	–	94 [a]
NZE	29	36	77 (82)
Māori	7	2	11 (12)
Pacifica	2	1	3 (3)
Other	1	1	3 (3)
Total	47	49	–

Note. NZE = New Zealand European.

[a] Sample size varies due to missing data from some participants; [b] More than one ethnicity could be selected.

Figure 1

QUEST Items From Wheelchair Users (n = 47)



Positive expectations of TWAS were indicated across all stakeholder groups, and related to reducing the timeframe from a wheelchair user's service request to their needs being met (52/92, 57%), addressing wheelchair user priorities (67/91, 74%), enabling wheelchair user participation in activities and spaces they valued (62/92, 67%), prioritisation of the urgency of assessment (71/92, 77%), and minimising travel time for health professionals (86/92, 94%) and wheelchair users (79/92, 86%) (see Figure 2). The potential of TWAS to support return of unwanted equipment was viewed positively by most wheelchair users (26/37, 70%) and managers (*n* = 2/3), but only a minority of assessors (14/41, 34%). The most positive expectations of TWAS were consistently from wheelchair users, with perceived negative impacts reported by less than five participant responses across all areas and stakeholders. While acknowledging the small and unequal sample size for Māori, non-Māori wheelchair users tended to have a somewhat more optimistic perception of the impact of telehealth assessment compared to Māori for most (5/9) aspects of care.

Confidence in the ability to learn to use TWAS was high and evenly spread across stakeholders (including Māori and non-Māori), with 88% (80/91) of respondents indicating moderate to high levels of confidence. In contrast, stakeholders varied in their belief in the need for training in a TWAS system, with over 70% (29/41) of assessors indicating training was very necessary, compared to only 22% (8/37) of wheelchair users.

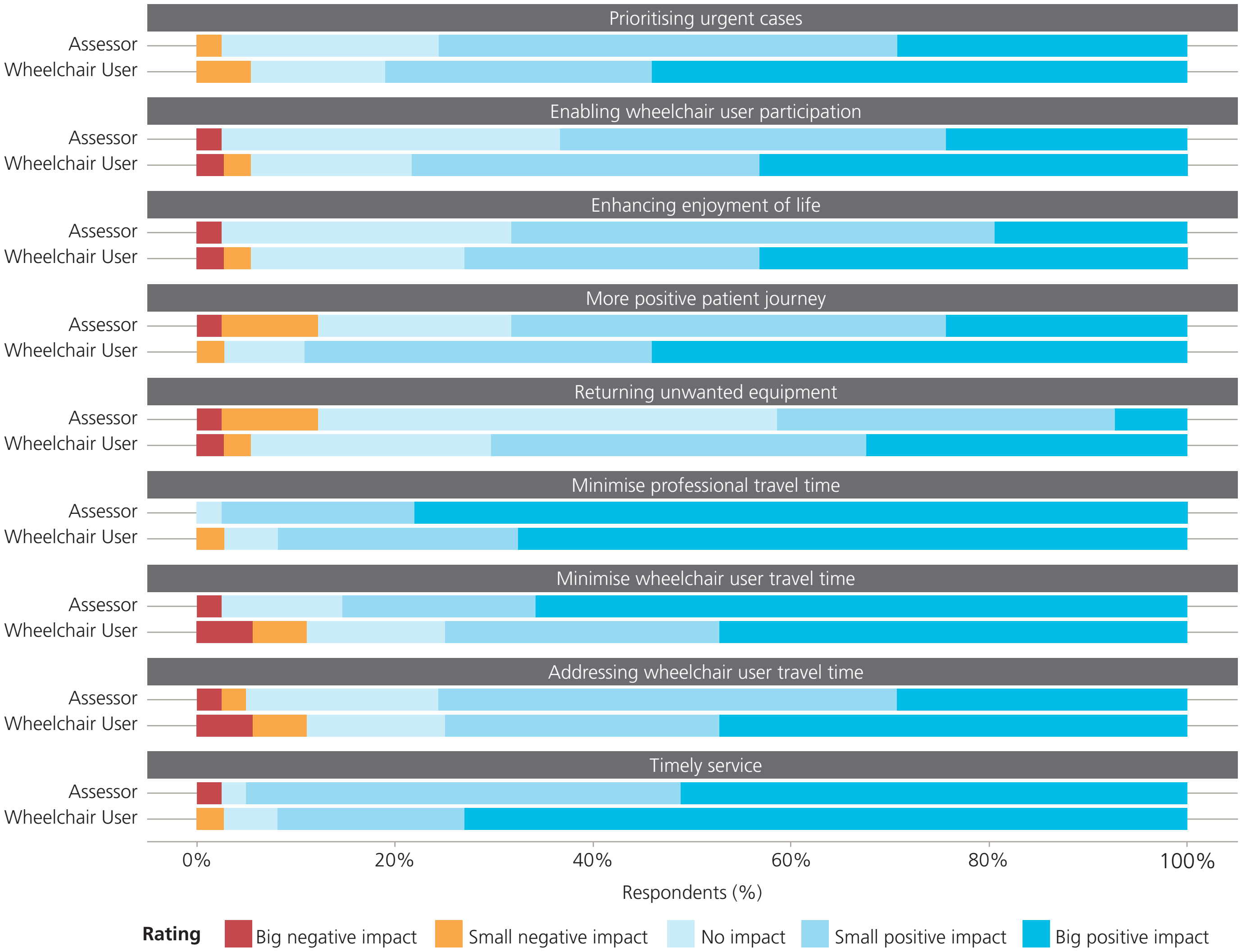
Internet access in the location TWAS was anticipated to occur was in place for only 57% (54/95) of stakeholders and 29% (14/49) of assessors, but 91% (10/11) of Māori and 92% (43/47) of wheelchair users. When internet was available, sufficient connectivity for video-conferencing "without freezing" was "usually/always" in place for 91% (41/45) of wheelchair users and 71% (32/45) of assessors. Payment for internet use for TWAS by service providers was considered essential by only 23% (16/69) of all stakeholders, and 30% (3/11) of Māori.

Internal system features considered most important to assessors, technicians, and managers related to compatibility with existing systems, such as the ability to share or transfer files (43/44, 98%). Views were mixed about features which guided clinical data collection. For example, structured clinical information gathering was seen as important by many (38/44, 86%), whereas more directive cues, such as alerts for missing information (28/44, 68%) and checklists for treatment options (18/44, 41%), were viewed less favourably, particularly by assessors. System security and confidentiality was absolutely important to all assessors and managers, but to only 76% (34/45) of wheelchair users.

Key hardware features considered important for all stakeholders were portability, camera reversal, and photo/video saving capability. Other features, such as onscreen measurement tripods, eye-gaze control, and voice activation, were considered important by very few. All assessors had access to at least one type of device that they could use to undertake a TWAS (smartphone, tablet, laptop and/or personal computer). But only 47% (22/47) of wheelchair users and 55% (6/11) of Māori had access to tablets, the device considered ideal by most.

Figure 2

Assessor and Wheelchair User Perceived Impact of Telehealth Wheelchair Assessment Service on Nine Areas of the Quality of Care



DISCUSSION

This study explored the social and technical design requirements for a telehealth wheelchair service for people with complex wheelchair and seating needs. Particular attention was paid to end-user acceptance of telehealth technology and the needs of Māori.

The modest level of satisfaction with current in-person wheelchair and seating assessment for people with complex mobility needs, particularly among wheelchair users and their family members, suggests a context of readiness to try alternative delivery formats, such as TWAS. Although the time taken to receive a wheelchair and seating solution that met mobility needs appeared to drive much of this dissatisfaction for all stakeholders, there was also only modest satisfaction from wheelchair users with the resulting wheelchair product, which is at odds with patterns internationally for people with NMC (Ward et al., 2010). TWAS as an alternative to in-person assessment was perceived to improve the timeliness of services, access to services, and other patient outcomes, but only moderately (see Figure 2); telehealth was not viewed by any stakeholder group as a panacea to current service issues, least of all by Māori.

The perceived usefulness of TWAS, an important criterion for the acceptance and uptake of new technology, appears to be high among all participant groups. Although the majority of stakeholders were confident in being able to learn to use technology for this purpose, the desire for training in TWAS among assessors was widely expressed and is, therefore, an important socio/human related requirement to its successful implementation. Prior research indicates that training for TWAS is likely to require clinical skills in the core elements of wheelchair assessment for tele-delivery, instruction in the safe use of technology (Edirippulige & Armfield, 2017; Graham et al., 2019), and for this specific population, a non-threatening learning environment (Jang-Jaccard et al., 2014).

Surprisingly, anticipated technology preferences were for simple SaaS products (e.g., Zoom, Facetime) when undertaking TWAS assessments. Ease of use (and ease of learning) were prioritised over bespoke functionality, such as on-screen measurement. Compatibility with existing record keeping and communication systems appeared to be prioritised over system functionality, such as internal note keeping options. Assessors' preference appeared to be an in-person assistant, such as a local therapist or family member, rather than highly specialised technical functions.

Preferred devices for wheelchair users appeared to be a tablet or smartphone, for their portability. Overall, it appeared that the hardware requirements for TWAS were in place for most stakeholders. Conversely, software infrastructure essential to telehealth, such as reliable internet connectivity, was not available to almost 30% of assessors. While this may have changed after COVID-19 response initiatives, if unresolved, this poses a substantial limitation on the capacity of the New Zealand public health service to deliver TWAS. These findings provide critical information to meet our United Nations member state obligations to develop and implement policies and programmes that improve access to assistive technologies that meet health and disability needs (World Health Organization, 2018).

Limitations

The categorical and numerical nature of survey questions limit understanding of participants' rationale for their responses. Further qualitative enquiry (phase 2 of the wider mixed methods study) is important to understand the dissatisfaction with current services and design components of TWAS. The extent of missing responses for some items may also confer a bias, particularly for wheelchair users. While forced response features could in future be enabled on the electronic survey, it is noteworthy that the greatest non-response related to demographic information, indicating that there may have been a perception from some wheelchair users that anonymity was a risk if they completed all demographic questions.

While several strategies were in place to encourage participation of Māori in this study, the percentage recruited (12%) fell short of population levels of Māori with disabilities (26%), thus interpretation of findings for Māori should be undertaken with care. Most Māori were wheelchair users; responses for these two groups are closely related. Education levels were high among wheelchair users, thus their views may not accurately represent those of the wider wheelchair user population.

Recruitment of non-specialist (level 1) assessors was low. Level 1 assessors are often regionally based and may have different infrastructure available. They also have dual roles in TWAS as rehabilitation provider and learner, when assessing jointly with specialist assessors. Garnering their willingness to engage in TWAS and identifying their preparation needs will be an important factor in its success. Similarly, recruitment of physiotherapists as assessors was low. While service user responses about their satisfaction with wheelchair assessment services related to all health professionals, physiotherapists' perspectives on the requirements of TWAS will be critical to its success, given their distinctive contribution to wheelchair assessment and the current advocacy for team assessment of assistive technology needs (Smith et al., 2018). No funders or policy developers could be recruited to this study. Their perspective on key design features of TWAS will be critical to the purchasing and roll out of such a service.

COVID-19 instigated physical distancing measures in New Zealand during 2020; this resulted in substantial unplanned and fluctuating changes to the use of telehealth in assessment of wheelchair and seating needs, and resulted in other disruptions to service delivery, such as the ceasing of some services for several months. It is unclear how these social, funding and service delivery changes might impact on the social and technical requirements of TWAS in New Zealand or how long-term such changes will be.

CONCLUSION

This study examined the social and technical requirements of a telehealth wheelchair and seating assessment service, as perceived by wheelchair users, their family members, assessors, managers, Māori, and non-Māori pre COVID-19 social distancing initiatives. Telehealth assessment was largely viewed as valuable and a means to positively impact the quality of service delivery and wider health outcomes by all stakeholders. The technical requirements for tele-assessment of wheelchairs are in place for the majority but may need upgrading for some assessors. Assessor training in telehealth assessment will be critical to widespread uptake.

KEY POINTS

1. A telehealth wheelchair and seating assessment service (TWAS) for people with complex wheelchair and seating needs is widely supported by both wheelchair users and health professionals, and is viewed by many as a way to address some of the shortcomings of the current service design.
2. Length of time to provision of wheelchair solutions is a shortcoming of the current in-person assessment system that all stakeholders expect to change through TWAS.
3. Robust training in use of a TWAS will be critical to its successful uptake among health professionals, for both specialist and non-specialist assessors.
4. Māori wheelchair users and assessors welcome a TWAS, and are equipped with the devices and internet access as equally as non-Māori, yet are more conservative in their expectations that TWAS will address current service issues.

DISCLOSURES

This study was funded by the Neuromuscular Research Fund of New Zealand ($18,000). There are no conflicts of interest which may be perceived to interfere with or bias this study.

PERMISSIONS

This study was approved by the University of Otago Ethics Committee (Health) (reference number #H19/046). Informed consent was provided by all participants prior to participation in the study.

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Self-Reported Depression and Anxiety are Correlated with Functional Disability in Parkinson's Disease

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ABSTRACT

Non-motor symptoms, namely cognitive and affective domain function, may impact the physical functioning and perceived health status of people with Parkinson's disease (PD). The aim of this cross-sectional observational study was to explore the relationship between the severity of non-motor symptoms (cognitive and affective) and physical function in individuals with PD living in the community. The outcome measures were completed in 19 participants diagnosed with PD, with or without affective symptoms and cognitive impairments. The main constructs included in the bivariate statistical analyses were: self-reported non-motor experiences of daily living (Movement Disorder Society – Unified Parkinson's Disease Rating Scale [MDS-UPDRS] Part I); self-reported motor experiences of daily living (MDS-UPDRS Part II); clinician-rated impression of motor symptoms (MDS-UPDRS Part III); motor fluctuations (MDS-UPDRS Part IV); self-reported anxiety and depression symptoms (Hospital Anxiety and Depression Rating Scale [HADS] – a total score comprising sub-scores for "anxiety" [HADS-A] and "depression" [HADS-D]); global cognitive function (Montreal Cognitive Assessment [MoCA]); functional gait and balance performance (Dynamic Gait Index [DGI]); and perceived quality of life (European Quality of Life – Visual Analogue Scale [EQ-VAS]). Significant positive correlations ($p \leq 0.05$) were observed between the MDS-UPDRS Part II and MDS-UPDRS Part I ($p < 0.01$), HADS, HADS-A, and HADS-D ($p < 0.05$). The Hoehn and Yahr (H & Y) scale was the only variable to significantly correlate with the DGI ($p < 0.01$). MDS-UPDRS Part III significantly correlated with the H & Y scale ($p < 0.01$) and MoCA ($p < 0.05$). HADS-D was the only significant and negative correlate with perceived health status ($p < 0.05$). A significant relationship was observed between the severities of self-reported depression and anxiety, and physical function in people with PD. The severity of the depression symptom was a significant determinant of perceived health status.

Still, A., Hale, L., Swain, N. & Jayakaran, P. (2021). Self-reported depression and anxiety are correlated with functional disability in Parkinson's disease. *New Zealand Journal of Physiotherapy, 49*(1), 40–49. https://doi.org/10.15619/NZJP/49.1.06

Key Words: Anxiety, Cognitive Impairment, Depression, Gait, Non-Motor Symptoms, Parkinson's Disease, Physical Function

INTRODUCTION

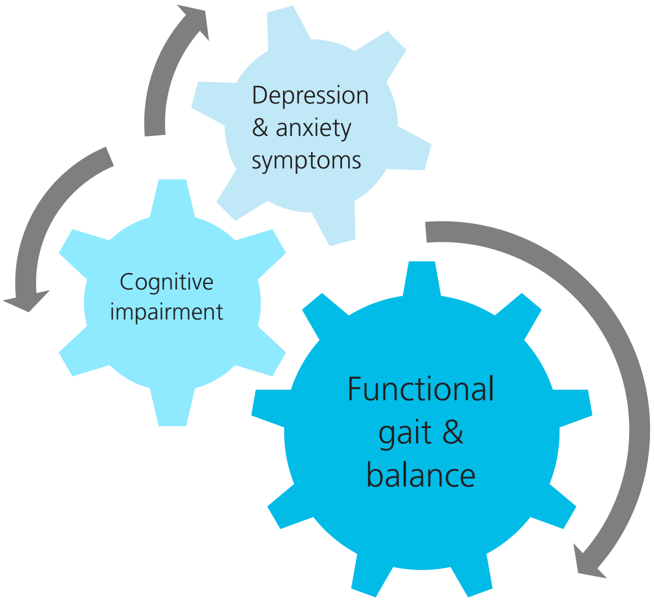
Parkinson's disease (PD) is a progressive neurological condition, which has increased more than two-fold in the last two decades (Mak et al., 2017; Rocca, 2018). The current global prevalence is estimated at 6.1 million (Mak et al., 2017; Rocca, 2018), and is projected to increase by approximately 770,000 by 2040 (Rossi et al., 2018). In New Zealand, PD is one of the leading neurological causes of disability affecting approximately 210 per 100,000 people (Pitcher et al., 2018).

PD significantly impacts physical function, perceived quality of life (QoL), and health status (Schrag et al., 2000). Gait and balance impairments are reportedly the most frequent motor symptoms that contribute to disability and poor health-related quality of life (HR-QoL) in people with PD (GBD 2015 Neurological Disorders Collaborator Group, 2017; GBD 2016 Neurology Collaborators, 2018; Soh et al., 2011). Along with motor symptoms, it has been shown that the presence and severity of non-motor symptoms (NMS), particularly in the early stages of PD, have a greater negative impact on the QoL of people with PD than motor disability (Erro et al., 2016; Prakash et al., 2016). The common NMS shown to be significant determinants of HR-QoL are cognitive impairment, depression, and anxiety (Hinnell et al., 2012; Soh et al., 2011). These NMS have also been reported to influence gait parameters, such as stride/step length, gait velocity, and variability in the PD population (Lord et al., 2011).

While the pathophysiology of gait and balance impairments, and the aforementioned NMS in PD is complex, the loss of dopaminergic neurons in the substantia nigra and the resultant deficiency of dopamine concentration appears to be a common contributing etiology (Clark, 2015; Gilat et al., 2017; Khan et al., 2017; Lewis & Barker, 2009; Peterson & Horak, 2016). To walk safely and effectively, people with PD must compensate for their PD-related gait and balance impairments, which often demands increased cognitive resources, particularly attention-demanding executive functions (Gilat et al., 2017). The basal ganglia receives, processes and integrates motor, cognitive and limbic inputs from separate cortico-striatal neuronal networks to coordinate function (Lewis & Barker, 2009). Dopamine depletion reduces the processing capabilities of the basal ganglia, leading to gait and balance impairments (Clark, 2015; Gilat et al., 2017; Lewis & Barker, 2009). Furthermore, it has been suggested that these processing resources can be overloaded by increased cognitive demands and affective symptoms, and thus augment the gait and balance impairments (Gilat et al., 2017). Figure 1 illustrates the potential relationship between gait and balance impairments, and cognition and affective symptoms in PD. To our knowledge, this relationship between the severity of NMS and motor symptoms has not been reported and is poorly understood. While NMS in PD includes a wide range of symptoms, in this study, NMS refers to cognitive impairment, depression, and anxiety.

Figure 1

Potential Inter-Relationship Between Functional Gait and Balance Performance With the Severity of Cognitive Impairment, Depression and Anxiety Symptoms



The aim of this study was to gain a preliminary understanding of the relationship between NMS, namely cognitive impairment, depression and anxiety symptoms, with physical function, particularly functional gait and balance performance, and the perceived health status in individuals with PD. In line with the functional pathophysiology of gait and balance impairments in PD, we hypothesised that the severity of these NMS would correlate with motor dysfunction and poorer perceptions of health status. We anticipated an inverse relationship between the increase in severity of cognitive impairment, depression and anxiety symptoms with functional gait and balance performance.

METHODS

Design

A cross-sectional observational study of participants diagnosed with PD.

Sample size

In the absence of any current information in the literature about the influence of NMS on physical function, a modest sample size was considered for this exploratory observational study. However, for a bivariate correlation analysis with an expected $r = 0.50$, $\alpha = 0.05$, power of 80% ($\beta = 0.2$), a sample size of $n = 20$ was estimated for a Spearman rank correlation test (Bonett & Wright, 2000).

Participants

Individuals diagnosed with PD were recruited from the local community through flyers placed in the community PD exercise classes, an advertisement in the local newspaper, email correspondence circulated to the members of the local Parkinson's Society, and word of mouth.

The study included individuals diagnosed with PD who could walk at least 100m of level ground with or without an ambulatory device. Individuals were excluded from the study if they had co-morbidities, such as vertigo, stroke and arthritis, that could potentially affect their physical function (functional gait and balance). Also excluded were individuals who could not understand and follow instructions and/or who scored ≥ 4 on item 1.1 of the MDS-UPDRS for cognitive impairment. This set of exclusion criteria was applied to minimise the impact of the other comorbidities on the outcome measures.

Procedure

Potential participants responding to the recruitment call were provided with a detailed information sheet. Individuals who confirmed their interest to participate were screened for their eligibility over the phone or at the time of assessment. Individuals who had not responded within 2–4 weeks from receiving information about the study were followed-up with an email or a phone call. All participants completed the initial screening and demographic questions comprising age, sex, weight, height, and ethnicity, and time since their diagnosis of PD. Also collected were details of any comorbidities that may have affected their walking ability, or required use of an ambulatory device or support from another person to walk; exercise tolerance; and medications taken for PD. All participants attended one assessment session lasting up to 90 min, with all data recorded on paper forms.

Participants were requested to take their medication as usual, and all outcome measures were administrated during a self-reported "on state". All participants provided written informed consent, and ethical approval was granted by the University of Otago Human Ethics Committee (reference number H19/048).

Outcome measures

The following outcome measures were included in bivariate correlation analysis: Hospital Anxiety and Depression Scale (HADS) – with subscale scores for "anxiety" (HADS-A) and "depression" (HADS-D) (Zigmond & Snaith, 1983), Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005), Dynamic Gait Index (DGI) (Herman et al., 2009), Movement Disorder Society – Unified Parkinson's Disease Rating Scale (MDS-UPDRS) Part I-IV (Goetz et al., 2008), and EuroQoL-Visual Analogue Scale (EQ-VAS).

Hospital Anxiety and Depression Scale (HADS)

Severity of anxiety and depression symptoms were evaluated using the self-reported HADS, which is reported to be reliable and valid for use in the PD population (Leentjens et al., 2011). HADS-A and HADS-D subscale scores that range from 0 to 21 were calculated to categorize the severity of symptoms (Zigmond & Snaith, 1983). Each subscale contained seven questions that were scored 0–3; higher scores denote greater severity. A pre-determined scoring criterion as described elsewhere (Smarr & Keefer, 2011) was used to interpret the severity of symptoms as follows: ≤ 7, normal; 8–10; mild; 11–15, moderate; ≥ 16, severe (Smarr & Keefer, 2011) Subscales scores were also summated to give an impression of global mood (Zigmond & Snaith, 1983).

Montreal Cognitive Assessment (MoCA)

Global cognitive function was determined using MoCA, which assesses cognitive function across eight domains: executive and visuospatial functions, attention, working memory, language, learning, memory, and orientation (Nasreddine et al., 2005). MoCA is a reliable and valid measure of cognitive function in people with PD (Nasreddine et al., 2005; Skorvanek et al., 2018). Scores from each domain as assigned by the clinician were summated to produce a total score ranging between 0 and 30 (Nasreddine et al., 2005). Scores were interpreted as described elsewhere: normal, ≥ 26; PD-related mild cognitive impairment, 21–25; PD-related dementia, ≤ 20 (Skorvanek et al., 2018).

Dynamic Gait Index (DGI)

The DGI is an eight-item clinician-rated objective assessment of functional gait and balance performance that is a reliable and valid in people with PD (Bloem et al., 2016; Huang et al., 2011). The DGI requires people to adapt their gait during eight different walking demands (Herman et al., 2009). Each item is scored 0–3 by the clinician, where 0 = severe impairment, 1 = moderate impairment, 2 = mild impairment, and 3 = normal. Scores from each item were summated to produce a score ranging from 0–24; higher scores denote greater functional performance. People who scored ≤ 21 were interpreted as an increased falls risk (Dibble & Lange, 2006).

Movement Disorder Society – Unified Parkinson's Disease Rating Scale (MDS-UPDRS) Part I–IV

The MDS-UPDRS is a comprehensive assessment tool of PD-related symptoms and overall disease severity, which is composed of four parts: Part I: Non-motor experiences of daily living (self-reported); Part II: Motor experiences of daily living (self-reported); Part III: Motor examination; and Part IV: Motor complications (Goetz et al., 2008). Each question is scored using a 0 to 4 rating system that is designed to capture both the presence and severity of symptoms where 0 = normal, 1 = slight, 2 = mild, 3 = moderate, and 4 = severe problems (Abdolahi et al., 2013; Goetz et al., 2007; Goetz et al., 2008). Each part was scored separately where higher scores denoted greater disease severity. The disease stage was scored using the Hoehn and Yahr (H & Y) five-point ordinal scale from 0–4, with higher scores indicating greater disability (Goetz et al., 2008). The MDS-UPDRS, including the five-point H & Y scale, is reliable and valid for use in the PD population to evaluate disease severity and disability (Goetz et al., 2004; Goetz et al., 2008).

EuroQoL-Visual Analogue Scale (EQ-VAS)

EQ-VAS is a self-reported generic measure used to report a person's perception of their health status on a scale from 0 (worst health imaginable) to 100 (best health imaginable), which was used in the correlation analysis. EQVAS has been recommended by the MDS to evaluate HR-QoL in the PD population (Martinez-Martin et al., 2011). The general perception of QoL (European Quality of Life – five domain, five-level questionnaire [EQ-5D-5L]) (Martinez-Martin et al., 2011) was only used as a descriptive categorical variable.

Demographic details and self-reported estimates of physical activity levels over the last 7 days (International Physical Activity Questionnaire – version for elderly [IPAQ-E] – short form) (Craig et al., 2003; Heesch et al., 2010) were obtained to describe the characteristics of the study sample.

Data extraction and processing

All paper-based data were converted into an electronic format in Microsoft® Excel. Each outcome measure was processed and scored according to their respective scoring protocol. The score for each of the MDS-UPDRS sub-sections was used for statistical analysis. The IPAQ-E was scored as the total metabolic equivalent from all reported activity, estimated as minutes/week (MET-minutes/weeks) in accordance to scoring criteria described elsewhere (Craig et al., 2003). The EQ-5D-5L dimensions were analysed descriptively.

Statistical analyses

Statistical analyses were performed with the IBM SPSS Statistics 25.0 software. Spearman's correlation analysis was used to assess the bivariate association of non-motor measures (HADS, HADS-A, HADS-D, MoCA, MDS-UPDRS Part I and H&Y scores) with physical function measures (DGI, MDS-UPDRS Part II, MDS-UPDRS Part III, MDS-UPDRS Part IV) and EQ-VAS. The guideline used to interpret the relationship between variables was as follows: $r \geq 0.75$, good to excellent relationship; 0.50–0.75, moderate to good relationship; 0.25–0.50, fair relationship; 0.00–0.25, little or no relationship (Portney & Watkins, 2015). A p-value (two-tailed) < 0.05 was considered statistically significant. MDS-UPDRS, IPAQ-E, EQ5D-5L and EQ-VAS were descriptively analysed to inform the disease severity, self-reported physical activity levels, and perceived HR-QoL of study participants. An additional bootstrap analysis of 5,000 was conducted between all bivariate variables to validate statistical findings. While bootstrap analysis has a number of different applications (Lai, 2020), it was used in this study to estimate the confidence intervals, with simulation for 5,000 samples.

Descriptive statistical analyses were performed for all demographic and clinical characteristics of the study population, and are shown as mean, standard deviation, and range. All variables included in the statistical analysis underwent normality testing using the Kolmogorov Smirnoff test ($p < 0.05$ was not considered normally distributed) (Field, 2009). A test for normality of the data suggested that MDS-UPDRS Part I, MDS-

UPDRS Part II, MDS-UPDRS Part IV, H&Y, DGI, and EQ-VAS were not normally distributed; therefore, Spearman's rank-order correlation coefficients were used.

RESULTS

Participants

The 25 individuals who expressed preliminary interest in participating in the study were provided with the study information sheet and consent form. After the screening process, a sample of 19 participants were eligible, and they completed all outcome measures. Figure 2 illustrates the step-by-step process of participant recruitment and participation.

All participants except one were regularly taking dopaminergic medication, and in addition, four participants were prescribed anti-depressants and/or anxiolytic medications. Participant demographics and descriptive characteristics are presented in Table 1. The summary of EQ-5D-5L measure for participants is as illustrated in Figure 3.

The median physical activity levels of participants quantified as metabolic equivalents (MET-minutes/week) was 2,000 MET-minutes/week with a range between 192 and 6,906 MET-minutes/week.

In the EQ-5D dimensions, the majority of study participants reported "no problems" (32%–74%) or only "slight problems" (21%–58%). Only 5%–22% reported moderate to severe problems. No participants reported extreme disability or an inability to perform tasks.

Descriptive analyses of outcome measures

Descriptive analyses of outcome measures are summarised in Table 2. The majority (79%) of participants were classed as having a "normal" severity of anxiety and depression symptoms, and normal cognitive function (53%), evaluated with the HADS and MoCA assessments, respectively. No participants were suggested to have moderate-severe affective symptoms or Parkinson's disease-related dementia according to the respective cut-off scores used.

Bivariate correlation analysis

The results of Spearman's rank-order correlation analysis are shown in Table 3. Simple bivariate correlation analysis suggested that no significant ($p > 0.05$) correlations existed between DGI and self-reported NMS severity as evaluated by the HADS ($r_s = 0.269$), HADS-A ($r_s = 0.132$), HADS-D ($r_s = 0.239$), MoCA ($r_s = 0.367$, $p > 0.05$) or MDS-UPDRS Part I ($r_s = 0.029$). Furthermore, self-reported motor disability and clinician-rated severity of motor symptoms as evaluated by the MDS-UPDRS Part II and MDS-UPDRS Part III did not show any significant correlation with DGI scores. Bootstrap analysis of 5,000 did not change the significance of the results or the confidence intervals. The H & Y score was found to correlate significantly and negatively with the DGI scores ($r_s = –0.507$, $p < 0.05$), and positively with disease duration ($r_s = 0.482$, $p < 0.05$) and MDS-UPDRS Part III ($r_s = 0.590$, $p < 0.05$), but disease duration did not correlate significantly with the DGI scores ($r_s = -0.441$, $p > 0.05$).

Though NMS measures did not correlate significantly with the DGI scores, MDS-UPDRS Part I ($r_s = 0.624$), HADS ($r_s = 0.575$), HADS-A ($r_s = 0.536$), and HADS-D ($r_s = 0.481$) were shown to correlate significantly ($p < 0.05$) and positively with self-reported motor disability as evaluated by the MDS-UPDRS Part II. Contrastingly, cognitive function as evaluated by MoCA was

Table 1

Demographic and Clinical Characteristics of Participants

Characteristics	Mean (SD) [a]	Range (min–max)
Age (years)	68.8 (6.5)	55–77
Sex (male/female) [b]	11/8	
Body height (m)	1.68 (0.10)	1.50–1.83
Body mass (kg)	74.65 (12.24)	53–100
Disease duration (~years)	3.77 (2.83)	0.92–10
Education ≥ 12 years [b]	19	
Number of participants receiving:		
PD medication [b]	18	
Mood medication [b]	5	
IPAQ-elderly (MET–min/week)	2,274 (1,643)	192–6,906
Low [b]	2	
Moderate [b]	13	
High [b]	4	

Note. IPAQ-elderly = International Physical Activity Questionnaire – version for elderly; MET = metabolic equivalent; min–max = minimum to maximum; PD = Parkinson's disease.

[a] Except where indicated; [b] Number of participants.

Figure 2

Participant Recruitment and Retention in the Study

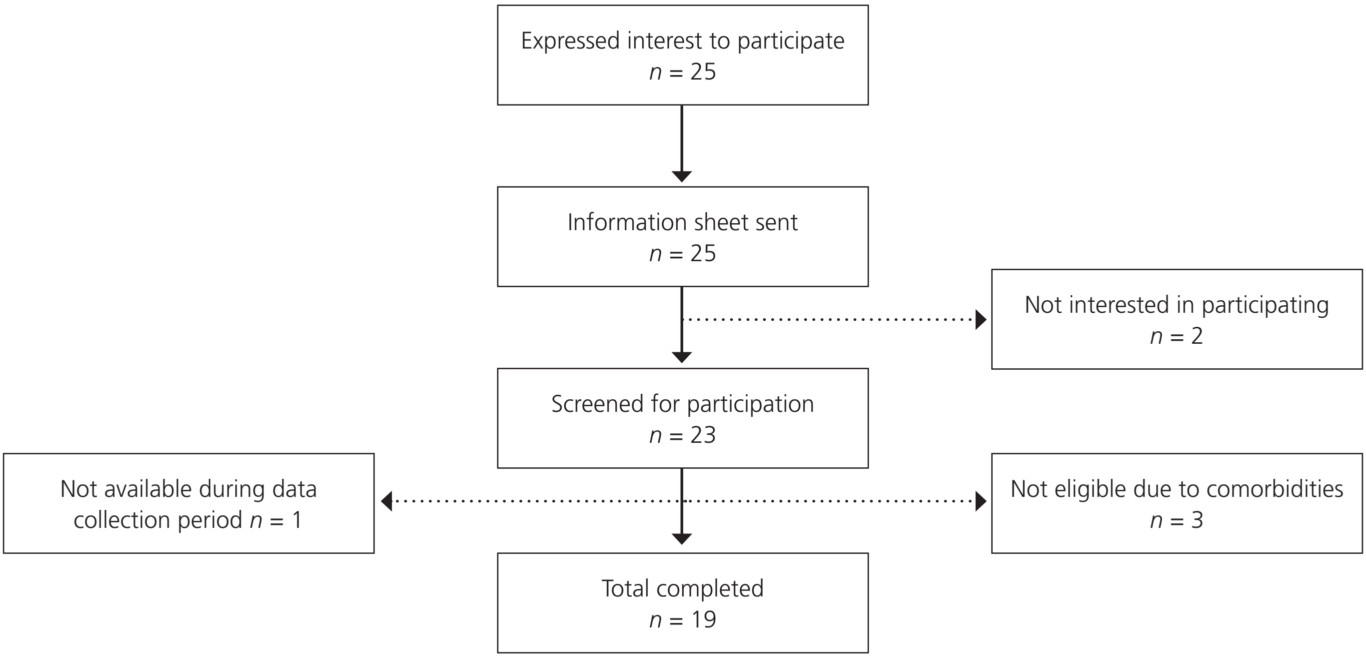


Figure 3

Summary of the ED-5D-5L Measure for Participants

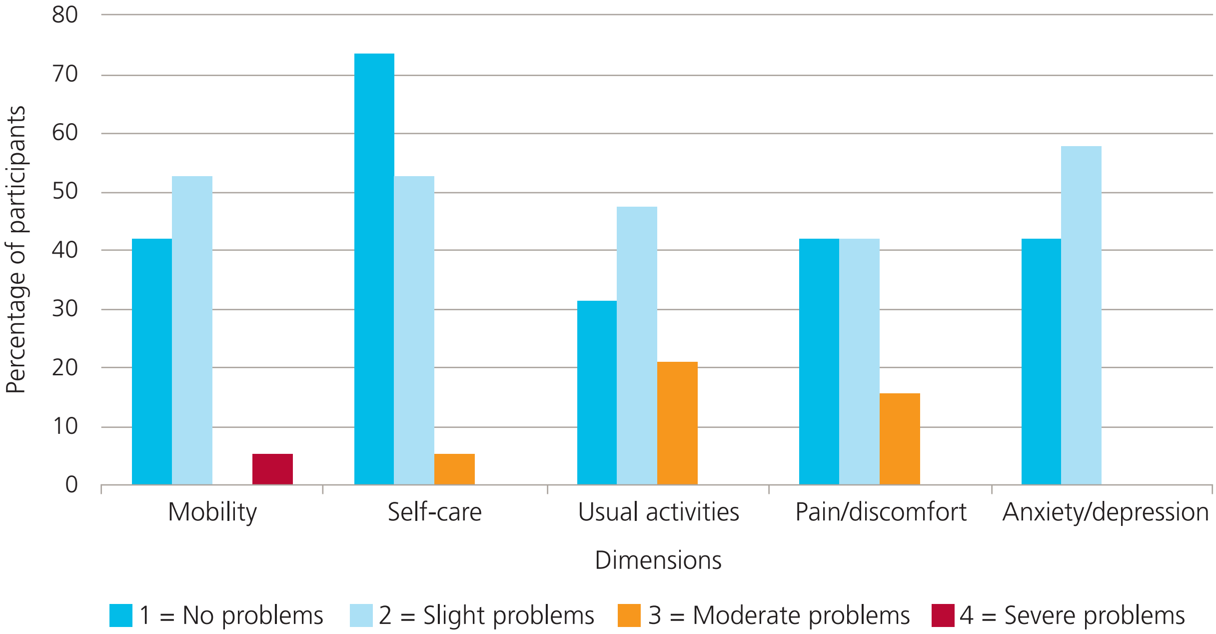


Table 2

Descriptive Statistics of the Outcome Measures

Outcome measures	Mean (SD) [a]	Range (min–max)
MDS-UPDRS Part I (0–52)	10.63 (6.92)	0–26
MDS-UPDRS Part II (0–52)	11.26 (7.00)	1–25
MDS-UPDRS Part III (0–132)	22.21 (10.79)	4–45
MDS-UPDRS Part IV (0–24)	3.05 (3.32)	0–11
H & Y scale (0–5)	1.79 (0.85)	1–4
HADS (0–42)	9.32 (5.04)	0–16
HADS-D (0–21)	4.79 (2.88)	0–10
Normal (0–7) [b]	15	
Mild (8–10) [b]	4	
HADS-A (0–21)	4.53 (3.12)	0–9
Normal (0–7) [b]	15	
Mild (8–10) [b]	4	
MoCA (0–30)	26.11 (2.62)	22–30
Normal (26–30) [b]	10	
PD-MCI (21–25) [b]	9	
DGI (0–24)	18.41 (3.55)	8–22
Falls risk (0–21) [b]	15	
EQ-VAS (0–100)	76.84 (11.08)	50–95

Note. DGI = Dynamic Gait Index; EQ-VAS = EuroQoL-Visual Analogue Scale; HADS = Hospital Anxiety and Depression Scale; HADS-D = Depression subscale; HADS-A = Anxiety subscale; H & Y = Hoehn and Yahr; MDS-UPDRS = Movement Disorder Society – Unified Parkinson’s Disease Rating Scale; MDS-UPRDS Part I = non-motor experiences subscale score; MDS-UPRDS Part II = motor experiences subscale score; MDS-UPRDS Part III = motor examination subscale score; MDS-UPRDS Part IV = motor complications subscale score; min-max = minimum to maximum; MoCA = Montreal Cognitive Assessment; PD-MCI = Parkinson’s disease-related mild cognitive impairment.

[a] Except where indicated; [b] Number of participants.

Table 3

Spearman’s Rank-Order Correlation Coefficients for the Associations Between Non-Motor and Motor-Related Clinical Assessments in Addition to Disease Duration, EQ-VAS and H & Y Score

	HADS	HADS-A	HADS-D	MoCA	MD-UPDRS Part I	H & Y
DGI	0.269	0.132	0.239	0.367	0.029	–0.507**
MDS-UPDRS Part II	0.575*	0.536*	0.481*	–0.010	0.624**	–0.117
MDS-UPDRS Part III	–0.044	–0.301	0.320	–0.471*	–0.318	0.590**
MDS-UPDRS Part IV	0.442	0.586*	0.183	0.301	0.438	–0.253
EQ-VAS	–0.322	–0.075	–0.488*	0.156	–0.093	–0.247
Disease duration	0.104	0.160	0.042	0.086	0.064	0.482*

Note. Values are two-tailed pairwise results. DGI = Dynamic Gait Index; EQ-VAS = EuroQoL-Visual Analogue Scale; HADS = Hospital Anxiety and Depression Scale; HADS-D = Depression subscale; HADS-A = Anxiety subscale; H & Y = Hoehn and Yahr; MoCA = Montreal Cognitive Assessment; MDS-UPDRS = Movement Disorder Society – Unified Parkinson’s Disease Rating Scale; MDS-UPRDS Part I = Non-motor experiences subscale score; MDS-UPDRS Part II = motor experiences subscale score; MDS-UPRDS Part III = motor examination subscale score; MDS-UPRDS Part IV = motor complications subscale score.

*$p < 0.05$; **$p < 0.01$.

not found to correlate significantly with self-reported motor disability, but did correlate with clinician-rated impressions of motor disability as evaluated by the MDS-UPDRS Part III ($r_s = -0.471$, $p < 0.05$). Furthermore, HADS-A was found to significantly and positively correlate with motor complications ($r_s = 0.586$, $p < 0.05$), and HADS-D was found to be the only significant determinant of health status as evaluated by the EQ-VAS ($r_s = -0.488$, $p < 0.05$).

DISCUSSION

This study explored the relationship between the severity of NMS (cognitive impairment, depression, and anxiety), and functional gait and balance performance in people diagnosed with PD. A significant positive correlation was found between the severity of self-reported affective NMS and self-reported physical function. No correlation was observed between the clinician-rated measures of physical (DGI) and cognitive function (MoCA), and self-reported NMS.

NMS are clinically under-recognised in the early stages of the disease, although they have been shown to have greater impact on motor disability and associated QoL (Erro et al., 2016; Prakash et al., 2016). Understanding the relationship between these constructs can provide direction for future research and clinical management of PD. In the current study, self-reported depression (HADS-D) and anxiety (HADS-A) did not significantly correlate with either clinician-rated physical function (DGI) or clinician-rated motor disability (MDS-UPDRS Part III). These findings differ from those of Ehgoetz-Martens et al. (2016), who found a significant and positive correlation between depression and anxiety with the clinician-rated impression of motor symptom severity (UPDRS Part III). Though not significant in the current study, the strength of association between depression (HADS-D) and motor disability (MDS-UPDRS Part III) was similar to that reported in the previous study (Ehgoetz-Martens et al., 2016). We also observed a fair negative correlation between anxiety (HADS-A) and motor disability (MDS-UPDRS Part III). These differences may be attributable to the motor symptom severity. It is observed that the mean scores of the motor symptom severity were higher in the previous study (Ehgoetz-Martens et al., 2016) than the current study.

The severity of self-reported depression and anxiety symptoms of participants in our study can be classified as “normal” to “mild”, according to the criterion described for the elderly population (Smarr & Keefer, 2011). Although previous studies with participants of a similar severity of depression (Kincses et al., 2017; Lord et al., 2011; Lord et al., 2013; Rochester et al., 2008) and anxiety (Ehgoetz Martens et al., 2014) demonstrated significant correlations with alterations to gait parameters, our results suggest that changes in gait parameters due to these symptoms may not necessarily determine functional or motor disability. It may be that the level of severity of affective symptoms in our participants was not severe enough to overload the processing resources of the basal ganglia (Gilat et al., 2017) and thus impact functional gait and balance (DGI).

Cognitive impairment (MoCA) had no significant correlation with functional gait and balance (DGI) or motor disability (MDS-UPDRS Part II). However, a significant correlation was found between cognitive impairment (MoCA) and clinician-rated motor disability (MDS-UPDRS Part III). These results suggest that cognitive impairment may affect motor symptom severity, but not influence self-reported or clinician-rated impressions of functional mobility. Again, the severity of cognitive impairment in our participants may not have been sufficient to interfere with the increased cognitive demands required to compensate for gait and balance impairments when walking, or the DGI may not have significantly challenged cognitive demands. Thus, insufficient cognitive demand may explain why no correlation with functional gait and balance was shown in this study (Gilat et al., 2017).

Though no correlations were found between functional gait and balance (DGI) with most of the disease specific outcome measures, namely sub-sections of the MDS-UPDRS and disease duration, a significant correlation between functional gait and balance (DGI) with the stage of PD (H & Y scale) was found. These findings suggest that DGI is sensitive to detect functional gait impairment as rated by the clinicians using the H & Y scale. The current findings suggest that motor symptom severity, and functional gait and balance are influenced by disease stage but not disease duration. This is similar to previous findings on freezing of gait, which reportedly is not linearly related to freezing or festination of gait (Amboni et al., 2008).

The majority of participants were classified as having a “normal” severity of affective symptoms and cognitive function, and no risk of falls. This differs from prevalence studies which have suggested clinically relevant symptoms of depression, anxiety, and mild cognitive impairment in 42% (Reijnders et al., 2008), 25.7% (Broen et al, 2016) and up to 21% of the PD population, respectively (Hobson & Meara, 2004, 2015; Luck et al., 2010). The cut-off score of DGI for falls risk is 16.3 (Cakit et al., 2007), while our study had a mean DGI score of 18.41.

Furthermore, the majority of participants reported no problems (32%–74%) or only slight problems (21%–58%) in the EQ-5D dimensions. Participants with moderate problems to extreme disability were underrepresented in this sample. Thus, the external validity of the findings is reduced among those with a greater severity of NMS, and gait and balance impairments with poorer QoL. Our study did, however, include people with a disease stage that ranged from 1 to 4 as evaluated by the H & Y scale, with a wide range of self-reported disease duration (11 months to 10 years).

While a generic hypothesis was made for the correlation between NMS and physical function measures, no specific *a priori* hypotheses were made about the self-reported and clinician-rated measures. However, the findings suggest that the hypothesis was upheld for the self-reported measures but not for the clinician-rated measured. The self-reported measures of affective symptoms and cognition correlated with self-reported motor disability. The clinician-rated physical function did correlate with cognitive impairment but not for other NMS (depression and anxiety). These findings are in line with the functional pathophysiology of PD previously discussed. Our additional hypothesis that NMS severity and functional disability might be correlated with poorer perceived health status (EQ-VAS) was upheld for depression symptoms but not for anxiety.

It is understood that the severity of anxiety symptoms, cognitive impairment, and gait and balance impairments may not have been sufficient to influence the health status of the study sample.

Strengths and limitations

A narrative review published in 2018 suggested the need for further research to better understand the influence of NMS on gait and function in PD (Avanzino et al., 2018). To our knowledge, this is the first study to explore the correlation between the severity of NMS on self-reported and clinician-rated impressions of functional mobility in the PD population. Additionally, to our knowledge, this is the first study to explore the correlation between motor disability and symptom severity as evaluated by the MDS-UPDRS Part II and Part III with a functional gait and balance outcome measure, which we believe is a strength of the study. Another strength of this study is that participants were recruited from people living in the community, thus reducing selection bias. The small sample size (n = 19) limited our study from being a true representation of characteristics in the PD population. However, bootstrap analysis suggested that the significance of the findings was not limited by the sample size.

The questionnaires used in the study adopted a 7-day recall for any symptoms, which induces the likelihood of recall bias in the self-reported severity – a delimitation of questionnaire-based studies. The recall bias that was present may have caused participants to underestimate the severity of their symptoms, and so may explain why most participants were classified as having only "normal" to "mild" symptom severity.

Finally, this study did not compare findings against a control group of healthy age-matched people, nor did it explore the influence of NMS fluctuations on functional gait and balance due the cross-sectional study design used, which is a limitation of the findings. Thus, it remains unclear whether or not NMS severity influences functional gait and balance in the PD population compared to healthy age-matched controls. Furthermore, a longitudinal study may have shown fluctuations in NMS severity to have a stronger association with physical function than symptom severity assessed at one point in time.

Implications

The findings provide preliminary information to suggest that the severity of NMS may be a significant correlation of self-reported functional disability in addition to poorer perception of health status, particularly depressive symptoms. Clinically, the findings point to the need to further explore the relationship between self-reported functional disability and perceived health status with the severity of self-reported NMS. A qualitative investigation exploring the relationship will inform clinicians involved in the management of PD about the use of additional strategies to counter NMS severity and thus improve physical function and QoL. Nevertheless, the findings suggest that the clinician-rated measures may not necessarily reflect the subjective experiences of motor or non-motor experiences. Clinicians should therefore be cognisant of this difference and apply due caution in the interpretation and application of these outcome measure in their practice. Collectively, findings from the current study add to the body of knowledge on the relationship between NMS and physical function, which may help to build future research on PD interventions.

CONCLUSION

Self-reported functional disability and perceived health status of people with PD appears to correlate with the severity of self-reported NMS. Though no significant correlation was found between self-reported NMS, namely affective symptoms and cognitive impairment, with clinician-rated functional mobility, this possible contention cannot be excluded among people with a greater severity of NMS.

KEY POINTS

1. There is a relationship between the severity of non-motor symptoms, particularly depressive symptoms, and self-reported functional disability and perceived health status in people with Parkinson's disease (PD).
2. Clinician-rated measures of function may not reflect self-reported experiences of motor or non-motor experiences.
3. PD stage may be a stronger correlate with function than disease duration.

DISCLOSURES

No funding was received. There are no conflicts of interest which may be perceived to interfere with or bias this study.

PERMISSIONS

Ethical approval was obtained from the University of Otago Human Ethics Committee (reference number H19/048).

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