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PHYSIOTHERAPY NEW ZEALAND
Kōmiri Aotearoa

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MOVEMENT FOR LIFE

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NEW ZEALAND JOURNAL OF PHYSIOTHERAPY

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The super conference – stepping outside our comfort zones

I would like to praise Physiotherapy New Zealand and their organising committee for their stimulating and enjoyable *Linking the Chain* "super" Conference held 19-21 September 2014. I know there was trepidation amongst some members at the thought of combining all the special interest groups into one big conference, but it worked, and it worked well. Let's face it, when you need further information in your area of physiotherapy interest you usually know the best authors / experts / textbooks to refer to, or at least you know where or who to turn to. But when a patient presents with a complex or new condition, or with an array of co-morbidities, it is not easy to search for appropriate information in a new area of practice. Where does one start with the plethora of information now available to us? Well, one could start at a "super" conference; listen to presentations in areas that you would not traditionally attend, starting talking to other physiotherapy colleagues from other areas of interest, and meet experts in other fields.

At the recent Physiotherapy New Zealand Biennial Conference I attended a lively presentation by Diane Lee on "An introduction to the Integrated Systems model and how to find the primary driver for linking chains for optimal function" – Diane had us all standing feeling sacroiliac alignment and effects of posture and movement on our neighbour …. that made me think about the influence of my neighbour's shoes on her posture (Chris Sole had presented on "The effect of footwear asymmetry on dynamic postural stability") ….. and then I thought how much movement practice would it take to change this alignment (Julie Bernhard had presented "Physical activity in rehabilitation: Why, when, what and how?") ….. which got me thinking about whether we approach our patients in a truly patient-centred manner or do we actually coerce patients into doing what we need them to do (Lynley Anderson had really got me contemplating this dilemma with her presentation on "Coercion or persuasion: Physiotherapy and mobilising reluctant patients") ….. perhaps motivational interviewing would be of assistance here (Eileen Britt "An Introduction to Motivational Interviewing") or maybe learning from the Context Therapy Approach (Johanna Darrah). I think you get the picture; a "super" conference is a good place to start gathering information and knowledge in a wide variety of areas of practice.

Likewise, this November 2014 issue of the New Zealand Journal of Physiotherapy covers a multitude of topics that are both interesting and pertinent to practice, no matter your area of interest. With the rapidly changing face of physiotherapy practice, the increase in number of patients presenting for physiotherapy with a variety of multiple co-morbidities, and our profession's increasing need to move further into the realms of health promotion (Dean et al 2014; Nicholls and Larmer 2005; Patrick et al 2001) it behoves us, as physiotherapists to increase not only the depth but also the breadth of our knowledge. I hope you enjoy reading this issue of our journal and thereby widening your horizons.

Leigh Hale
Editor
New Zealand Journal of Physiotherapy

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Physiotherapy management of knee and hip osteoarthritis: a survey of patient and medical practitioners' expectations, experiences and perceptions of effectiveness of treatment

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ABSTRACT

Osteoarthritis (OA) is a common cause of hip and knee pain. Current research advocates physiotherapy as an effective form of treatment to help manage OA. The aim of the study was to investigate the self-reported behaviour, experiences, expectations, and perceptions of general practitioners (GPs), orthopaedic surgeons, and patients with regard to physiotherapy referral and management of individuals with OA of the hip and knee. A survey questionnaire was designed to gather this information. A total of 98/320 (30% response rate) participants with hip or knee OA responded. Twenty four GPs from a pool of 52 (46%), and 20/76 orthopaedic surgeons (26%) responded. Fifty-one percent of participants with OA had received physiotherapy with the majority being referred by their GP or surgeon. Common interventions applied by physiotherapists appeared to be in keeping with best practice evidence. The 49% of participants who did not receive physiotherapy were not given an indication of the benefits of treatment from physiotherapists. Those participants with OA of the hip and knee who had good access to physiotherapy services, were receiving treatment in keeping with current best practice. GPs do regularly refer patients to physiotherapy but less so orthopaedic surgeons. Further improvements in referral patterns may be possible by increasing awareness of the benefits of exercise and physiotherapy management for OA.

Reid D, Potts G, Burnett M, Konnings B (2014) Physiotherapy management of knee and hip osteoarthritis: a survey of patient and medical practitioners' expectations, experiences and perceptions of effectiveness of treatment New Zealand Journal of Physiotherapy 42(2): 118-125.

Key words: Osteoarthritis, Physiotherapy, Conservative management

INTRODUCTION

Osteoarthritis (OA) is the most common type of arthritis in Western society (Jordan et al., 2004) and a leading cause of disability (Juby et al 2005). Its prevalence increases with age and affects 70% of individuals over the age of 65 years (Glazier et al, 2003). Due to increasing life expectancies (Bopf et al 2010), and a significant rise in the prevalence of obesity (Hunter, 2010), an increase in the prevalence of OA is to be expected. A projected estimate taken from the 2006-07 New Zealand Health Survey, shows that 8.8% of New Zealanders over the age of 15 years old were affected by OA in 2010. This figure is expected to rise to 9.9% by 2020 (Arthritis New Zealand 2010).

Osteoarthritis is a progressive disease of the synovial joints commonly affecting the hip and knee (De Bock et al 1992), and is characterised by hyaline cartilage degeneration, sub-chondral bone thickening, and novel bone formation (Peat et al 2001). Symptoms of OA typically include insidious onset of joint pain, swelling, stiffness, limited range of movement and muscle weakness (Williams and Spector 2006). Ten percent of people over 55 who have OA of the knee in particular will be significantly disabled by these symptoms (Peat et al 2001).

A number of evidence-based Clinical Practice Guidelines (CPGs) have been published to guide physicians, patients and allied health professionals in the management of hip and knee OA. The common theme throughout these guidelines is to apply non-pharmacological and pharmacological interventions until such time as surgery may be required (Aso OA, 2000, Jordan et al 2003, National Institute for Health and Care Excellence 2014, Zhang et al 2008).

One type of conservative non-pharmacological treatment is physiotherapy. Interventions such as supervised exercise programmes, acupuncture, bracing, taping, manual therapy, hydrotherapy and patient education have all been proven to be effective in the management of knee OA (Thomas et al 2009, Jansen et al 2011). A recent randomised controlled trial by Abbott et al, (2013) demonstrated that manual therapy and exercise are effective at improving pain and physical function in people with OA of the hip or knee and are more effective than usual care from a GP or other health care providers, with benefits lasting for at least one year. A follow on study by Pinto et al (2013) also demonstrated this type of approach has significant economic benefits in comparison to usual care.

Despite this positive evidence, there continues to be significant underutilisation of physiotherapy in the management of hip and knee OA in some countries (Linsell et al 2005). Other studies have demonstrated a heavy reliance on the early prescription of non-steroidal anti-inflammatory drugs (NSAIDs) (Jordan et al., 2004, Juby et al 2005) and referral of patients to an orthopaedic surgeon before more conservative treatments have been tried (Porcheret et al 2007).

Currently no research has been undertaken in New Zealand to determine if people with OA of the hip and knee are consistently being referred to physiotherapy, and whether the physiotherapy interventions they are receiving are in keeping with best practice. Additionally, little research has been completed examining the behaviour of GPs and orthopaedic surgeons with regard to their referral patterns to physiotherapy for OA of the hip and knee. Therefore, the aim of the study was to investigate self-reported behaviour, experiences, expectations and perceptions of individuals with OA of the hip and knee GPs, and orthopaedic surgeons with regards to physiotherapy referral and management.

METHODS

A questionnaire survey design was utilised to achieve the study aims. The Auckland University of Technology Ethics Committee granted ethical approval for this research project (AUTEC Approval number 12/103).

Questionnaire development

Following a review of literature pertaining to the expectations and experiences of people receiving physiotherapy for OA of the hip or knee, three questionnaires were developed; one each for people with OA of the hip or knee joints, one for GPs, and one for orthopaedic surgeons. The questions to the patient group covered such topics as common physiotherapy treatment options, access and barriers to physiotherapy and onward referral from GP's and orthopaedic surgeons. These were based on surveys used by Mitchell and Hurley (2008) and Juby et al (2005). The questions to the GPs and orthopaedic surgeons were aimed to ascertain their knowledge of the non-surgical management of OA and addressed topics including the utilisation of physiotherapy and medications, referral patterns to physiotherapists and their perceptions of the effectiveness of physiotherapy interventions. These were based on a similar survey questionnaire developed by Chevalier et al (2004). Questions in all surveys were structured using a closed format as either yes, no, multiple-choice or Likert-type responses. After the first draft of the questionnaire was completed, the research team assessed the content before sending the draft out for expert review.

Face validity was undertaken through expert review and was performed by a small group of patients with OA of the hip or knee, GPs and orthopaedic surgeons (Babbie 2011). Readability, time required to fill out the questionnaires along with the preferred method of delivery (hard copy or an online version) were considered. On receiving feedback from the reviewers, several small changes were made to improve the clarity of some questions. The final versions of questionnaires for those people with OA of the hip and knee comprised 15 questions while a set 14 questions was provided for the GPs and orthopaedic surgeons.

An online version of each questionnaire was constructed using software from the web-based survey development company Survey Monkey© (www.surveymonkey.com). This online survey tool allowed participants to access and complete the questionnaires via a web link sent to their email address.

Participants

Potential participants living on the North Shore and West Auckland with OA of the hip or knee were recruited from the Arthritis New Zealand members' database. General practitioners were identified as currently practising within the North Shore City region and orthopaedic surgeons from the national membership list of the New Zealand Orthopaedic Knee Society. Participants were excluded if they could not understand English sufficiently to complete the required questionnaires. All participants provided written informed consent to participate in the survey and were given two weeks to consider their participation following which a further two weeks was allowed to complete the survey. Hard copy versions of the questionnaire were mailed out, along with a self-addressed return envelope, to those who requested this method. The link to SurveyMonkey© was emailed to those who preferred the online version. Within one month of the completion date a follow up phone call was made to those who had agreed to participate but had not replied. Following a review of the initial responses attempts were made to increase the response rate of all three questionnaires through phone calls and emails to the groups outlined above.

SurveyMonkey© and hard copy responses from each completed participant form were directly inputted into an excel spreadsheet. The data were then analysed using descriptive statistics via SPSS (IBM SPSS Inc, Chicago, Version 19).

RESULTS

OA participant responses

Demographics of OA participants

A total of 98 participants with hip or knee OA completed the survey from a total pool of 320 (30% response rate). The demographics of the participants are presented in Table 1. See Figure 1 for flow of participant recruitment.

Figure 1: Flow diagram of recruitment of participants with OA knee or hip

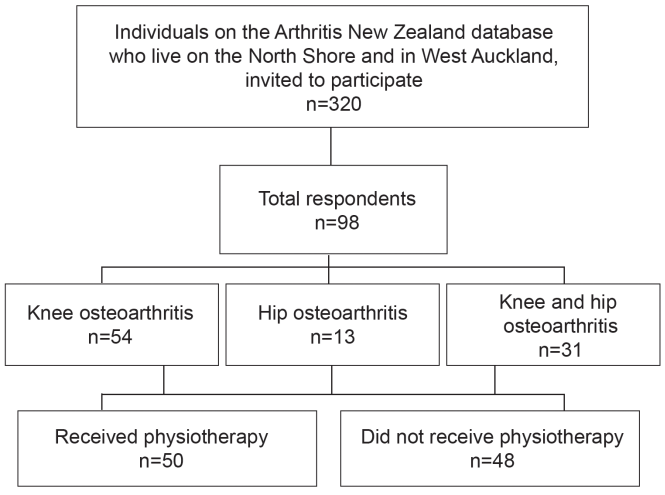

Table 1: Demographics of participants surveyed (n=98)

Age	67.6 (11.1) years		
Gender	Male: 26%	Female: 74%	
Length of time affected by OA	8.1 (6.5) years		
Location of OA	Hip and knee: 35%	Knee: 52%	Hip: 13%
Received physiotherapy for OA	Yes: 51%	No: 49%	

Data are means and standard deviations unless otherwise indicated.
Abbreviations: OA, osteoarthritis

Participants who received physiotherapy (n=50)

Of patients who had received physiotherapy for their hip or knee OA, 86% believed physiotherapy to be an important part of their management, with 80% reporting that it helped improve their condition with respect to range of motion and strength. Seventy percent of this group stated that they would like to keep using physiotherapy as long as possible, while 15% preferred to have joint replacement surgery.

(i) Perceptions of the effectiveness of physiotherapy: Responses to the question 'was physiotherapy helpful in managing your OA and if so what helped?' are displayed in Table 2. A combination of range of motion (ROM) exercises; strengthening exercises, joint mobilisations, and management advice were the most helpful interventions reported for hip or knee OA.

Table 2: Participant responses to perceived effectiveness of physiotherapy (n=50)

Response	Percentage
Physiotherapy helpful	63%
Physiotherapy not helpful	20%
Uncertain	17%
Would continue to use physiotherapy in future	51%
Would continue only if did exercises	39%
Uncertain	8%

(ii) Referral to physiotherapy: The methods of referral to physiotherapy are shown in Table 3.

(iii) Access and barriers to attending physiotherapy: Access was defined as the ability to be within close proximity of a physiotherapy clinic as well as the ability to have funding for their physiotherapy treatment. The majority of respondents reported physical access to physiotherapy in their area as being good (90%). However, 56% of respondents indicated that from a funding perspective current Accident Compensation Corporation (ACC) legislation not covering conditions like OA, was the main barrier to attending physiotherapy. Overall cost (59%) and high pain levels (24%) were the most commonly selected barriers preventing patients from attending physiotherapy treatment. Sixty-four percent of those who had received physiotherapy were aware that a referral from a medical practitioner was not required to access physiotherapy.

Table 3: Referral patterns of patients with osteoarthritis of the hip and knee to physiotherapists (n=50)

Method of Referral	Percentage
GP	53%
Orthopaedic surgeon	18%
Self-referral	29%
Immediate referral from GP	49%
Delayed referral as last resort	20%
Advice from other sources (Arthritis New Zealand or friends)	20%

Abbreviations: GP, general practitioner

(iv) Orthopaedic referral: Of the respondents who had previously undertaken physiotherapy treatment, 61% reported their surgeon suggested physiotherapy could provide advice, exercise, joint mobilisations and pain relief strategies including acupuncture, TENS and hot or cold therapy, until such a time when joint replacement may be required. Of the participants who had not responded well to physiotherapy treatment in the past, 71% reported that their surgeon still suggested the above interventions.

Participants who did not receive physiotherapy (n=48)

Forty-nine percent of respondents reported they had not received physiotherapy as a treatment for their hip or knee OA. Of these, 86% were unaware of the different interventions that physiotherapy could provide. Despite this, the majority of these patients (93%) stated that they would consider seeing a physiotherapist if they had known the benefits. Cost and the thought that physiotherapy would increase their pain were reasons why 43% of this group of participants did not want treatment. The majority of respondents (94%) stated that their

GP or orthopaedic surgeon had not discussed physiotherapy as a possible option to treat their hip or knee OA.

Medical Practitioner Responses

Demographics

A total of 24 GPs completed the survey from a pool of 52 (46% response rate), and a total of 20 orthopaedic surgeons from a pool of 76 responded (26% response rate).

Table 4: Demographic of medical practitioners surveyed (n=24)

Type of Practitioner	GP: 54%	Orthopaedic surgeon: 46%
Age years	52.2 (8.5)	
Gender	Male: 66%	Female: 34%
Number of years qualified as a medical practitioner	22.6 (8.5)	

Data are means and standard deviations unless indicated otherwise.

Abbreviations: GP: general practitioner

GP and orthopaedic surgeon management (n=44)

(i) Knowledge and management of OA: Seventy-seven percent of GPs and orthopaedic surgeons surveyed reported they gathered their information on general OA management from a combination of formal training sources (undergraduate and residency training, professional development workshops and conferences), literary resources (medical journals, clinical guidelines and internet resources), and their colleagues. Just over half of the respondents (52%) referred their patients to physiotherapy if; they had high levels of pain and disability, were of a younger age, and where radiographic evidence of OA was present. Twenty-five percent referred if they found muscle weakness or wasting, joint stiffness and preceding or following joint replacement surgery.

(ii) Criteria for surgery: With respect to referring a patient for joint replacement surgery, 18% of GPs and orthopaedic surgeons indicated that they take into account pain levels and amount of disability as their only criteria, while 25% stated using those same criteria as well as getting to the point where all other conservative options have been exhausted. A further 57% reported that a combination of the above criteria along with the patient being at the end-stage of the condition, having radiographic evidence present, and the patients request for request for surgery were important to consider.

GP management (n=24)

When treating hip or knee OA, all GPs (100%) surveyed indicated that they commonly recommended a combination of two or more management strategies including education, exercise prescription, mobilisation, walking aids, weight reduction, knee brace, orthotics, heat/ice, transcutaneous electrical nerve stimulation, acupuncture, analgesics, NSAIDs, rest, surgery, cortisone injection and physiotherapy. With respect to whether or not co-morbidities such as hypertension, diabetes and obesity influenced their referral to an exercise-based therapy such as physiotherapy, 92% stated these were not factors that prevented referral. Ninety six percent of GPs stated they had good access to physiotherapy in their area.

(i) Prescription of medication: When asked about their prescription of NSAIDs and analgesic medications, 29% of respondents indicated that they prescribe NSAIDs and analgesic medications to their OA patients before and during physiotherapy. Eighty-eight percent of respondents indicated that they prescribe NSAIDs and/or analgesic medication to patients with moderately severe OA as opposed to mild or severe OA.

Orthopaedic surgeon management (n=20)

(i) Pre-operative and post-operative referral: The recommendations for pre- and post-operative physiotherapy referral are presented in Table 5. Of the respondents who stated that they did not refer to physiotherapy preoperatively, 57% indicated that a lack of availability of physiotherapy, and a poor rate of previous success were barriers to referral. Forty-six percent of respondents indicated that if a patient was not going to have surgery on their hip or knee for years to come, they would implement a management strategy combining a range of conservative interventions. The main reason for post-operative physiotherapy referral (95%) was to provide management advice, joint mobilisations, range of motion exercises and strengthening exercises.

Table 5: Surgeon referral pre- and post-operatively (n=20)

Referral	Pre-operative percentage	Post-operative percentage
Physiotherapy required	15%	65%
Physiotherapy not required	30%	
Sometimes required	55%	35%

(ii) Perceptions of the effectiveness of physiotherapy: With respect to questions relating to the helpfulness of physiotherapy in the management of hip or knee OA, 72% of orthopaedic surgeons agreed, or strongly agreed that "there is a paucity of evidence in regards to the effectiveness of physiotherapy treatment for OA hip and/or knee". Seventy two percent disagreed or strongly disagreed that "physiotherapists lack expertise in OA management." Eighty-six percent disagreed or strongly disagreed that "conservative treatment is not an important part of OA management". Seventy-five percent of respondents agreed or strongly agreed that "past experience has shown physiotherapy to be ineffective".

DISCUSSION

The aim of the study was to investigate the self-reported behaviour, experiences, expectations, and perceptions of patients GPs, and orthopaedic surgeons with regard to physiotherapy referral and management of individuals with OA of the hip and knee. To our knowledge this was the first survey of its kind in New Zealand to gather such information.

The response rate for the OA participants was 30%, which is consistent with other research using a questionnaire survey (Reid et al 2002, Larmer et al 2002). The response rate was higher (46%) for the GPs and lower for the orthopaedic surgeon participants (26%).

Physiotherapy utilisation and perceptions of effectiveness

The current study found that approximately half of the patient population surveyed had received physiotherapy treatment for their hip or knee OA. The majority of participants with OA of the hip or knee (80%) stated physiotherapy was an important part of their management and that the benefits of physiotherapy continued after the conclusion of treatment. Some reported that these benefits depended on their continued performance of prescribed exercises. These findings support the work of Thomas et al. (2009), who demonstrated that these particular physiotherapy interventions are effective for the purpose of reducing pain and increasing function in OA patients. The results are also consistent with similar surveys of patient preferences whereby medications and physiotherapy were the most requested interventions by patients with OA of knee when consulting their GP (Mitchell and Hurley 2008). Recent findings from Abbott et al (2013) are also consistent with respect to the use of exercise and mobilisation in particular. Furthermore, recommendations made in the OARSI guidelines support referral to physiotherapy, along with patient education and self-management, aerobic and muscle strengthening exercises, thermal modalities, and acupuncture (Zhang et al 2008).

The strong support for physiotherapy from those people with OA of the knee and hip was not mirrored in the responses from the orthopaedic surgeons. This raises some concern given the amount of positive evidence available in current guidelines (Zhang et al 2008), systematic reviews (Jansen et al, 2011) and randomised controlled trials (Abbott et al, 2013). It is also in contrast to a study by De Bock et al (1992) that indicated 62% of patients were referred to physiotherapy by their doctors as part of their normal practice policy. It may also be possible that orthopaedic surgeons see patients more often at the stage where surgery is appropriate as all other conservative measures have failed to reduce the pain and disability associated with OA and hence see little need to refer on. The reasons for the reluctance to refer to physiotherapy based on a lack of evidence for effectiveness remains unclear given this evidence is widely available and accessible in electronic form. However, this may present a good opportunity for physiotherapists to apply the current strong evidence base in their treatments and strengthen the relationships with surgeons in order to increase their awareness of the effectiveness of physiotherapy.

Access and barriers to physiotherapy

Access to physiotherapy services in the current study was reported to be very good by nearly all respondents in all groups, including patients who do and do not attend physiotherapy. Of those who had previously attended physiotherapy most were aware that a doctors referral was not required to attend, however of those who have never accessed physiotherapy, a significant proportion (86%) were not aware they could attend therapy without a medical referral. This finding supports previous research by Jordan et al (2006), and Clemence and Seamark (2003), who demonstrated that previous experience and knowledge of the healthcare system can predict future consultations among patients with knee pain, and influence patient expectations of what healthcare services such as physiotherapy have to offer. Raising awareness of health system protocols, specifically that a medical referral is not needed in order to attend physiotherapy for OA, may be a key factor in improving physiotherapy utilisation. There were still a high percentage of respondents who had not received physiotherapy and were unaware of what it could offer. What is clear from this study is that more information regarding physiotherapy treatment of OA, and how to access it, needs to be delivered to patients in an effective and credible manner.

The most significant barrier noted which prevented attendance was cost (59%), followed by the belief that physiotherapy interventions may increase pain and symptoms (43%). The costs associated with accessing health care services for physiotherapy are clearly different for individuals who meet the ACC's criteria for treatment cover (personal injury by a physical event such as an accident), compared to those with a chronic long term illness or condition such as OA. These costs are relevant to both physiotherapy and medical consultations and are seen as problematic by the majority of participant responses in the current study. This disparity in health funding may also be a result of the fact that arthritis and musculoskeletal pain are not listed as priorities in the New Zealand Health Strategy and therefore do not attract the same levels of government funding as other chronic and costly diseases such as diabetes and cardiovascular disease (King 2000). This disparity in funding may require health professional groups to lobby the government to alter these current funding provisions given the future projections of those who will be living with OA (Arthritis New Zealand 2010).

Referral to physiotherapy

Fifty three percent of respondents in this survey were referred to physiotherapy by their GP. Approximately half reported immediate referral, while one fifth were referred as a last resort. Of the half that had not received physiotherapy, the majority stated that their GP or orthopaedic surgeon had not discussed physiotherapy as a possible option for them. Previous research by Linsell et al (2005) in a similar patient population in the United Kingdom found that just 2.4% of patients were referred to physiotherapy from their GP on the first consultation, with this figure increasing to 17.7% if they again consulted within 36 months. While the current study displays improved referral statistics compared to the study by Linsell et al (2005) referral patterns still remain low.

With respect to pre-operative referral to physiotherapy for knee or hip replacement surgery, the majority of respondent orthopaedic surgeons (55%) believed physiotherapy to be 'sometimes' worthwhile before surgery, but almost one third did not. Current evidence from a recent systematic review and meta-analysis by Wallis and Taylor (2011) indicates that there is low to moderate strength evidence that pre-operative physiotherapy is useful to improve pain and function, and that these improvements are not carried over to the post-operative phase. Further research into the effectiveness of pre-operative physiotherapy will be required if these views are going to change.

With respect to the utilisation of post-operative physiotherapy, 65% of surgeons stated they would refer to physiotherapy

following a joint replacement. This is in keeping with a recent RCT by Bade and Stevens-Lapsley (2011), who found that high intensity rehabilitation after total knee joint replacement provided lasting benefits with respect to quadriceps strength and function at three, 12 and 52 weeks post-operatively when compared to a low intensity exercise control group.

Implementation of Clinical Practice Guidelines

The current study found that the most common management strategy suggested by GP's and orthopaedic surgeons to patients with hip or knee OA was to use a combination of pharmacological and non-pharmacological interventions. These modalities would continue to be recommended by surgeons if the patient was not going to have surgery for some time. These approaches are consistent with current OARSI guidelines (Zhang et al 2008). However given that 94% of the participants in the current study who had not attended physiotherapy stated that their GP or orthopaedic surgeon had not discussed physiotherapy with them, there would seem to be a lag between the use of the guidelines and current practice. Further research into the uptake of guideline based care for the management of OA hip and knee is required.

Prescriptions

The prescription of NSAIDs and analgesic medications by GPs in the current study was found to occur most often when OA was perceived to be moderately severe, as opposed to mildly or very severe. A number of studies have commented that pharmacological treatments in general are being overused while non-pharmacological treatments such as physiotherapy are being underutilised (Chevalier et al 2004, Glazier et al 2003, Jordan et al 2004, Mitchell and Hurley 2008). However, other research has found that patients are often more satisfied with medications and surgery rather than other conservative measures (Juby et al 2005). Many participants in the current study seem more satisfied with conservative measures such as physiotherapy.

Referrals for surgery

All respondent GPs and orthopaedic surgeons were found to use pain and disability as criteria for surgical referral. Most exhausted all other conservative treatment options first, and the majority also took into account the patient being at the end-stage of their condition, radiographic evidence, and/or patient request. These results are in contrast to other studies. Bedson et al (2003) demonstrated that the presence of radiographic OA caused a marked increase in orthopaedic referrals, while Porcheret et al (2007) observed that surgical referral was initiated before more conservative interventions had been tried. Glazier et al (1998) also found that a quarter of physicians referred patients with knee OA inappropriately, typically on to receive orthopaedic surgery. These types of referral were not evident in the participants of the current study.

Limitations

There are a number of limitations in this study. Surveys of this type are affected by the response rate and the population of interest. The patient response rate in the current study was low but an alternative to this method would have been individual in-depth interviews with participants who have OA and the medical professionals who treat these people.

The participants with OA in this study were recruited from the Arthritis NZ database. This may have biased the sample as they have already demonstrated an interest in the management of OA by joining Arthritis NZ. There may be other potential participants in the community who have a different level of knowledge and experience with physiotherapy. The sample population was chosen to try and give a good spread of socioeconomic participants by including the North Shore and West Auckland. Therefore these results are not generalisable to all people suffering from OA of the hip and knee in New Zealand. However, it should be acknowledged that in other parts of Auckland city, there are areas of greater socioeconomic hardship that may prevent these people accessing or seeking medical or physiotherapy care. These participants' information may well have altered the results, should they have been surveyed.

The survey questionnaires did not include questions that would have differentiated between services delivered in the public or private sectors nor were there questions on the severity of the disease or the length of time determined as the pre-operative period.

Future research

Broadening the scope of this survey to other parts of Auckland City and New Zealand in general, would be of interest. The survey could also be repeated in years to come to see if the referral patterns and access to therapy have changed following future promotional campaigns by physiotherapists. Combining this type of survey with focus groups or qualitative interviews to expand on the experiences of these participants and to see how access and services might be better delivered in future, would also be helpful. This study has shown there are a group of patients who are consulting their GPs about their knee and hip OA, but are not being referred onto physiotherapy, the reasons for non-referral warrants further examination.

CONCLUSIONS

The current study investigated the self-reported behaviour, experiences, expectations, and perceptions of general practitioners (GPs), orthopaedic surgeons, and patients with regard to physiotherapy referral and management of individuals with OA of the hip and knee. It found that physiotherapy interventions such as ROM exercises, strengthening exercises, joint mobilisations and management advice, which are strongly recommended by CPGs and current research, are valued by OA patients who have received them, and are the interventions that GPs and orthopaedic surgeons commonly request when referring to physiotherapy. The referrals for physiotherapy-led treatment are not as strongly supported by orthopaedic surgeons. A balanced mixture of pharmacological and non-pharmacological interventions are currently utilised by GPs when treating OA hip and knee, which reflects CPGs. However referral patterns are not in keeping with current evidence supporting the efficacy of physiotherapy in the management of OA of the knee and hip. This may change with improved funding support to GPs and physiotherapists which in turn may improve access. Further awareness of health system protocols specifically that a medical referral is not needed in order to attend physiotherapy for OA, may be a key factor in improving physiotherapy utilisation.

KEY POINTS

- Physiotherapy treatment is perceived by patients with hip and knee OA to be effective in the management of their condition
- Patients who are receiving physiotherapy are provided management consistent with current best practice guidelines
- GPs do regularly refer patients to physiotherapy but further improvements may be possible from other groups such as orthopaedic surgeons
- Based on the responses of orthopaedic surgeons further research is required to determine the effectiveness and utilisation of physiotherapy pre-operatively for joint replacement

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CONFLICT OF INTEREST

The authors hereby declare there is no conflict of interest with this submission.

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Does use of the Cough Assist Machine reduce respiratory morbidity for children with neuromuscular disease?

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ABSTRACT

The role of the Cough Assist Machine (CAM) in the long term respiratory management of children with neuromuscular disease (NMD) is unclear. This study examined the impact of regular, home use of the CAM on the respiratory status of six children with NMD and significant respiratory morbidity. Individualised CAM programmes were devised to be undertaken regularly. Retrospective review of hospital records was undertaken to obtain admission data, lung function data, community antibiotic prescriptions and chest radiology reports for the two years prior to CAM initiation. These data were compared to data collected for two years following CAM initiation. Fewer days hospitalised for respiratory infections following machine initiation were evident for all participants. Qualitative feedback indicated high treatment compliance and satisfaction. Four of the five participants, with persistent or recurrent chest radiology abnormalities on enrolment, achieved resolution. Half of the participants had a reduction in community antibiotic prescriptions. No adverse events were reported. Acknowledging the small sample size, domiciliary use of the CAM appears a safe and effective form of airway clearance for some children with NMD. In addition, CAM's may potentially reduce respiratory admission time for some children with severe respiratory morbidity as a result of their NMD. Furthermore an impact on radiological abnormalities and community antibiotic prescriptions may also be possible.

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Key words: Neuromuscular diseases, Cough, Physiotherapy modalities, Spinal Muscular Atrophy, Duchenne Muscular Dystrophy

INTRODUCTION

Neuromuscular diseases (NMD's) are disorders caused by an abnormality of any component of the lower motor neuron system. This can include anterior horn cell, peripheral nerve, neuromuscular junction, or muscle (Rossi et al 2004). The most common NMD's in children are genetic and include a range of dystrophies, spinal muscular atrophy (SMA), hereditary motor sensory neuropathy, and congenital myasthenia gravis (Rossi et al 2004). Early symptoms include infant floppiness, poor feeding, and failure or delay in achieving motor milestones. In more severe neuromuscular disorders, symptoms can progress to include loss of ambulation, scoliosis, and respiratory impairment (Rossi et al 2004). Despite significant advances in respiratory management, respiratory complications remain the most common cause of hospital admission and often, the eventual cause of death in this severe group (Chatwin and Simonds 2009).

Children with NMD have normal chest wall, lung, and upper airway structure at birth. In those with severe respiratory involvement prolonged low lung volumes can result in chronic microatelectasis, muscular fibrosis, articular contracture, and subsequent chest wall deformity. Furthermore, reduced muscle activity can contribute to chronic hypoventilation, reduced cough peak flows (CPF), and subsequent impaired chest clearance (Chatwin et al 2003). Long term this impairment in chest clearance can result in pneumonia, atelectasis, and altered gas exchange, with subsequent supplemental oxygen dependency and respiratory acidosis (Miske et al 2004).

Consensus statements for the management of Duchenne's Muscular Dystrophy (DMD), SMA and Congenital Muscular Dystrophy (CMD) all highlight regular pulmonary function testing, polysomnography, Non-Invasive Ventilation (NIV), and appropriate airway clearance techniques as imperative (Finder 2009, Wang et al 2007, Wang et al 2010), if the inevitable spiral to respiratory failure is to be delayed (Homnick 2007). Airway clearance strategies involve techniques to:

- Loosen secretions (manual percussion vibrations and High Frequency Chest Wall Oscillation),
- Assist insufflation (glossopharyngeal (frog) breathing, breath stacking with an ambu bag, insufflation with cough assist machine),
- Augment cough (manually assisted cough and mechanically assisted cough (CAM)) (Wang et al 2010).

Given children with NMD's tend to retain mucociliary clearance while losing cough clearance, at least in the early stages, it is the latter two categories that tend to be of greatest effect (Finder 2009). Despite an absence of randomised controlled trial data suggesting an advantage, the use of CAM's has increased over the last two decades (Hull et al 2012). However, for many

children and young people in New Zealand access to devices is precluded by the relatively high cost and limited expertise to support optimal use.

The use of CAM's to augment cough peak flow (CPF) in NMD was championed by Bach in the early nineties (Bach 1993). Observational studies followed, suggesting that in combination with non-invasive ventilation (NIV), CAM's may reduce pulmonary morbidity in both adults and children with a range of NMD's (Bach et al 1997, Simonds 2006, Tzeng and Bach 2000). In an acute paediatric setting, CAM's have been shown to reduce chest physiotherapy treatment time (Chatwin and Simonds 2009) and reduce the incidence of treatment failure leading to tracheostomy (Vianello et al 2005). Further studies have concluded that CAM's may be a useful tool post operatively for children with NMD to avoid prolonged intubation, particularly following scoliosis surgery (Marchant and Fox 2002).

In an out-patient setting CAM's have been shown to result in significant increases in CPF both after (Fauroux et al 2008) and during use (Chatwin et al 2003). This increased CPF is particularly evident when used in combination with manually assisted cough manoeuvres (Chatwin et al 2003). Three previous studies have examined the safety and efficacy of long term routine use of the CAM at home in the paediatric population (Chatwin et al 2011, Miske et al 2004, Moran et al 2013). Only one has previously considered hospitalisation as an outcome measure (Moran et al 2013). The primary focus of Moran et al's study was to assess the impact of home use of the CAM on hospital admissions in children with NMD. Though only considering a small sample of ten children, they concluded that CAM's were an effective and well-received means of managing inter-current infections at home (Moran et al 2013). The current study builds on Moran et al's findings by considering the impact of the CAM on both hospital admissions and the wider respiratory health of participants.

BACKGROUND

In 2006, monies donated by the local Muscular Dystrophy Association (MDA) funded a CAM for acute use at the Starship Children's Hospital (SCH) in Auckland, New Zealand. Initial outcomes from its use were overwhelmingly positive. Seven years on, SCH now has fourteen machines in total, three for acute in-patient use and eleven for use in the community. Funding for these was sought annually through the hospital budget and Starship Charitable Foundation. Due to the significant cost of the machine ($12,000 NZD) evidence of treatment effect was requested by hospital management, hence implementation of this study. We hypothesised that regular domiciliary use of the CAM would be safe and improve the respiratory morbidity of participants over a two year period.

METHODS

Participant recruitment

Any child with a diagnosed neuromuscular disorder (excluding SMA I) admitted between January 2007 and May 2010 fitting the criteria below were approached to participate. Children with severe respiratory morbidity were identified following acute admissions for respiratory infection. If these children presented with severely impaired cough and failure to maintain respiratory health despite optimal conventional management then they were invited into the study. Conventional management was defined as consisting of parenteral or enteral antibiotics, nutritional supplementation, non-invasive ventilation, and age appropriate traditional chest clearance techniques as indicated. Failure to maintain respiratory health was defined as experiencing:

- One severe respiratory infection resulting in Paediatric Intensive Care Unit admission or a significant deterioration in respiratory status from their baseline which is not significantly improved by discharge.

  or

- Two or more admissions with significant respiratory infections in a six month period requiring antibiotics and a prolonged hospital stay.

  or

- Three or more prolonged courses of oral antibiotics at home for repeated chest infections over a nine month period.

Children with SMA I were excluded from the study due to their young age and difficulties in identifying optimal conventional respiratory management (Chatwin et al 2011).

Children were identified by their treating therapist or respiratory consultant as an in-patient. Both families and children were provided with age appropriate written and/or pictorial information regarding the study. Written consent was obtained from each child's legal guardian. Children provided informed verbal or written, assent or consent appropriate to their age and developmental stage. Over the enrolment period seven young people were identified as fitting the inclusion criteria. One young person refused consent to participate, the further six families consented. Once enrolled, all programme prescription, education, and machine set-up was undertaken by the researchers.

Investigations / observations undertaken

Once identified and consented, management was identical to the optimal conventional management outlined above with the addition only of the CAM as part of an airway clearance programme. Follow-up was as per standard best practice care. This consisted of annual reviews with both the respiratory physician and the physiotherapist, with routine chest x-ray (CXR) and lung function performed at these times. Respiratory physiologists performing lung function tests and radiologists reading and reporting on CXR's had no knowledge of the study and as such were fully blinded. Participants were individually assessed by an experienced respiratory physiotherapist and two tailored CAM programmes were developed in partnership with the patient and family. One programme was for use when 'well' and one when 'unwell' with respiratory symptoms. Participants and their care-giver were fully trained on the implementation of the two programmes. The lowest effective pressure that enabled thoracic expansion on inspiration and effectively cleared secretions on expiration was prescribed for each participant (range ±25cmH20 to ± 45 cmH20). This was increased slightly (by 5cmH20) for some participants when they became unwell. Adaptations to programmes were made based on patient need and presentation throughout the two year study period. All were asked to use the CAM at least once a day.

Over a two year period from initiation, the number of inpatient days for respiratory infections was measured. Their data were compared to that collected in the two years prior to CAM initiation by retrospective review of hospital records. Secondary outcomes considered were the number of oral antibiotic prescriptions, pulmonary function tests (PFT) (forced vital capacity (FVC), forced expiratory volume in the first second ($FEV_{1)}$, and cough peak flow (CPF) where available) and radiological changes. Qualitative feedback about use of CAM and compliance with its use was obtained from families and children where appropriate. In the absence of any suitable published questionnaires, a treatment satisfaction survey and a treatment impact questionnaire, specifically developed for this study, were utilised. The survey consisted of ten statements to be scored on a Likert scale and three open ended questions regarding participant's views of the positive and negative elements of the CAM (Appendix 1, see website). The treatment impact questionnaire consisted of six open ended questions regarding compliance and treatment impact on both the child and the wider family (Appendix 2, see website). The questionnaire was not validated or checked for reliability but was based on past literature and our previous research experience. The New Zealand Health and Disability Ethics Committee approved the study.

RESULTS

Demographics

Six children with NMD were prospectively followed for two years following initiation of a regular, at-home CAM programme (Table 1). All were wheelchair bound and had scoliosis either on study initiation or developed one during the study. Four underwent spinal rodding surgery to correct their spinal deformity prior to or during the study. In case 3, the parents declined operative intervention, and in case 2 the surgery was completed after the study finished. One child was gastrostomy fed due to failure to thrive. None had significant symptoms of or were prescribed therapy for gastro-oesophageal reflux which has been highlighted as a precaution of use of the CAM (Miske et al 2004).

Table 1: Patient characteristics

Case	Diagnosis	Sex	Age at initiation of CAM (years)	Age at initiation of home NIV (years)
1	SMAII	F	14.9	12.5
2	SMAII	F	2.8	2.8
3	CMD	M	12.0	6.8
4	SMAII	F	5.6	-
5	SMAIII	F	7.5	-
6	SMAII	F	12.8	6.5

CAM: Cough Assist Machine, NIV: Non-Invasive Ventilation, SMA: Spinal Muscular Atrophy, CMD: Congenital muscular dystrophy; F: female; M: male

Outcomes

Admission numbers and days hospitalised for respiratory infections for each child are summarised in Table 2. Statistical analysis of the admission and community antibiotic data is summarised in Table 3. Data from two years prior to CAM initiation were compared with those collected during the two years following initiation using a paired t-test. Secondary outcome measures are summarised in Table 4.

Table 2: Summary of days hospitalised (admission numbers) 2 years before and after initiation of CAM

Case	-2 years	-1 year	CAM initiated	+1 year	+2 years
1	60 (2)	85 (5)	26/01/07	37 (2)	0
2	4 (2)	39 (3)	23/10/07	36 (4)	10 (3)
3	6 (1)	5 (1)	09/11/07	0	0
4	3 (1)	13 (1)	30/08/08	0	0
5	0	29 (1)	22/01/10	4 (4)	6 (1)
6	0	10 (3)	01/04/10	1 (1)	4 (1)
Total	73 (6)	181 (14)		78 (11)	20 (5)

CAM: Cough Assist Machine

All participants had fewer days hospitalised for respiratory infections per year following CAM initiation. Though p-values are not significant, mean values demonstrated a clear trend to lower admission days and to a lesser extent of admission numbers post CAM initiation.

In cases 1 and 3, a reduction in community antibiotic use per year was marked, with no antibiotics prescribed in the second year of study. In case 2, antibiotic use reduced slightly per year. In cases 4-6, community antibiotic use remained static or slowly escalated despite the introduction of the CAM. Of note, Case 6 was prescribed Cotrimoxazole once daily as prophylaxis for her recurrent chest symptoms prior to study initiation and this was continued throughout the study period.

Five of the six participants had persistent or recurrent CXR abnormalities prior to the study. Of these five, four demonstrated radiological resolution after initiation of the CAM. Overall, there were no trends or changes in PFT's during the course of the study.

Qualitative information

Patient and family satisfaction with the CAM was high with mean treatment satisfaction scores of 92% (range 85%-97.5%). Qualitative feedback was overwhelmingly positive. Ease of use, prophylactic benefits, reduced treatment time, greater treatment comfort and efficiency were highlighted as the most common positive aspects. Negative aspects identified the limited portability of the device, noise and age appropriate resistance to use initially in the two youngest participants.

Compliance

The recommended daily usage was undertaken in all cases for the first six months of the study period, and for the entire study period in three cases. All participants reported regular usage (ranging from twice daily to twice weekly) when well for the entire two year study period. This was increased to multiple times a day when unwell in all cases to aid secretion clearance. One patient (case 4) complained of sore ears and another (case 6) experienced initial musculoskeletal chest pain. Inspiratory and expiratory pressure was subsequently reduced by ±5cmH2O with acceptable effect in both cases. No other complications were reported.

Table 3: Statistical analysis of outcome measures at 1 and 2 years post CAM initiation

Outcome measure	Mean (SD) 1 yr Pre CAM	Mean (SD) 1 yr Post CAM	Mean difference (95% CI)	p-value	Mean (SD) 2 yrs post CAM	Mean difference (95% CI)	p-value
Days hospitalised	30.2 (29.7)	13.0 (18.3)	-17.2 (-35.0 to 0.7)	0.06	3.3 (4.1)	-26.8 (-58.3 to 4.7)	0.08
Number of hospital admissions	2.3 (1.6)	1.3 (1.5)	-1.0 (-2.5 to 0.5)	0.14	0.8 (1.2)	-1.5 (-3.5 to 0.5)	0.11
Number of community antibiotic prescriptions	3.7 (2.4)	3.5 (2.1)	-0.2 (-1.7 to 1.4)	0.79	3.0 (2.7)	-0.7 (-3.9 to 2.6)	0.62

CAM: Cough Assist Machine

Table 4: Summary of secondary outcome measures

	Pre CAM Initiation					Post CAM initiation				
Case	PFT 2 years prior to enrolment		Chronic radiological abnormalities	Community Antibiotic courses		PFT 2 years following study enrolment		Chronic radiological abnormalities	Community Antibiotic courses	
	FVC	FEV_1		-2 years	-1 year	FVC	FEV_1		+1 yrs	+2 yrs
1	0.92 (29%)	0.83 (30%)	Y	7	4	0.79 (20%)	0.69 (18%)	N	3	0
2	Too Young		Y	2	8	Too Young		N	7	6
3	1.48 (62%)	1.18 (58%)	Y	6	4	1.73 (59%)	1.16 (43%)	N	2	0
4	0.65 (50%)	0.50 (41%),	N	1	1	0.72 (40%)	0.68 (42%)	N	1	2
5	1.31 (96%)	0.91 (74%)	Y	1	2	1.58 (90%)	1.42 (89%)	N	4	5
6	0.59 (19%)	0.46 (15%),	Y	2	3	0.55 (19%)	0.57 (19%)	Y	4	5

CAM: Cough Assist Machine; PFT: pulmonary function tests; FVC: forced vital capacity; FEV_1: forced expiratory volume in the first second; Y: yes; N: no;

DISCUSSION

CAM's are an expensive and therefore scarce resource in New Zealand. Furthermore, there is limited information regarding the benefits of long term use in children with NMD. This study supports previous work highlighting the safety, tolerance, and acceptability of CAM's in children (Fauroux et al 2008, Gauld 2009, Miske et al 2004, Moran et al 2013). While the cohort of this study was small and heterogeneous, it demonstrates the ability of CAMs to reduce hospitalisation time despite the inexorable decline in pulmonary function documented in children with severe NMD's. Furthermore, in some cases, resolution of radiological abnormalities, and reduced community antibiotic use was also seen.

Two previous studies have examined the effects of long-term use of CAM's in children. In a similar study, Moran et al (2013) considered hospitalisation time for children with NMD using CAM at home. Our study supports the findings of Moran et al demonstrating days hospitalised as the primary improvement for all participants over the study period. Though Moran was able to demonstrate a slightly larger magnitude of change, the trend is clear in both studies. The limiting factor for both studies is seen in the small sample size and subsequent limited statistical power.

Neither study was able to demonstrate a statistically significant effect on the number of hospital admissions, though a reducing trend is evident in our data. This may suggest a reduction in both severity of respiratory infections or greater empowerment of families to manage inter-current infections out of hospital. Feedback from our families suggests elements of both are true, along with improved overall respiratory health.

In addition to reduced hospitalisation time and radiological resolution, a high level of treatment satisfaction was observed. A similar level of treatment satisfaction was seen in both an on-demand CAM programme for adults with ALS (Vitacca et al 2010) and a patient survey regarding the impact of CAM on life style in paediatrics (Moran et al 2013).

The positive qualitative findings reported from parental surveys in Moran et al (2013) are supported by the feedback we received from the families involved in our study. Key elements in both studies were the ability to remain at home during respiratory infections, prevention of infections through regular effective clearance, and increased well-being. Both study groups reported the size of the CAM and its reliance on mains power as negative elements of the machine but none felt these outweighed the positive aspects. In addition to these elements, our study families identified reduced treatment time and greater treatment practicality as major bonuses. These elements have been highlighted previously as benefits in the acute paediatric setting (Chatwin and Simonds 2009); though these have not been considered before in the community context.

Although we had intended to measure quality of life using the PEDS-QOL, our participants and their families found this questionnaire inappropriate to their situations and as such they were not completed. The questionnaires that we designed for this study were not validated, but based on domains found to be important in past research of parent satisfaction for paediatric nursing and hospital care i.e. information, outcome, harm from treatment, staff professionalism and overall satisfaction (Bitzer et al 2012, Erden et al 2006, Thomas et al 1995, Thompson and Sunol 1995).

In our questionnaires we also included device effectiveness, reliability convenience, ease of use and portability, because these had been identified as important aspects of parental satisfaction with medical technology (McNamara et al 2009). In future research we suggest a specific quality of life questionnaire needs to be constructed and validated for use in this population.

Miske et al (2004) described a cohort of 62 young people (median age 11.3 years) using CAM's for mean duration of 13.4 months (Miske et al 2004). Only five of the 62 had reduced lower respiratory tract infections (LRTI's) post-treatment and demonstration of this was reported to be difficult due to the small number of LRTI's experienced pre-treatment (Miske et al 2004). In our series, the primary criterion for allocation of CAM's was increasing LRTI's, and subsequent hospitalisation. As such, an effect on this variable was more easily demonstrated.

In the study by Miske et al (2004), resolution of chronic atelectasis over the study period was reported in only four of the 64 participants. In contrast, in our study, four of the five cases with chronic radiological changes demonstrated complete resolution over the study period. This suggests that an impact on radiology is possible and the difference in findings for both LRTI's and radiological resolution may simply reflect the stage in disease at which the CAM was introduced. This may be similar in regards to the findings for community antibiotic use. In our first three cases, both hospitalisation and community antibiotic use declined, suggesting an overall improvement in respiratory management. Many children with respiratory complications of NMD present with persistent atelectasis and likely increased bacterial load. As such, they are at greater risk of bacterial super-infection. Though CAM's are unable to prevent infections, we suggest that, through optimising airway clearance, the severity and complications of respiratory infections can be reduced. As identified previously, reduced hospital admissions may reflect a greater capacity and confidence of families to manage increased respiratory symptoms at home. This may explain why for some participants, community antibiotic prescriptions increased as hospitalisation time reduced. Given the small cohort of this study, however, these suggestions can only be speculative. Further research is required in this area to determine the optimal point of initiation of the device to balance burden of care and cost with maintenance of optimal respiratory health.

Increased LRTI, and failure to maintain respiratory status with standard ACT's have been suggested as clinical indicators for the initiation of the CAM (Chatwin and Simonds 2009, Miske et al 2004). Pulmonary function tests have been proposed as the main means of guiding ACT initiation in some types of NMD. In Duchenne's Muscular Dystrophy (DMD) a CPF of <160L/min has been proposed as the level at which a CAM is likely to be required (Bach et al 1997). In children, initiation of domiciliary CAM has been proposed when Peak Expiratory (PE) Max dropped below 60cmH20 (Miske et al 2004). However, clinically these thresholds have their limitations due to difficulties gaining reproducible figures in those with severe restrictive patterns and children under the age of six (Miske et al 2004).

Though an increase in FVC and Peak Inspiratory (PI) Max has been hypothesised with CAM use (Bach 2002), no evidence of effect was seen on PFT's of participants in our group. This may reflect both the longevity of disease prior to CAM initiation and disease severity of participants. It is also noted that while five of the six children had established kyphoscoliosis at initiation of CAM. Case 2, the youngest child, developed kyphoscoliosis regardless of regular CAM use from two years nine months of age. It has been proposed that CAM may assist in maintaining lung compliance and chest wall range of motion (Chatwin et al 2011), which should theoretically prevent development of kyposcoliosis. The patients and caregivers in this series were encouraged to utilise the CAM a minimum of once daily when well and increase use as required to clear secretions when unwell. This decision was made because, although limited evidence exists, daily prophylactic use has been proposed to maintain expansion (Bach 2002), clear secretions in those with chronic sputum retention, and ensure familiarity (and thus treatment effectiveness) is maintained (Miske et al 2004).

A limitation of the CAM model used in this study was the inability to log usage data to provide an objective measure of treatment compliance. The machines were reported to be used from twice daily to twice weekly when participants were clinically well and multiple times a day when unwell to clear secretions. This varied usage is similar to that reported in other studies (Miske et al 2004, Moran et al 2013). As newer digital CAM's with compliance downloadable data become more available, further research opportunities in the area of compliance can be explored.

Pressure settings were individualised in a comparable way to that described in other studies (Chatwin et al 2011, Miske et al 2004). Despite a relatively homogenous group, pressures prescribed ranged from ±25 to 45cmH2O (median ±35cmH2O). Model based research suggests a minimally effective pressure of ±30cmH2O (Go´mez-Merino et al 2002). Clinical papers have described pressure use in paediatrics from ±15cmH2O (Miske et al 2004), to ±50cmH2O (Bach 2002), and this reflects the need to develop individualised programmes based on clinical assessment rather than on age or disease type (Miske et al 2004). Inspiratory and expiratory times for the participants in this study were not set, as all caregivers were taught to utilise the device on manual mode. This was done to enable caregivers to synchronise the device to the child, depending on individual needs and clinical presentation, and to provide the children with a level of control. To date, criteria to determine when manual or automatic modalities should be used in children are lacking (Panitch 2009).

A limitation to this study was that our sample comprised of a small and heterogeneous group. However, given the small prevalence of children with such significant neuromuscular weakness and subsequent respiratory morbidity to fulfil our criteria, an extended multi-centre international trial would

be required to address this. Though a randomised controlled trial would be considered optimal, growing research support for CAM's, along with their gradual increased use in clinical practice, means withholding this treatment from study participants may be difficult to justify ethically.

In addition, although community antibiotic prescription was recorded for each case, this does not necessarily equate with antibiotic use, due to the potential of non-compliance with medication use.

Lastly, specific cost benefit analysis has not been undertaken for this study. However with a day's admission to the medical subspecialty ward at Starship costing $1600 NZD and one day in the Paediatric Intensive Care Unit costing $6000 NZD the approximately $12,000 NZD outlay for a CAM presents a fiscally as well as clinically attractive option.

CONCLUSION

This report demonstrates the potential effectiveness of CAM's in reducing hospitalisation for respiratory infections and improving chest radiology and community antibiotic prescriptions in children with severe NMD. We hope this study and its report will assist both those considering utilising the device clinically and in the development of a protocol for larger prospective studies. Furthermore, the findings may encourage paediatric services to consider trial of CAM's as an effective means of supporting those children who are experiencing significant respiratory morbidity despite optimal traditional management. Even if this intervention and investment only off sets the healthcare costs from paediatric to adult years, the feedback from children, young people and their families suggests the investment is justified.

KEY POINTS

- Home use of the Cough Assist Machine can safely reduce hospitalisation for respiratory infections in children with neuromuscular disease within the New Zealand context.
- A positive impact may also be seen on chronic chest radiological changes with home use of the Cough Assist Machine.
- Qualitative feedback from children and families supports a high level of treatment acceptability and satisfaction with home Cough Assist Machine use.
- Prophylactic home treatment with Cough Assist Machines could be considered a safe, effective and fiscally responsible means of managing severe respiratory morbidity in children with neuromuscular disease.

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Permissions

Ethics

The study received ethical approval from the Northern X branch of the Health and Disability Ethics Committee (Ref #NTX/09/03/018) In addition approval was obtained from the Auckland District Health Board Research Review Committee (A+4351) and the Maori Research Review Committee All caregivers gave written informed consent for inclusion in the study. All children provided informed verbal or written, assent or consent appropriate to their age and developmental stage.

DISCLOSURES

This study received no funding from any source. None of the authors identify any conflicting or competing interests

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Learning needs analysis comparing novice and expert opinion, to develop a simulation-based intensive care unit training programme

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ABSTRACT

A learning needs analysis was performed using an online survey to establish the most appropriate curriculum for a simulation-based intensive care training programme for junior physiotherapists. Perceptions were compared between an intensive care-naïve 'novice' group of rotational physiotherapists from a single tertiary teaching hospital in Melbourne, Australia, and an 'expert' group of senior intensive care physiotherapists from across Australia. The learning needs analysis survey involved two questions. Question one required participants to rank assessment topics for perceived training importance from 1 (greatest) to 6 (least). Question two required participants to select which treatment topics from a list (total 15) they felt important for further training. 14/15 (93%) of the novice group, and 15/16 (94%) of the expert group completed the surveys. The highest ranked assessment topics for both groups were assessing intubated, ventilated patients and assessment of haemodynamically unstable patients. The highest rated treatment topics for both groups were lung hyperinflation, and rehabilitation. Based on these results and practical considerations, the subsequently developed simulation-based intensive care training programme comprised four modules: general assessment of an intensive care unit patient, assessment of haemodynamically unstable patients, positioning, and lung hyperinflation.

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Key words: Physiotherapy specialty; Critical care; Continuing education; Questionnaires; Simulation training

INTRODUCTION

The use of immersive simulation in health professional training is growing at a dramatic rate (Blackstock and Jull 2007, Bradley 2006, Issenberg and Scalese 2007, Jones 2011, Jones and Sheppard 2007, Jones and Sheppard 2011, McGaghie et al 2010, Shoemaker et al 2009). Medical specialties including emergency medicine, intensive care and anaesthesia have been the longest users and continue to lead this growth (Bradley 2006, Issenberg and Scalese 2007, McGaghie et al 2010, Shoemaker et al 2009, Singer et al 2013). Simulation use within nursing education is also increasing worldwide, including in Australia and New Zealand (Brown et al 2012). Other health professionals, including physiotherapists, have been slower to adopt these newer teaching methods (Blackstock and Jull 2007, Gough 2011, Jones 2011, Jones and Sheppard 2007). Simple forms of simulation have been part of physiotherapy training for many years (Blackstock and Jull 2007), with classmates or colleagues acting as standardised patients to enable learning and practising of manual assessment and treatment techniques (Health Workforce Australia 2010). Also, part-task trainers such as resuscitation mannequins have been commonly used to teach CPR skills. There is a growing body of research into many different aspects of simulation use with physiotherapy students (Blackstock et al 2013, Gough 2011, Huhn et al 2008, Jones 2011, Ladyshewsky et al 2000, Watson et al 2012), including an Australian Government report into simulation use in physiotherapy education, prepared by representatives of seven Australian universities (Health Workforce Australia 2010). Despite this, there remains a paucity of literature relating to simulation training for qualified physiotherapists. A search of the literature (Electronic databases searched, to 31st October 2013: Medline, CINAHL, Google Scholar; bibliographies of identified articles hand-searched) found only one peer-reviewed English-language publication relating to simulation training for qualified physiotherapists: a conference report on a nationwide survey of simulation use in the United Kingdom (Gough 2011).

It is common practice in Australia and New Zealand hospitals for recently graduated or inexperienced physiotherapists to rotate through a number of clinical areas to develop their clinical abilities. These rotational physiotherapists often also undertake rostered weekend work in the Intensive Care Unit (ICU).

Prior to 2010, the weekend training programme for rotational physiotherapists at St Vincent's Hospital, Melbourne, consisted of five consecutive days of supervised clinical practice with the ICU Senior Physiotherapist. An internal programme audit in 2008 highlighted the narrow clinical exposure this practice provided for these rotational physiotherapists: they only experienced those clinical presentations present in ICU at the time of their training. Also, there were no formal refresher sessions after the initial five days of training.

In response to this audit, it was decided to develop a modular, simulation-based ICU training programme for the rotational physiotherapists. The proposed programme would consist of four discrete training modules, based on the specific topics determined through a learning needs analysis. Each hour-long module would include three components: an introduction and tutorial to ensure participants had the necessary theoretical knowledge for that topic; a 'bedside' practical session with the mannequin (METI Human Patient Simulator, CAE Healthcare, Canada) to allow practice of relevant technical skills; and an informal debrief, to allow reflection and for discussion of any questions which had arisen. The reflection stage is considered to be key to acquisition of new knowledge and skills, as noted by Sandars (2009, p 686): 'The experience must be interpreted and integrated into existing knowledge structures to become new and expanded knowledge. Reflection is crucial for this active process of learning'. While the programme primarily focused on developing theoretical knowledge and practical skills, the reflection stage was also intended to foster some of the attributes necessary for physiotherapists working in ICU. These attributes included critical analysis, and the ability to assimilate multiple sources of information to arrive at a clinical decision. An additional aim of the programme was to improve the low level of confidence in ICU anecdotally reported by many rotational physiotherapists. This programme was intended to complement rather than replace the original training (Huhn et al 2008) and also be used as a regular refresher programme. Planned evaluation of the programme consisted of brief surveys of participants' reactions at the completion of each module: level one of Kirkpatrick's model of training programme evaluation (Kirkpatrick 1996).

To determine the specific topic for each module, a learning needs analysis was undertaken investigating the perceived ICU clinical skills most in need of further training. Different methods of performing learning needs analyses are reported in the literature, both general (Kirkpatrick 1977) and specific to health professionals (Harden 1986, Lockyer 1998, Mann 1998). Some are relatively simple, consisting of questionnaires (Dent et al 2008, Lai 2009), while some are complex, multi-faceted approaches (O'Shea and Spike 2005). One method of learning needs analysis includes consideration of both novice and expert opinion (Kirkpatrick 1977). Whilst identifying novices is often relatively easy, identifying experts can be more challenging. There are numerous different methods of determining expertise discussed in the literature, both in general (Dreyfus and Dreyfus 2005, Shanteau et al 2002), and within healthcare (Benner 1984, Boshuizen and Schmidt 1992). There are also numerous studies exploring aspects of expertise within general physiotherapy (Jensen et al 1990), as well as within and between different physiotherapy specialties (Jensen et al 2000, Jensen et al 1992). Within cardiorespiratory physiotherapy, there are studies investigating qualities of expert physiotherapists (Roskell and Cross 2001), clinical reasoning processes of expert physiotherapists (Smith et al 2007, Smith et al 2010) and comparison of novice and expert physiotherapists (Case et al 2000, Dunford et al 2011). Many of these studies reported differences between novice and expert physiotherapists in perceptions, cognitive processes, and behaviours. In contrast, Dunford et al (2011) showed no significant differences between novice and expert physiotherapists providing emergency on-call (primarily cardiorespiratory) physiotherapy in New Zealand hospitals in their responses to an emergency on-call clinical vignette task. There were however statistically significant differences between the groups in their self-rated confidence, self-rated stress, and perceived support required in emergency on-call situations. Despite the large number of studies investigating aspects of expertise, there is a lack of consensus of how exactly to determine expertise, with a number of different approaches used. Many of the studies within cardiorespiratory physiotherapy use experience as a surrogate for expertise (Case et al 2000, Dunford et al 2011, Smith et al 2010), however Case et al (2000) acknowledge that 'experts require something additional to experience to define them' (p 15). According to Shanteau et al (2002, p 254): 'At best, experience is an uncertain predictor of expertise. At worst, experience reflects seniority – and little more'.

This article reports the results of a learning needs analysis, comparing novice and expert opinion, as the first stage in developing a simulation-based ICU training programme for rotational physiotherapists.

METHODS

Participants

All rotational physiotherapists (Novice group, n = 15) at St. Vincent's Hospital were eligible to participate, irrespective of whether they had previously completed the weekend training programme. A convenience sample of experienced ICU physiotherapists (Expert group, n = 16) was recruited from professional contacts known to the author (DS) or other senior members of the St. Vincent's Hospital Physiotherapy Department, from metropolitan tertiary teaching hospitals in three Australian states (Victoria, Queensland, Western Australia). To be eligible, these participants had to be employed as senior ICU physiotherapists in their organisation. This is a variation of the 'Social Acclamation' approach described by Shanteau et al (2002), with our expert respondents identified for their ICU expertise by their employers, rather than their peers (Shanteau et al 2002) or a governing body (Roskell and Cross 2001).

Whilst a number of the expert participants had simulation experience, the majority did not; this was not a consideration in participant recruitment.

Consent

Ethical approval was gained from the St. Vincent's Hospital Human Research Ethics Committee (QA001/10). Informed consent was obtained with the initial survey question: 'Are you happy for the de-identified data collected from this survey to be used in future for research purposes?'

Survey

An online survey was developed (www.surveymonkey.com), which investigated a number of issues relevant to novice physiotherapists working in ICU.

Five demographic questions investigated time since graduation; acute cardiorespiratory clinical experience – general, and ICU-specific (time); ICU-specific in-house education and training (time); and relevant external professional development courses they had undertaken. As well as these demographic questions, the survey had two sections: 'Learning Needs Analysis', and 'ICU Perceptions'.

The learning needs analysis compared 'felt' needs (what participants felt they needed), and 'normative' needs (what

experts felt the participants needed) (Gillam and Murray 1996). The survey introduction described the purpose of the learning needs analysis as 'to identify skills and topics in ICU physiotherapy felt most important for ongoing training and education of junior physiotherapists'. The email containing the survey hyperlink also explained the planned outcome of the project: 'Results from this survey will be used to develop a number of ICU teaching modules using high-fidelity simulation for junior physiotherapists at St Vincent's Hospital, Melbourne'. The learning needs analysis contained two questions, one pertaining to assessment topics, the other to treatment topics. Respondents were asked to rank six assessment topics in order of importance for ongoing training from 1 (most important) to 6 (least important) (Figure 1). Treatment topics were presented as a list of 15 different physiotherapy techniques commonly used in ICU, with respondents selecting as few or as many as they felt further education and training were necessary for (Figure 2). To enable teaching modules to be developed, these treatment topics were divided into five groups of similar techniques: positioning, manual techniques, lung hyperinflation, suctioning, and rehabilitation. The lists of assessment and treatment topics were derived from the existing St Vincent's Hospital ICU physiotherapy competencies. Both assessment and treatment questions allowed respondents to add 'Other' topics.

Figure 1: Assessment topics

1. Which are the most important assessment skills for ongoing training? Please rank the following topics from 1 (most important) to 6 (least important).

	Ranking
Prioritisation of ICU patients	
Assessing acute neurosurgical/head-injured patients	
Assessing haemodynamically unstable patients	
Assessing intubated, ventilated patients	
Assessing mobility of ICU patients	
Assessing ICU patients with tracheostomy	

Any other topics?

The 'ICU Perceptions' section of the survey investigated attributes of physiotherapists working in ICU such as self-confidence, self-rated competence, and experience, related to different aspects of ICU including equipment, physiotherapy techniques, and clinical diagnoses. This section was included to provide a detailed description of the St. Vincent's Hospital rotational physiotherapist cohort, however was not used to develop the simulation-based ICU training programme.

The survey was tested on a cohort of senior (non-rotational) physiotherapists at St. Vincent's Hospital who had worked there as rotational physiotherapists and were therefore familiar with the weekend training programme. This testing was used to determine survey length, as well as ensuring appropriate and unambiguous wording of questions and instructions to respondents (Lockyer 1998, Portney and Watkins 2009, Woodward 1988). A hyperlink to the finalised survey was circulated via internal hospital email to all novice group participants.

Figure 2: Treatment topics

2. Of the techniques listed below which do you feel you need extra education and training for?

- [ ] Positioning intubated patients
- [ ] Positioning head-injured patients
- [ ] Positioning patients with orthopaedic injuries
- [ ] Positioning patients with unilateral CXR changes
- [ ] Percussions
- [ ] Vibrations
- [ ] Manual hyperinflation
- [ ] Ventilator hyperinflation
- [ ] Suctioning - via ETT
- [ ] Suctioning - via trache
- [ ] Suctioning - via nasopharyngeal/guedel
- [ ] Transfers: SOEOB (ventilated)
- [ ] Transfers: Sit -> stand (ventilated)
- [ ] Transfers: Bed -> chair (ventilated)
- [ ] Mobilisation (MOS, ambulation) on ventilator
- [ ] Any additional techniques?

The expert group survey was based on the novice group survey, with wording modified to make it appropriate to staff in a senior clinical role, with teaching or supervisory responsibilities. Demographic questions were also modified, and one open-ended question added pertaining to staff supervision and teaching experience. The learning needs analysis section introduction also clarified that 'These questions are general – not specific to your hospital'. Otherwise, the content of the survey was identical to the novice group survey. A hyperlink to this survey was then emailed to all expert group participants.

Three reminder emails were sent to all participants during the four-week data collection period. Novice group data collection was undertaken in November 2009, and expert group data collection was undertaken in January 2010.

Data Analysis

Data analysis was limited to descriptive statistics. Non-parametric assessment topic ranking data was described by medians and inter-quartile ranges. Treatment topics were scored as a number (%) of respondents selecting each topic and graphed for visual comparison. Due to the small sample, visual analysis of results, as well as practical considerations, were used to select the final topics for the ICU training programme. Data were collated and analysed using Microsoft Excel 2007.

RESULTS

Demographics – *Novice Group*

14/15 (93%) surveys were completed by the novice group. The majority of respondents had either '6-12 months' (5/14,

36%), or '12-24 months' (4/14, 29%) of experience. Only 3/14 participants (21%) had greater than two years experience, one of whom (7%) had greater than three years experience.

Expert Group

15/16 (94%) of surveys were completed by the expert group. The majority of respondents had more than 10 years clinical experience (9/15, 60%), with no respondents having less than 2 years. There was a similar result for ICU-specific clinical experience, with 8/15 (53%) having more than 10 years ICU experience, and only 2/15 (13%) respondents having less than 2 years ICU experience. More than half of the respondents had formal post-graduate qualifications, either a Doctorate (4/15, 27%), a Masters (3/15, 20%) or a Post-Graduate Diploma (1/15, 7%). The remaining respondents (7/15, 47%) reported no post-graduate qualifications.

Assessment Topics

The two highest ranked assessment topics from both groups were: assessing intubated, ventilated patients, and assessment of haemodynamically unstable patients. The ordered rankings of both groups for each assessment topic are outlined in Tables 1 and 2.

Table 1: Ranked Assessment Topics – Novice Group

Overall Ranking	Assessment Topic	Median (IQR) Ranking
1	Assessing haemodynamically unstable patients	2.5 (2 - 3.75)
2	Assessing intubated, ventilated patients	3 (1.25 - 4)
3	Assessing acute neurosurgical / head-injured patients	3 (2.25 - 4)
4	Assessing ICU patients with tracheostomy	3.5 (2 - 5)
5	Prioritisation of ICU patients	5 (2 - 6)
6	Assessing mobility of ICU patients	5 (4.25 - 6)
Additional Topics*	Assessment of drips, drains and lines; Assessment of imaging and pathology results	

* Entered by respondents

Treatment Topics

Results for individual treatment topics can be seen in Table 3, as well as pooled treatment topic groups (Figure 3). The two highest ranked treatment topic groups were lung hyperinflation (79% of all respondents), and rehabilitation (74% of all respondents).

Additional treatment topics suggested by the novice group were prone positioning and medications. Additional treatment topics suggested by the expert group were orthopaedic restrictions, Intermittent Positive Pressure Breathing (IPPB) and saline instillations.

DISCUSSION

Both novice and expert group respondents showed a high level of agreement for the four most important topics for further training for physiotherapy assessment and treatment of patients in ICU. Of the two assessment topics, assessing

Table 2: Ranked Assessment Topics – Expert Group

Overall Ranking	Assessment Topic	Median (IQR) Ranking
1	Assessing intubated, ventilated patients	1 (1 - 2)
2	Assessing haemodynamically unstable patients	3 (2 - 3)
3	Prioritisation of ICU patients	3 (2 - 3.5)
4	Assessing ICU patients with tracheostomy	4 (4 - 5)
5	Assessing mobility of ICU patients	5 (4 - 5)
6	Assessing acute neurosurgical / head-injured patients	6 (3.5 - 6)
Additional Topics*	Assessment of non-intubated patients, including the need for non-invasive ventilation; Assessing paediatric patients; Medical assessment in multi-organ failure, musculoskeletal assessment, and assessment of respiratory failure and vital capacity.	

* Entered by respondents

intubated, ventilated patients is clearly a very important skill, as it is relevant to many patients within the ICU. However, assessment of haemodynamically unstable patients has both specific and general application in ICU patients. As well as being relevant to those patients with a primarily cardiac diagnosis, it also has important wider application: many patients with non-cardiac diagnoses such as septic shock often exhibit severe haemodynamic instability. In addition, haemodynamic instability is a major contraindication to many physiotherapy treatment techniques (Paratz 1992, Stiller 2000) – including all of the treatment topics listed in this study. The ability to establish a patient's haemodynamic stability is therefore vital to enable safe patient treatment (Paratz 1992, Stiller 2000). As one of the expert group respondents commented, 'identifying the ... haemodynamically unstable patient among any other group from a safety point of view would be up near the top'. Whether respondents chose this topic for its specific relevance to cardiac patients or its general applicability to establishing haemodynamic stability of all ICU patients was not clear – respondents only ranked the assessment topics, and were not asked to justify their responses. There is potential overlap between respondents' perceptions of 'assessing intubated, ventilated patients' and 'assessing haemodynamically unstable patients', which highlights the complex nature of many ICU patients. We recognise that a broad range of complementary assessment skills are necessary for physiotherapists working in ICU. However, our aim was to find the two assessment topics perceived to be most important, to develop an ICU training programme. For this reason, we asked respondents to rank assessment topics by relative importance, rather than using a more restrictive method such as selecting a limited number of topics from the list.

The two highest rated treatment topic groups were the specific technical skills of lung hyperinflation and the broader collection

Table 3: Treatment topic responses, by group

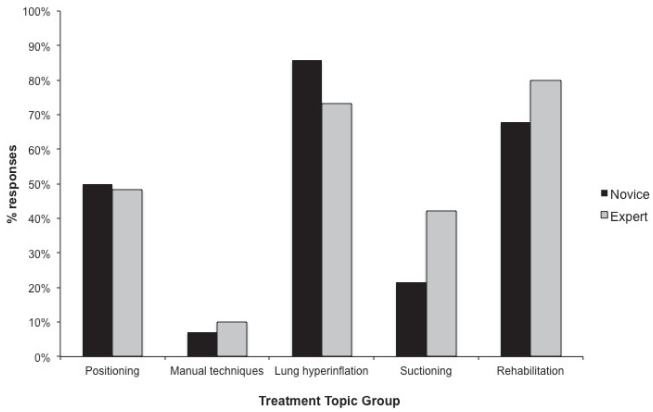
Treatment topics	Novice Group (n = 14)	Expert Group (n = 15)
Positioning intubated patients	5 (36%)	8 (53%)
Positioning head-injured patients	12 (86%)	9 (60%)
Positioning patients with orthopaedic injuries	6 (43%)	6 (40%)
Positioning patients with unilateral CXR changes	5 (36%)	6 (40%)
Percussions	1 (7%)	2 (13%)
Vibrations	1 (7%)	1 (7%)
Manual hyperinflation	12 (86%)	9 (60%)
Ventilator hyperinflation	12 (86%)	13 (87%)
Suctioning – via ETT	2 (14%)	5 (33%)
Suctioning – via trache	3 (21%)	3 (20%)
Suctioning – via nasopharyngeal / guedel	4 (29%)	11 (73%)
Transfers: SOEOB (ventilated)	9 (64%)	12 (80%)
Transfers: Sit → stand (ventilated)	9 (64%)	10 (67%)
Transfers: Bed → chair (ventilated)	9 (64%)	12 (80%)
Mobilisation (MOS, ambulation) on ventilator	11 (79%)	14 (93%)
Additional topics*?	1† (7%)	2‡ (13%)

CXR: Chest x-ray; ETT: endo-tracheal tube; Trache: tracheostomy; SOEOB: Sit on edge of bed; MOS: March on spot; * Number of responses listing additional topics; † Novice additional topics: Prone positioning – indications and technique with lines and ventilator; medications; ‡ Expert additional topics: Orthopaedic restrictions, IPPB (intermittent positive pressure breathing), saline instillations; tracheostomy weaning.

of techniques and skills which comprise the rehabilitation topics. Specific application of lung hyperinflation techniques will vary between patients depending on their clinical status, goals of treatment and physiological response. However, the technique itself is still relatively easy to reproduce and teach in a simulation environment, and manual hyperinflation has been taught for many years using part-task trainers (Blackstock and Jull 2007). Whilst simulation techniques are not reported as being used in the acquisition of ventilator hyperinflation skills in Australia and New Zealand (Hayes et al 2011), there would appear to be no reason why they could not. In contrast, a number of practical factors make all of the rehabilitation topics difficult to reproduce appropriately in a simulation environment. These include both patient-related factors and the significant practical and fidelity issues associated with attempting to mobilise a large, heavy, inanimate, cable-laden mannequin – which would potentially outweigh the learning benefits. Therefore, the next highest ranked treatment topic group – 'positioning' (49% of all respondents) – was selected as the second treatment topic for the ICU training programme. There are currently no commercially available mannequins suitable for the rehabilitation topics, however one alternative strategy may be the use of standardised patients.

While visual analysis of the data showed generally good agreement between groups for both assessment and treatment

Figure 3: Percentage of positive responses for treatment topics (grouped) requiring further training, for novice and expert respondents.



questions, there were a number of apparent differences. The assessment topic 'assessment of acute neurosurgical / head-injured patients' – was the third-ranked topic for the novice group, but the sixth-ranked (i.e. lowest) ranked topic for the expert group. This may reflect a desire in the novice group for further training in areas of perceived higher clinical acuity, which are potentially more challenging and unfamiliar to those with limited ICU experience. This reason may also account for the low ranking by the expert group – the topic is only applicable to a small sub-group of those patients seen in ICU.

One treatment topic which demonstrated a substantial difference between groups was 'suction – via nasopharyngeal / Guedel'. Four (4/14, 29%) novice respondents felt that this was important for further training, compared to 11/15 (73%) of the expert respondents. There appeared to be minimal difference between groups with the other two topics in this treatment group, both 'suction – via endotracheal tube' (novice group 2/14 (14%) vs expert group 5/15 (33%)), and 'suction – via tracheostomy' (novice group 3/14 (21%) vs expert group 3/15 (20%)). While respondents were instructed to complete the surveys with specific regard to 'ICU physiotherapy skills and topics', there was no requirement to justify their choices. As such, the reason for the difference between groups on this one topic is not apparent. It may be that the expert group feels that this is a more difficult technical skill than the other suction topics and therefore more important for further training. Alternatively, 'suction – via nasopharyngeal / Guedel' is the suction technique most likely to be an important skill for a physiotherapist working outside the ICU. Therefore, it is possible that it is the awareness of this potential wider applicability that caused the expert group to rate it more highly overall.

Our method of comparing novice with expert opinion is a variation on the 'Survey of Needs' approach described by Kirkpatrick (1977, p 22-23): '…the superiors of the supervisors [learners] could be given the same form and asked to identify needs of the supervisors as seen by the "boss"'. As our expert group were not the direct clinical superiors of the novice group, there is also some similarity with the 'Advisory Committee' approach also described by Kirkpatrick (1977).

As well as the modified 'Social Acclimation' approach (Shanteau et al 2002) used to identify our expert respondents, those with

post-graduate qualifications (8/15, 53%) would also satisfy the 'Certification' approach (Shanteau et al 2002). Selecting our expert respondents in this way, rather than purely on experience, accounts for the wide variation in duration of experience in the expert group. For this reason, it is also possible that some of the novice respondents may have had a similar duration of experience to some of the expert respondents.

Our use of online surveys had a number of advantages over other methods of learning needs analysis such as focus groups or interviews (either phone, or face-to-face). The anonymity of a survey may have allowed novice group participants to feel less threatened (Lockyer 1998) and therefore answer more honestly. Also, an online survey allowed us to gather opinions from an expert group spread across three Australian states. A survey-based learning needs analysis was also used by Dent et al (2008) to develop the simulation-based Advanced and Complex Medical Emergency (ACME) Course for emergency medicine fellows. Their survey asked Fellows of the Australasian College of Emergency Medicine to rate sixty topics from 'undesirable' to 'highly desirable' for further continuing professional development, using Likert scales. One of the major reported disadvantages of survey-based needs analysis is poor response rates (Lockyer 1998, Portney and Watkins 2009). With our response rates of 93% for the novice group and 94% of the expert group, we avoided this.

The goal of this study was to develop an ICU training course specifically for the rotational physiotherapists at St Vincent's Hospital. Selecting this cohort as our novice group provided the most accurate description of the 'felt' needs (Gillam and Murray 1996) for the course, similar to the approach described by Dent et al (2008) and Lai (2009). By developing the ICU training programme curriculum specifically for those who would be undertaking it, we hoped to enhance their intrinsic motivation to learn (Mann 1999). This would promote a deeper approach to learning than if the learners had perceived the topics as less relevant to them (Pasquale 2013).

Of the literature relating to simulation programme development (Jones 2011, Seropian 2003, Seropian et al 2004), none deals with training programmes for qualified physiotherapists. The only published physiotherapy-specific study, by Jones (2011), describes a process to develop simulation scenarios for third-year physiotherapy students. Scenario topics were selected by the course developers based on common diagnoses treated by a cardiorespiratory ward physiotherapist. The difference between participants in Jones' (2011) study and those in this study – that of third-year students compared to qualified physiotherapists – is a major reason why the learning needs analysis process was important. It would have been simpler to select topics for the training programme based solely on the experience of the senior physiotherapist responsible for ICU training – termed a 'Dictator' approach (Harden 1986). However, this would have relied heavily on their judgement, taking little account of the ongoing learning which occurs as junior staff gain experience, and potentially better insight into their learning needs. Undergraduate students however, with limited or no experience to draw upon, are likely to have far less insight into this – essentially they don't know what they don't know. Other published non-physiotherapy related studies relating to simulation programme development deal with general considerations such as budgeting and business models, staffing with appropriately trained staff, or purchasing the appropriate equipment for the intended programmes (Seropian 2003, Seropian et al 2004), rather than curriculum development.

Limitations

A limitation of this study was the small sample – larger cohorts may have provided a more representative sample of novice and expert physiotherapists' perceptions of which topics are most important for further training. Also, a larger sample would have allowed more detailed formal statistical analysis. The purpose of this learning needs analysis was to identify the four ICU skills most in need of further training for rotational physiotherapists at one hospital. As such, visual analysis of the survey data achieved this. However, we recognise that more robust statistical analysis, using a validated testing tool, would have allowed far stronger conclusions to be drawn. A further limitation of this study was that considerable time has elapsed since the data collection was undertaken, so these results may not reflect the ICU training and educational needs of the current cohorts of rotational physiotherapists. A strength of the study was the high response rate (Portney and Watkins 2009).

CONCLUSION

Based on visual analysis, there appeared to be good agreement between the novice and expert groups in both the assessment and treatment topic questions. The four highest ranked assessment and treatment topics were: assessment of intubated, ventilated patients; assessment of haemodynamically unstable patients; lung hyperinflation techniques; and rehabilitation. From these results, coupled with practical considerations, the pilot simulation-based ICU training programme was developed consisting of the following four modules: general assessment of an ICU patient; assessment of haemodynamically unstable patients; positioning; lung hyperinflation techniques. This pilot programme has since evolved to form two separate simulation-based ICU training programmes for rotational physiotherapists.

KEY POINTS

- The two highest rated assessment topics for intensive care training of junior physiotherapists were assessment of intubated, ventilated patients in intensive care, and assessment of haemodynamically unstable intensive care patients.
- The two highest rated treatment topics for intensive care training of junior physiotherapists were lung hyperinflation techniques, and rehabilitation.
- There was good agreement between physiotherapists of varying levels of intensive care experience regarding the most important topics for further training.

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The authors wish to acknowledge the support of Julian van Dijk (Simulation Co-ordinator, Medical Education Unit, St Vincent's Hospital, Melbourne, Australia), during the development of this training programme, including undertaking this learning needs analysis.

PERMISSIONS

Ethical approval was gained from the St. Vincent's Hospital Human Research Ethics Committee (Approval number QA 001/10). Informed consent was obtained with the initial survey question: 'Are you happy for the de-identified data collected from this survey to be used in future for research purposes?', as well as implied by completion of the online survey.

DISCLOSURES

No funding was sought or obtained to undertake this project.

A Victorian Government Department of Health 'Improving care for older people and people with complex needs' Scholarship was received to aid development of the simulation training programme for junior physiotherapists. This scholarship was used to fund a local and international study tour of centres currently utilising simulation for physiotherapy training, and was not related to undertaking this learning needs analysis.

The authors have no conflicts of interest to declare.

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The Patient-Rated Wrist and Hand Evaluation: a systematic review of its validity and reliability

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ABSTRACT

The Patient-Rated Wrist and Hand Evaluation is a region specific, patient reported outcome measure that aims to evaluate pain and disability of the wrist and hand. This review appraised the evidence for the validity and reliability of the Patient-Rated Wrist and Hand Evaluation as a measure of therapeutic outcomes in musculoskeletal conditions affecting the wrist and hand. Relevant studies were identified by a search of the literature and evaluated according to the Consensus standards for the selection of health status measurement instruments checklist. Five studies met the inclusion criteria for review. Four studies utilised Classical Test Theory and were in support of the reliability and validity of the Patient-Rated Wrist and Hand Evaluation. However, all of these studies were of fair to poor methodological quality. A fifth study, which utilised Rasch analysis, was of good methodological quality and supported the validity and reliability of the Patient-Rated Wrist and Hand Evaluation as a three subscale instrument. In conclusion, there is some good evidence for the validity and reliability of the Patient-Rated Wrist and Hand Evaluation. Further work needs to be done to enable clinicians to rescore the tool into three subscales and to examine its cultural validity.

Taylor J, Kersten P (2014) The Patient-Rated Wrist and Hand Evaluation: a systematic review of its validity and reliability New Zealand Journal of Physiotherapy 42(2): 141-147.

Key words Patient-Rated Wrist and Hand Evaluation, Psychometrics, Rasch analysis, Hand injuries, Patient outcome assessment

INTRODUCTION

The routine evaluation of outcomes in hand therapy is important due to an increasing demand to justify the quality and cost effectiveness of health services, to direct treatment plans and to communicate therapeutic outcomes with patients and colleagues (Accident Compensation Corporation 2009, Amadio 2001, Jette 2009, Physiotherapy Board of New Zealand 2009). In hand therapy, pain and loss of function are key considerations when implementing an intervention, such as splinting, mobilisation, or exercise. The Patient-Rated Wrist and Hand Evaluation (PRWHE) is a commonly used outcome measure in hand therapy practice aiming to measure such outcomes. This review aimed to appraise the evidence for the validity and reliability of the PRWHE.

The PRWHE is a region specific outcome measure designed to evaluate pain and disability of the wrist and hand. It evolved from the Patient-Rated Wrist Evaluation (PRWE), which was originally developed and validated for conditions affecting the wrist. Both instruments consist of the same 15 items separated into two domains of pain (5 items) and function (10 items). However, the PRWHE makes reference to the wrist and/or hand as opposed to the wrist in isolation and includes two optional aesthetics questions. Function is further categorised as specific activities and usual activities (5 items each). An 11 point numerical scale (0-10) is utilised for each item. The scoring system is simple, whereby the functional scores are added and divided by two and then added to the pain scores, to give a total out of 100 (MacDermid and Tottenham 2004). Lower scores denote better function and less pain.

It is important that health related patient rated outcome (PRO) measures are developed from a strong conceptual basis, which rationalises and clearly defines what and how it intends to measure (Holmbeck and Devine 2009, Rothman et al 2007). The conceptual basis and developmental process undertaken for the PRWE is thoroughly presented and discussed by MacDermid (1996). Although the author did not report the literature review strategy in detail, the review appropriately aimed to identify articles, which studied the physical requirements of various functional tasks and other patient reported outcome measures for pain and/or disability. MacDermid (1996) initially surveyed members of the International Wrist Investigators on current outcome measure use and opinions were sought regarding structure and content, promoting content validity and clinical utility of the measure. While MacDermid (1996) adequately promoted the International Wrist Investigators as an appropriate group to survey they did not reveal the size of the sample surveyed or the response rate. The surveyed members deemed pain, functional ability and patient satisfaction to be the most important subjective indicators of outcome.

A PRO measure may be useful in determining the relative effectiveness of a particular intervention. There is an inherent degree of error with any type of measurement. Therefore, in order to correctly interpret the findings it is important to ascertain the validity, reliability and responsiveness of a measure, for a specific purpose, in a specific population (Horner and Larmer 2006). These terms are otherwise known as the psychometric properties of a measure and refer to the theoretical principles and rules as applied to measurement (Nunnally and Bernstein 1994). The PRWE has good psychometric properties in a number of conditions affecting the wrist (Hoang-Kim et al 2011). However, a standardised measure for a variety of conditions affecting both the wrist and hand would have greater clinical utility in a typical hand therapy

clinic as it would potentially negate the need to select specific instruments for different regions or conditions.

The aim of this review was to appraise the evidence for the validity and reliability of the PRWHE to inform measurement of therapeutic outcomes in musculoskeletal conditions affecting the wrist and hand.

METHODS

Literature Search Strategy

A literature search was conducted during September 2013 in Medline, Allied and Complementary Medicine Database (AMED), Cumulative Index to Nursing and Allied Health Literature (CINAHL) and the Cochrane Library with the aim of identifying relevant clinical articles for the review (Table 1). The search strategy included subject headings related to the target outcome measure and keywords related to the target study design (Table 2). Truncation was utilised where appropriate to allow for spelling variations. Booleans, AND and OR, were utilised to combine search terms. Scopus was also utilised to cross reference the reference lists of relevant articles forward and back.

Table 1: Electronic search for articles evaluating the psychometric properties of the PRWHE

Date	Database	Search Provider	Period	Results
19/09/2013	Medline	Ebsco	1998 onwards	44
19/09/2013	AMED	Ovid	1985 onwards	4
19/09/2013	CINAHL	Ebsco	1998 onwards	17
19/09/2013	Cochrane Library	Ovid		15

Allied and Complementary Medicine Database (AMED), Cumulative Index to Nursing and Allied Health Literature (CINAHL), Patient Rated Wrist and Hand Evaluation (PRWHE)

Table 2: Search strategy for articles evaluating the psychometric properties of the PRWHE

Subject Heading		Target Study Design
"patient rate* wrist evaluation"		valid*
OR "patient rate* wrist and hand evaluation"		OR reliab*
OR PRWE	AND	OR responsive*
OR PRWHE		OR "classical test theory"
		OR "rasch analysis"

Inclusion Criteria

Studies designed to examine the validity and reliability of the PRWHE were included for review. Only studies in English were included.

Appraisal

Eligible studies were analysed according to the Consensus Standards for the Selection of Health Status Measurement Instruments (COSMIN) checklist. The COSMIN checklist is designed to assess the methodological quality of studies evaluating the psychometric properties of a health related outcome measure (Mokkink et al 2010a, Mokkink et al 2010b). It was developed using an international consensus process and has established reliability and validity (Mokkink et al 2010c). It is increasingly used in outcome measurement research, including physiotherapy related reviews (Mijnarends et al 2013). The COSMIN tool is divided into sections for each psychometric property (such as internal consistency, reliability, and criterion validity); each ranked using a quality score. These scores are labelled as excellent, good, fair, and poor, and a detailed description of these labels for each psychometric property is given (Terwee et al 2012).

RESULTS

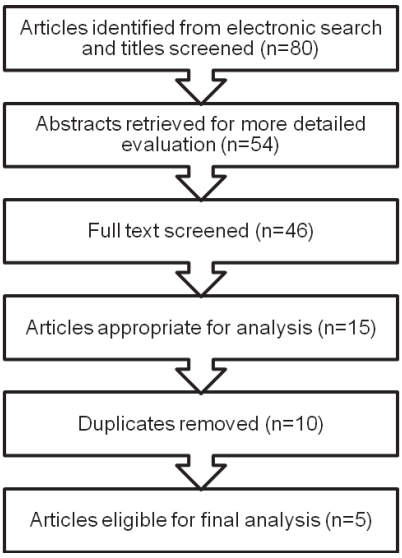
In total 80 citations were retrieved from the database search. After removing duplicates and full review of manuscripts, five articles were identified that met the inclusion criteria for review (Figure 1). A summary of their findings are presented in Table 3. A summary of the methodological quality of these studies according to the COSMIN checklist is presented in Table 4.

Validity of the PRWHE

Content validity refers to the degree to which the content of an instrument is an adequate reflection of the construct to be measured (Mokkink et al 2010b, Streiner and Norman 2008). While the PRWE was originally developed for wrist disorders, MacDermid and Tottenham (2004) argue that from a functional perspective the wrist and hand are interrelated, and therefore, there is good face validity for its application in a population with hand injuries by changing the word "wrist" to "wrist/hand" and the name of the scale from PRWE to PRWHE. However, a formal evaluation of the face validity with clinicians or patients has not been conducted. The PRWHE includes pain as a measure of impairment, and with respect to function, specific activities as a measure of disability and usual activities as a measure of handicap. The inclusion of usual functional activities (personal care, household work, work and recreation), in addition to specific functional tasks, aims to encompass a wide range of tasks relevant to the individual. Additionally, the items are intended to cover a wide spectrum of each domain, for example, pain at rest designed to capture those with severe pain through to pain with a repeated wrist movement or lifting a heavy object designed to capture those with mild levels of pain (MacDermid 1996). When administering the PRWHE, difficulty may arise when a patient has not performed a certain activity, such as lifting a heavy object in the past week. In this case, patients are instructed to estimate the amount of pain or difficulty they would expect. If a patient has never performed an activity they can leave it blank. However, the content validity of the tool is affected by the potential of irrelevant items for some patients.

Criterion validity refers to how well a measure compares to a gold standard, either at the same time (concurrent validity) or one that will be available in the future (predictive validity)

Figure 1: Diagram of search selection process for relevant articles



(Streiner and Norman 2008). In the case of functional status or symptoms there is no gold standard and therefore construct validity must be established in its place (Amadio 2001). Construct validity refers to the degree to which outcome measurement scores are consistent with the theoretic construct being measured (Streiner and Norman 2008). Evidence accumulates either in support or opposition of the construct validity of a specific measure. Three subtypes of construct validity (convergent, divergent and structural validity) of the PRWHE were evaluated with 122 patients post arthroplasty for osteoarthritis of the first carpometacarpal joint (MacDermid et al 2007). Convergent validity refers to how well the scores from a measure correlate with scores from other similar measures (Streiner and Norman 2008). The study by MacDermid et al (2007) supported convergent validity of the PRWHE in this post arthroplasty population when compared with the Australian/Canadian Osteoarthritis Hand Index (AUSCAN) and the Disability of the Arm, Shoulder and Hand (DASH). Divergent validity, refers to the degree with which the scores from a scale do not correlate to scores from a scale that measures a dissimilar construct (Streiner and Norman 2008). This was demonstrated by a lack of association, as predicted, with self-reported hand appearance. Structural validity refers to the degree to which the scores of a scale are an adequate reflection of the dimensionality of the construct (Streiner and Norman 2008). The findings of MacDermid et al (2007) challenged the structural validity of the PRWHE as both the pain and function subscales unexpectedly loaded onto one factor. If subscales are valid and distinct they should load on different factors (Thompson 2002). The MacDermid et al (2007) study had well defined hypotheses and utilised appropriate statistical analyses to test them, including specification of the direction and magnitude of correlations to be examined a priori. However, it received a fair rating for methodological quality due to not adequately reporting how missing data were dealt with. Generalisability of the results was good with a thorough description of the sample characteristics.

While the study by MacDermid et al (2007) utilised Classical Test Theory (CTT) to assess validity of the PRWHE, Rasch analysis, a form of Item Response Theory (IRT), may also be used in the development and evaluation of the internal construct validity of a patient reported outcome measure (Tennant et al 2004, Kersten and Kayes 2011). Internal construct validity is confirmed when a scale conforms to the definition of the construct. Packham and MacDermid (2013) utilised Rasch analysis to assess the psychometric properties of the PRWHE in 264 patients with acute traumatic or postoperative wrist and/or hand injuries. These authors found that while the PRWHE does not fit the Rasch model when considered as a whole, three subscales demonstrate a good fit to the Rasch model if the disability scale is separated into two subscales of specific and usual activities. Tests for unidimensionality of the entire scale also failed. However, acceptable unidimensionality was demonstrated for the three subscales, indicating that each subscale represents a unique construct (Packham and MacDermid 2013).

The Rasch analysis also identified disordered thresholds; i.e. increases in the trait (eg pain) did not correspond with ordering of the response categories. Therefore, it was necessary to collapse scoring categories for six of the 15 items. For example, response categories for the work item were re-scored to create six ordered categories. Results of the Rasch analysis suggest that for comparisons to be made across populations six of the 15 items need to be rescored which without the aid of a specialised computer programme would be laborious and error prone in a clinical setting (Packham and MacDermid 2013). The study by Packham and MacDermid (2013) had an appropriate sample size and met all but one of the COSMIN criteria for internal validity: it did not adequately describe how missing data were dealt with, along with the method of estimation used. A thorough description of sample demographics was given and a wide range of wrist and hand conditions were included in the sample ensuring good generalisability of the results.

A process of cross-cultural adaptation, involving culturally appropriate adaptation of questions if needed and language translation, must be followed if a patient reported outcome measure is to be administered to a different culture (Beaton et al 2000). The PRWHE has been cross-culturally adapted into Dutch and Italian (Brink et al 2009, Fairplay et al 2012). Both of these studies concluded the adapted instruments were valid and reliable. However, they achieved overall ratings of poor for methodological quality. A key limitation of both studies was a very small sample size, especially for a process of cross-cultural adaptation. Additionally, Brink et al (2009) did not present an adequate description of the translation process or the translator's expertise and the final translation was not reviewed by committee. Ease of patient comprehension was also not assessed. With ten percent of the sample failing to fully complete the questionnaire this may have been a reflection of poor comprehension. In contrast, Fairplay et al (2012) followed a standardised cross-cultural adaptation process as recommended by Beaton et al (2000). The authors gave a thorough description of the translation process including; the expertise of the translators, how differences of opinion were resolved, and the committee review process. Ease of comprehension was also assessed. However, generalisability of these results was compromised by not reporting on sample demographics such as age, gender and disease characteristics.

Internal consistency of the PRWHE

Internal Consistency, a type of reliability, refers to the homogeneity of scale items and therefore the extent to which they measure different aspects of the same construct (Giladi and

Table 3: Summary of studies examining psychometric properties of the PRWHE

Authors	Methods	Results
MacDermid and Tottenham (2004)	60 patients with wrist &/or hand problems completed the PRWHE & the DASH on their first clinic appointment & 3 months later.	Responsiveness: Demonstrated a large treatment effect (SRM: 1.51 & ES: 1.61). Slightly more responsive than the DASH (SRM: 1.51 vs 1.37).
MacDermid et al (2007)	122 patients 9-117 months post tendon interposition arthroplasty for OA of the first carpometacarpal joint completed the PRWHE, AUSCAN, DASH & SF-36.	Construct Validity: Convergent Validity: High correlations between similar subscales ($r>0.75$). Divergent Validity: No correlation ($r<0.05$) with self reported hand appearance. Discriminative Validity: does not discriminate between patients with localised hand OA versus those with OA affecting additional joints. Structural Validity: Pain (0.903) & function (0.906) subscales loaded on a single factor.
Brink et al (2009)	Dutch language versions of the PRWHE & DASH were completed by 58 patients with wrist &/or hand problems & then 2 days later.	Reliability: Internal consistency: Excellent for the total scale & the subscales (α=0.89-0.95) Test-retest reliability: High correlations for the total scale & the subscales (ICC=0.88-0.89) Construct Validity: Convergent Validity: High correlation with the DASH (r=0.84)
Fairplay et al (2012)	Italian versions of the PRWHE, DASH & SF-36 were completed by 63 patients with stable wrist &/or hand problems & then 5-7days later.	Reliability: Internal consistency: Excellent for the total scale (α= 0.96). Test-retest reliability: Very high correlation (ICC=0.92) Construct Validity: Convergent validity: High correlation with the DASH (r=0.80)
Packham and MacDermid (2013)	Rasch analysis was conducted on PRWHE scores in 264 patients with acute traumatic or postoperative wrist &/or hand injuries	Rasch Model: PRWHE does not fit the Rasch Model as a whole (item-trait interaction $\chi^2(30) = 83.15$, $p<0.001$) Three subscales of pain, specific activities & usual activities fit the Rasch Model (PSI=0.86, $\chi^2(6) = 10.01$, p=0.12) Reliability: Internal consistency: Good to excellent (PSI=0.86-0.95) (α=0.96) Construct Validity: Unidimensionality: Entire scale failed (p=0.216) Acceptable for 3 subscales: pain (p=0.075 [95% CI: 0.048-0.102]), specific activities (p=0.076 [95% CI: 0.048-0.103]), usual activities (p=0.049 [95% CI: 0.021-0.076]) Systematic Biases: No evidence for systematic bias, however, gender, age, diagnosis & duration since injury influenced scoring whereas hand dominance & affected side did not.

Australian/Canadian Osteoarthritis Hand Index (AUSCAN), Chi square value (χ^2), Chronbach's Alpha (α), Confidence Interval (CI), Disability of the Arm, Shoulder and Hand (DASH), Effect size (ES), Intraclass correlation coefficient (ICC), Osteoarthritis (OA), Patient Rated Wrist and Hand Evaluation (PRWHE), Person Separation Index (PSI), Standardised response mean (SRM)

Chung 2013, Streiner and Norman 2008). Good to excellent internal consistency of the PRWHE scale and its subscales was demonstrated with Person Separation Index (PSI) values ranging from 0.86 to 0.95 (Packham and MacDermid 2013). PSI statistics are similar to Cronbach's Alpha, which are used in studies employing Classical Test Theory approaches to outcome measurement. This study received a rating of good for internal consistency, although it did not adequately report on missing

Table 4: Methodological quality of studies examining the psychometric properties of the PRWHE according to the COSMIN checklist

Authors	IRT model requirements	Internal consistency	Reliability	Structural validity	Hypothesis testing	Cross-cultural validity	Responsiveness	Interpretability	Generalisability	Overall rating of methodological quality
MacDermid and Tottenham (2004)							Fair	0/7	5/8	Fair
MacDermid et al (2007)				Fair	Fair			2/7	4/8	Fair
Packham and MacDermid (2013)	Good	Good		Good				4/7	7/8	Good
Brink et al (2009)		Poor	Fair		Poor	Poor		2/7	4/4	Poor
Fairplay et al (2012)		Poor	Fair		Poor	Poor		3/7	3/8	Poor

Note: Only psychometric properties evaluated to date for the PRWHE are included in the table

data. Brink et al (2009) and Fairplay (2012) found the internal consistency for the Dutch and Italian language versions of the total scale and its subscales to be excellent with Cronbach's Alpha ranging from 0.89 to 0.96. However, both of these studies received a poor rating of methodological quality with respect to internal consistency.

Reliability of the PRWHE

Test-retest reliability refers to the extent to which repeated measurement scores are the same in patients who have not changed (Streiner and Norman 2008). Brink et al (2009) and Fairplay et al (2012) observed high to very high intraclass correlation coefficients in the Dutch and Italian language versions of the PRWHE, ranging from 0.88-0.92. However, both of these studies received a fair rating of methodological quality for test-retest reliability.

Responsiveness of the PRWHE

Responsiveness refers to the ability of an outcome measure to detect change in the construct being measured over time (Streiner and Norman 2008). It is a measure of longitudinal validity (van de Ven-Stevens et al 2009). The responsiveness of the PRWHE versus the DASH was evaluated in a cohort of 60 patients with wrist and/or hand problems (MacDermid and Tottenham 2004). The study included acute trauma and surgical patients with a variety of diagnoses such as fractures, carpal instabilities, osteoarthritis, tendon lacerations, and palmar fasciectomies. Both the PRWHE and the DASH demonstrated a large treatment effect, in both the wrist and hand injury groups following hand therapy intervention. Responsiveness was slightly higher in the PRWHE and the change measured in the two instruments was strongly correlated. This, in addition to the fact that the PRWHE contains half as many items as the DASH, led the authors to conclude that the PRWHE is a more efficient measure for detecting clinical improvement. However, hypotheses were either not formulated or they were not reported on, resulting in a rating of fair for overall methodological quality for this study. Key strengths of this study were a good sample size and a thorough description of an appropriate comparator instrument, i.e. the DASH, including its measurement properties. However, generalisability of these results was compromised due to inadequate descriptions of diagnoses, duration of time since injury/surgery, and the type of hand therapy received.

DISCUSSION

This review identified five papers designed to examine psychometric properties of the PRWHE. There was good evidence for the internal reliability of the PRWHE. However, evidence for test-retest reliability and the responsiveness of the tool was limited due to poor and fair ratings respectively for methodological quality of the relevant studies. There was also limited evidence for the convergent and divergent validity of the tool. For example, the PRWHE was compared to the AUSCAN and DASH only and not to other commonly used scales such as the Michigan Hand Questionnaire. Evidence for the structural validity was mixed, with one study suggesting all items load onto one factor (MacDermid et al 2007) and another that it consists of three subscales (Packham and MacDermid 2013). In addition, the response categories do not appear to work as intended.

A study by MacDermid and Tottenham (2004) found that hand therapists favoured routine use of the PRWHE over the DASH due to it being quicker and easier for patients to complete and for therapists to administer and score. The cost associated with administering and analysing the PRWHE is minimal and there is no requirement for further training or specialised equipment.

However, there are clinical implications based on the findings of this review for clinicians using the PRWHE. Clinical utility of the tool is challenged by the requirement for collapsing of response categories as found by Packham and MacDermid (2013). Furthermore, these authors did not provide a scoring algorithm to convert the ordinal raw PRWHE scores into interval level data. This would have been possible to do following the Rasch analysis. Until such a conversion table is available clinicians and researchers must exercise caution when considering the total summed PRWHE scores, since they remain ordinal in nature (Kersten and Kayes 2011).

Clinicians using the tool should also be aware that evidence for the content validity of the PRWHE is not fully established. For example, some patients may not be able to respond to all items since they may not have performed these activities. This is problematic both from a measurement standpoint and for people completing the tool. In addition, the items include words that may not be appropriate to a New Zealand context. Examples are the use of pounds (lb) for the weight of an object and terms such as bathroom tissue instead of toilet paper.

Limitations of this review include the quality scoring of studies by one, rather than multiple reviewers (JT). However, any uncertainties in the scoring were discussed with the second author. Strengths of this review include a thorough literature search across multiple databases and the use of an appropriate assessment tool, with established reliability and validity, to rate the methodological quality of included studies.

CONCLUSIONS

The methodological quality of the included studies was mixed, with the key limitations including a lack of reporting on how missing data were handled and in some instances small sample sizes. Four studies that utilised CTT were found to be of fair to poor methodological quality while a recent Rasch analysis was found to be of good methodological quality. Whilst evidence for the validity and reliability of the PRWHE were established as part of this review further work is required to evaluate cultural validity in the New Zealand context. In addition, research is required to further evaluate the internal construct validity of the scale and make recommendations regarding possible changes needed to the response categories and subscales.

KEY POINTS

- Four studies which utilised Classical Test Therory were found to be of fair to poor methodological quality while a Rasch analysis was found to be of good methodological quality.
- Rasch analysis supports the internal validity and reliability of a three subscale PRWHE instrument (Pain, Specific Activities, and Usual Activities).
- Clinicians should exercise caution when considering total summed scores.
- Cultural validity of the PRWHE in the New Zealand context needs to be evaluated.

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Older adults' experiences of community integration following traumatic brain injury

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ABSTRACT

Literature suggests community integration should be the primary rehabilitation goal for older people following a traumatic brain injury (TBI). However, little is known about older people's lived experience of community integration following TBI. This mixed method study explores community integration from the perspective of four older adults following mild TBI, and compares findings with results from two community integration outcome measures: the Community Integration Questionnaire (CIQ) and the Community Integration Measure (CIM). Findings showed that TBI caused major disruption in life planning, with participants discussing a battle to maintain their pre-TBI independence and having to deal with the consequences of losing some independence following their injury. Setting up or maintaining good support networks were identified as vital to reintegration into the community following TBI, including with physiotherapists whose ability to engage and listen to their patients' experiences can play an important role in their recovery. Physiotherapists must take care when using the CIQ or CIM to measure the experiences of older adults' community integration following TBI as this study suggests that the measures do not wholly reflect people's lived experiences. Findings from this study may be referred to by the providers of community-based services for older adults with TBI to develop strategies for supporting older adults' community integration following TBI.

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Key words: Traumatic brain injury (TBI), Mixed methods, Community integration, Older adults, Lived experience

INTRODUCTION

Traumatic brain injury (TBI) is recognised as a major concern for older adults, with accidental falls being the main cause (Thompson et al 2006). In 2004, approximately eight in every 100,000 New Zealanders aged 65 or over were reported as experiencing a head injury, with the total population incidence rates being higher for men than women, and over twice as high (20 per 100,000) for Māori men (Barker-Collo 2009). Given these high numbers, understanding older people's post-TBI experience of reintegrating back into the community will be integral to achieving positive community integration outcomes for patients following TBI, a key role for physiotherapists working as part of the multidisciplinary team (Goranson et al 2003). Definitions of community integration typically include dimensions of social and community participation, participation in the home setting and participation in meaningful, productive activities (Salter et al 2008). Successful community integration has been shown to increase health related quality of life in TBI populations (Hawthorne et al 2009, Huebner et al 2003). In contrast, an inability to achieve adequate community integration can lead to social isolation for TBI populations (Hawthorne et al 2009, Struchen et al 2011). A retrospective cohort study exploring the long-term outcomes of rehabilitation in patients with moderate to severe TBI using 306 participants, found a greater percentage of the TBI population were living alone than in the general population (Colantonio et al 2004). Hawthorne et al (2009) conducted a study examining the health quality of life outcomes for Australian TBI survivors compared to matched controls and found that prolonged social isolation amongst TBI populations can lead to further issues such as depression, loss of friendships and an inability to formulate new relationships.

As long term rehabilitation programmes around the world are rare, care of TBI survivors often becomes the role of family care givers which can cause increased financial and psychosocial stress for the TBI patients and their families (Layman et al 2005, Lefebvre et al 2008, Rotondi et al 2007). When the head-injured person is unable to participate in employment at the pre-injury level, a large financial burden may be caused from additional health service needs and living costs which further compromises community integration (Layman et al 2005). Similarly, it has been shown that an inability to return to work, or for a partner to take time off work to become a carer, places additional stress during an already stressful period; leading to social isolation and a decrease in satisfaction with the person's attempts at social integration (Lefebvre et al 2008). Caregivers of persons with TBI have identified the need for better rehabilitation services within the community to equip them with the knowledge necessary to successfully reintegrate back into the community,

such as long term planning, transitional training and access to support groups (Rotondi et al 2007). Consequently, community integration is considered by some as the primary goal of rehabilitation (Reistetter and Abreu 2005, Salter et al 2008). In addition, the literature suggests that rehabilitation practitioners, including physiotherapists, should use valid and reliable community integration measures as intervention guides and/or outcome measures.

Following a review of the literature, two outcome measures were identified as being valid, reliable and responsive measures of community integration with injured populations; the Community Integration Questionnaire (CIQ) and the Community Integration Measure (CIM). The CIQ is a 15-item questionnaire created specifically for TBI populations to measure community integration using the three subscales of home integration, social integration and productive activities (Willer et al 1994). The total score is ranked from 1-29 with a higher score indicating superior community integration (Willer et al 1994). The subscales are scored; out of 10 for home integration, out of 12 for social integration and out of seven for productivity (Willer et al 1994). The scoring of the CIQ places value on the frequency with which people engage in certain activities. For example, performing an activity by oneself is scored higher than performing it with someone else. The CIM is a 10-item questionnaire, developed to be used with people with brain injury (McColl et al 2001). The CIM does not prioritise activities or relationships and focuses on a personal perception of the person's integration into the community (Griffen et al 2010). The scoring is ranked from 10-50, with a higher score representing a high level of community integration (McColl et al 2001). Evidence of validity for the psychometric properties of both scales is good (Griffen et al 2010, McColl et al 2001, Salter et al 2008, Sander et al 1999, Willer et al 1994, Willer et al 1993). However, within the New Zealand setting it is unknown which tool would be most suitable to measure community integration in future service evaluations or research. This study aimed to explore community integration from the perspective of older adults following mild to moderate TBI who live within the Waitemata District Health Board (Waitemata DHB) region in Auckland, New Zealand. The study also compared people's narrated experiences with the results of the CIQ and CIM to test the appropriateness of the outcome measures in addressing important aspects of community integration.

METHODS

This exploratory summer studentship project was a mixed methods study, using qualitative descriptive and quantitative questionnaire based methods. Ethics approval was granted by the Auckland University of Technology Ethics Committee. Written informed consent was gained from all participants.

Older New Zealand men and women, Māori aged 55 or older or non-Māori aged 65 or older (due to different life expectancies), who had sustained a mild or moderate traumatic brain injury in the last two years were eligible for participation in the study. Further eligibility criteria included having lived in their own home for at least 3 months following discharge from treatment by the Waitemata DHB or as an outpatient by a general practitioner, at an emergency department, or other community rehabilitation service, and were resident within the Waitemata DHB region. People who were unable to speak or understand English, or unable to provide informed consent, were excluded.

Recruitment

Three people responded to an article in the North Shore Times, a free community newspaper, and one person was referred from ABI Rehabilitation, a brain injury rehabilitation facility in Auckland.

Data gathering

Qualitative descriptive data were gathered using a semi-structured interview guide to explore participants' community integration experiences and needs. Participants had the option of being interviewed at home (two participants) or at the multi-disciplinary clinic at the North Shore campus, Auckland University of Technology (two participants). None of the participants opted to have a family/whānau support person present. Interviews were conducted in English. Interviews were approximately 60-90 minutes duration. Participants were asked to complete the CIQ[1] and the CIM[2] standardised questionnaires at the end of the interview. The order for completion of each questionnaire was randomly assigned to each participant.

Data Analysis

With participant consent, the qualitative descriptive data were audio taped and transcribed verbatim. Line numbers were added to all transcripts to assist with location of narrative data. The interviews were analysed using thematic analysis as outlined by Braun and Clarke (2006). The thematic analysis began with transcribing and re-reading the data to become familiar with each interview. Each interview was then re-read with codes added to the side of text where appropriate such as 'lack of understanding' or 'not wanting help'. Themes were generated and put into a mind map connecting relevant themes and sub-themes like 'loss of independence' and 'isolation'. Mind maps from each interview were collated and reviewed to generate a collective set of themes in a thematic map, which were 'independence' and 'support networks'. These themes were then further refined as the data were applied to each theme and sub themes to come up with a final set of themes; 'returning to my normal life' and 'having support networks'.

The analysis was conducted using an inductive method and at a semantic level. Quotes presented in the results section are identified only by the person's self-chosen pseudonym.

The CIQ and CIM data were analysed using descriptive statistics and reported using frequency tables. Data analysis examined whether themes identified as important by the participants in the qualitative interviews were captured by the standardised outcome measures. The CIQ and the CIM were then critiqued for how well they measured community integration outcomes for the participants.

RESULTS

Four participants were recruited for this study with their details outlined in Table 1 below. All four participants reported they had suffered a mild TBI following injury.

Two main themes were identified from the thematic analysis: *Returning to my normal life* and *having support networks*. These themes are discussed below. Highly illustrative quotes drawn from the participant interviews are presented. Pseudonyms are used to protect participant confidentiality.

[1] The CIQ is available from http://tbims.org/combi/ciq/ciqrat.html
[2] The CIM available from http://www.disabilitypolicyalliance.ca/latest-news/the-community-integration-measure.html

Table 1: Demographic data with CIQ and CIM scores

Name	Age	Gender	Ethnicity	CIQ				CIM
				Home	Social	Productivity	Total	
Susan	75	F	NZ/Euro	10	11	4	25	49
Kate	78	F	NZ/Euro	10	7	4	21	49
Dane	84	M	NZ/Euro	0	7	4	11	36
Richard	73	M	NZ/Euro	10	10	2	22	50

* The CIQ consists of three subscales that give a total out of 29. Home integration is out of 10, social integration is out 12 and productivity is out of 7; † The CIM has a total score out of 50.

Returning to my normal life

Participants spoke about TBI as causing major disruption in life planning, and discussed their 'battle' to return to their normal life. This was often a balance between maintaining the independence that they had before their TBI and dealing with the consequences of losing their independence following their injury. Interestingly, the term 'independence' meant different things for different people. Three participants reflected on their independence as being their ability to do all the activities they enjoyed undertaking before their injury without needing the help of others; whilst for another participant it meant being able to go for a walk once per day just to get out of the house.

A loss of confidence and fear of activities outside the person's comfort zone were identified as an important precursor to a loss of independence. Susan is a 75-year-old woman who suffered a mild TBI from a fall on a bus in 2011. Having been an active person up until the accident, she found that her loss of confidence in doing what used to be everyday tasks such as walking down steps debilitating:

> *"Steps are my big problem. I almost get vertigo at the top of them…. I was in Rotorua on Monday and I went walking and I was talking and we climbed up the hill to look at a cemetery and then I realised I had to come back down again and that was horrible, I almost vomited with the fear" (crying slightly as talking) (Susan).*

This loss of confidence can also translate into a perceived reliance on others, which amplifies the person's feelings of lost independence. For Susan this meant resenting having to ask for help when doing a task that she once found simple:

> *"One of the chappies had to take me down [to the bottom of the hill] and I hate that. I'm a very independent person but it's taken all that away from me" (Susan).*

The participants did not always view a reliance on others as negative. Richard, a 73-year-old man who suffered a mild TBI following a fall, was comfortable enough with the friends he had around him to ask for help:

> *"I accept it. They don't think any less of me. If I felt they thought I was a nuisance I wouldn't bother" (Richard).*

Dane, an 84-year-old male stroke survivor with a history of TBI from numerous falls, was reliant on his wife for day to day assistance and to do chores around the house. Without this support he felt he would not have been able to cope alone in his own home. His appraisal of their relationship sums up his reliance on his wife's support:

> *"I couldn't exist without her" (Dane).*

A catalyst for a further loss of independence amongst these older adults with mild TBI was a reluctance or inability to return to driving immediately following their accident. Although all participants did return to driving some time later, the initial period of non-driving led to either an increased reliance on others or feelings of isolation:

> *"I wasn't allowed to drive straight away, I had a month off. This added to the isolation, as people didn't understand. I would never ring up and ask people to take me, so I didn't go. And I wasn't allowed to get in the bus either so I got stuck at home" (Susan).*

Another participant, Kate, is a 78-year-old woman who walked into a glass wall at an airport and suffered a mild TBI. An important excursion for her was to visit her son and daughter's farm 45 minutes away, but her TBI symptoms left her unable drive long distances so she could not visit without the help of others:

> *"We organised rides out to the farm as I couldn't drive for a few days. I don't like that either though as I lose my independence you see. I felt very independent before the injury" (Kate).*

Losing the ability to easily access family, friends and other support networks can leave the person isolated within their community, unable to easily interact with family and friends:

> *"Isolated, that was a big thing. I was up a drive and everybody worked so I didn't see anyone from dawn to dusk. Isolation was a huge factor as I'm totally independent" (Susan).*

For Susan and Kate, this enforced isolation was in contrast with the way they saw themselves, which was as independent, sociable people. Their ability to engage in activities that keep them busy makes them feel part of the wider community. This was important to them before their injury and it was important for them to regain this connection with their community as part of their recovery.

Maintaining a level of independence had both psychological and physiological benefits. All participants identified walking as a current pastime. For Dane walking was important for fitness, but also as a way to get out of the house and remain active:

> *"I do it for exercise so I can keep reasonably fit. You have got to get out otherwise you are stuck in a chair" (Dane).*

The participants were returning to their normal lives with an understanding that they may never be the same as they were

before. For some, this left bitterness about how they came to be the way they are. However, Richard had a different outlook; to dwell on the past would make returning to his normal life much harder:

"You can't dwell on the past. You use the past as a guideline but you've got to work towards what you're going to do. Like I've got my bucket list, things I need to do. I don't think about the injury. Except when I have a headache or I bounce into the wall" (Richard).

Following even a mild TBI, these findings show how many factors impact on the sufferer and long-term changes can contribute significantly on people's ability to return to their normal life. Understanding and accepting such changes is important and having the right support available makes this transition possible.

Having Support Networks

The importance of setting up or maintaining good support networks was identified by all participants as being vital to their ongoing recovery and reintegration. Within this study there seemed to exist a fine balance between being able to accept help and being hurt by people's responses to their situation.

All participants had at least one person close to them whom they could rely on for help and support. Kate was able to confide in her sister and not feel the need to hide her true feelings:

"My sister was very important as I could tell her anything. A friend would call and ask how I was I would say I'm fine, but if Mary (pseudonym) called I would tell her the truth. If I had a rotten day yesterday or I got tired, I could tell her and I still do. That was a great release for me and it would have made it harder without her" (Kate).

As well as having a close confidant to talk to, three participants were able to confide in healthcare professionals. Susan had a home visit by an occupational therapist and a physiotherapist whom she chose to confide in:

"The physiotherapist and occupational therapist that came round were lovely and that was lovely, someone coming into your home and chatting. I loved the therapy. I didn't choose to talk to a lot of people but they knew what I was going through" (Susan).

Not all support was considered beneficial though as three participants resented having to ask for help or being given sympathy.

"I hate giving in to where I need help. I hate fuss. I'd sooner keep it all to myself and get by without anyone knowing" (Kate).

Richard felt that encouragement from those around him was more beneficial than sympathy:

"I don't want sympathy. I want encouragement more than anything; Someone just to say that you're handling it well, that's all; rather than someone who says 'what the hell are you doing" (Richard).

Susan and Kate both held back from discussing their problem too much to avoid making a fuss, which may have left some people close to them unaware of the severity of their symptoms. This led Susan and Kate to resent the reactions from some of the people close to them as they felt they were showing a lack of understanding. Susan described her experience as being unique and misunderstood:

"I have all the sympathy in the world for someone who goes through this or has anything to do with concussion. I mean unless you go through it you never understand it" (Susan).

The psychological impact and symptoms of TBI often cannot be seen. This means that other people are not always receptive to the ongoing suffering that can occur. This makes having people around to confide in about these issues following TBI such an important part of the healing process

CIQ and CIM comparison

Table1 shows the results for scores on the CIQ and the CIM. CIQ home integration was 10/10 for three participants and 0/10 for one; Dane relied on his wife to do the house chores and planning social arrangements resulting in zero points. Kate and Dane only scored 7 out of a possible 12 on the social integration subscale, suggesting a lower level of activity than that reported by Susan and Richard. No participant gained full points for the productivity subscale, reflecting their lack of engagement in paid and voluntary work. Three of the four participants scored high on the CIQ and very high on CIM. Yet, all three reported ongoing problems in returning to their normal lives. Although this was a small sample it suggests that the questionnaires do not detect community integration issues in some people with a mild TBI. Two issues could be at play: firstly, it is possible the measures suffer from a ceiling effect for people with a mild TBI. Secondly, the CIQ puts value on how often someone takes part in an activity and neither questionnaire asks the person whether he or she is satisfied with their level of community participation. Whether the number of times activities are undertaken is adequate to indicate high social integration is a subjective opinion. For example, Dane may be content visiting friends two times a week, whereas Kate may consider this an extremely low number that leaves her feeling isolated. This may explain why Dane and Kate had identical scores in the social integration section of the CIQ despite Dane seeming less socially integrated.

DISCUSSION

Two reoccurring themes from previous research which closely matched the data were the feelings of social isolation (Colantonio et al 2004, Hawthorne et al 2009, Lefebvre et al 2008, Struchen et al 2011) and the need for ongoing support in the community (Huebner et al 2003, Rotondi et al 2007). Within this study, the experience of being social isolated seemed related to an inability to return to a normal life as known before the accident. The participants' return to normal life was also affected by an unwillingness to ask for help from friends and family leading to feeling of resentment due to a perceived lack of others' understanding. This was mentioned by all participants as sequelae of their mild TBI and reflected in the CIQ with low scores in the social integration subscale from two participants.

Participants acknowledged the important role of family, friends, church and healthcare professionals in their recovery. Relating these findings to a clinical setting, the understanding from healthcare professionals of their role to engage and listen

to their patient becomes vital to good practice and plays an important role in their patients' recovery and reintegration into the community.

Sub-themes identified through this paper's qualitative research such as a loss of confidence with everyday activities and a loss of, or interrupted, driving ability are not identified within either questionnaire. Although these themes are not specific to community integration, they were identified through the interviews as important constructs that affect people's ability to reintegrate successfully back into the community. This highlights an area for additional research as to whether these or other constructs identified within this research may be included in the questionnaires to improve content validity.

The development of the questionnaires utilised must also be considered when using them in the New Zealand context. Both questionnaires were formulated using an American population who had sustained moderate to severe TBI with the age range for participants in these studies 18-64 years for the CIQ and 19-58 years (35.8 average) for the CIM (McColl et al 2001, Willer et al 1993). This may affect the validity of the tools' use in the New Zealand environment due to potentially different needs, expectations and services of older adults with mild or moderate TBI. This also brings into question the use of either questionnaire with older adults, particularly those with mild TBI. The mild nature of the TBIs suffered by older adults within this study may be a reason for the apparent ceiling effect that occurred during testing, particularly for the CIM, as past tests for validity and reliability were not tested on this population. This indicates that further research should be undertaken to test the validity and reliability of the CIQ and CIM specifically on older adults in New Zealand, particularly those with mild TBI.

Description of study limitations and implications

The sample size for this exploratory study was small with four participants and lacked ethnic diversity. Because of this, these results cannot be regarded as transferable to all individuals with mild TBI in New Zealand. However, the findings may 'ring true' for others. Also the research did not set out to achieve data saturation due to the narrow scope of the project.

Recommendations for future research and clinical care

All previous research reviewed in this paper was based on work undertaken overseas, with no studies specific to the older adult population in New Zealand who may have unique or particular community integration needs. The majority of research into people's experience of community integration following TBI looks at younger adults and people with moderate or severe TBI. Further research must be done within New Zealand to fully understand the New Zealand context of older adults' experiences of community integration following TBI. Any future studies must use a larger recruitment base to increase the sample size and attempt to represent the multicultural make up of New Zealand by including a more ethnically diverse sample. Further research must also be completed with the specific population that this study addressed: older New Zealanders. This research suggests a gap exists in knowledge specifically studying older adults with mild to moderate TBI and their experience of community integration that may inform physiotherapy practice. This study also identified a possible ceiling effect of the CIM and component of the CIQ. Other measures could be explored; in particular those that examine how satisfied people are with their social integration, such as the Impact on Participation and Autonomy questionnaire (Cardol et al 2001, Kersten et al 2007) or the Activity Measure for Post-Acute Care (Jette et al 2007) participation measures developed by the Patient Reported Outcome Measurement Information System (PROMIS) group.

CONCLUSION

The incidence of older adults suffering TBI in New Zealand is increasing (Thompson et al 2006). As the population ages and health resources become scarcer, physiotherapists' understandings of how best to achieve community reintegration of older TBI patients must be addressed. This requires further research as, despite the fact that community integration has been identified as a primary goal of rehabilitation; this study has identified a paucity of research specifically into older adults' experience of community integration following TBI. Physiotherapists should be aware that the CIQ and CIM may have a possible ceiling effect when used to measure the experiences of older adults' community integration following mild TBI.

KEY POINTS

- Successful community integration following TBI should be the primary goal of rehabilitation.
- Physiotherapists should be aware that the CIQ and CIM may have a possible ceiling effect when used to measure the experiences of older adults' community integration following mild TBI in New Zealand.
- Further research is needed into the validity of outcomes measure for older adults' experiences of community integration following mild TBI in New Zealand.
- Physiotherapists have an important role as a support network and their ability to engage and listen to their patient is vital to good practice and plays an important role in their patients' recovery and reintegration into the community.

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PERMISSIONS

Ethics: this study was approved by the Auckland University of Technology Ethics Committee, approval number 12/285, and the Waitemata District Health Board, Awhina Health Campus Ethics Approval Committee. Signed informed consent was gained from the participants.

DISCLOSURES

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The reliability of measuring the inter-recti distance using high-resolution and low-resolution ultrasound imaging comparing a novice to an experienced sonographer

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ABSTRACT

Diastasis recti abdominis is an increase in inter-recti distance. This commonly occurs in women postpartum and may lead to weakness and dysfunction of the abdominal muscles. Ultrasound imaging has been previously used to quantify the inter-recti distance. The aims of this study were: 1) to examine the reliability of an experienced versus a novice sonographer in the measurement of inter-recti distance, and 2) to examine the reliability of using high-resolution versus low-resolution ultrasound imaging in the measurement of inter-recti distance. Ultrasound measures of the inter-recti distance were recorded in thirty healthy participants at rest and during an abdominal contraction by both an experienced and novice sonographer. Intra-rater, within-session measurement of inter-recti distance demonstrated good to very good reliability. Intra-rater, between session reliability remained very good for the experienced sonographer but declined for the novice sonographer. Results demonstrated excellent agreement between both low and high-resolution ultrasound imaging with no significant differences recorded. There were no significant differences between the novice and experienced sonographers' measurements. The results of this study indicate the potential of low-resolution ultrasound imaging to be implemented clinically in the future.

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Key Words: Ultrasound imaging, Inter-recti distance, Diastasis recti abdominis, Reliability

INTRODUCTION

Diastasis recti abdominis (DRA) has been defined as a condition characterised by an abnormal midline separation of the rectus abdominis (RA) from the linea alba (Barbosa et al 2013, Mota et al 2013). The cause of a DRA is most commonly related to pregnancy (Barbosa et al 2013). In males, as well as females, DRA has also been associated with increasing age (Chiarello and McAuley 2013, Lockwood et al 2006, Rath et al 1996), greater abdominal circumference (Chiarello et al 2012), hernia (Spitznagle et al 2012), and abdominal aortic aneurysm (McPhail 2009).

During pregnancy, the two rectus abdominis muscle bellies elongate and curve round the abdominal wall as it expands (Boissonnault and Blaschak 1988, Gilleard and Brown 1996) causing midline separation along the linea alba and protrusion of the umbilicus (Boissonnault and Blaschak 1988, Mota et al 2013). A measure of this mid-line separation is referred to as the inter-recti distance (IRD). From studies looking at the IRD using medical imaging, a separation of greater than 2.7cm at the level of the umbilicus has been suggested to indicate DRA (Coldron et al 2008, Rath et al 1996).

It is purported that DRA does not completely resolve and remains larger than in nulliparous women (Boissonnault and Blaschak 1988, Coldron et al 2008, Liaw et al 2011). The abdominal musculature performs an imperative role in stabilising the lumbar spine (Rankin et al 2006). Adverse clinical effects that have been reported with DRA are: lumbosacral instability (Chiarello and McAuley 2013, Coldron et al 2008); low back and pelvic girdle pain (Chiarello and McAuley 2013, Coldron et al 2008); decreased strength and endurance of the rectus abdominis (Chiarello and McAuley 2013); respiratory, pelvic floor and postural changes (Barbosa et al 2013, Chiarello and McAuley 2013).

It has been recently proposed that the current prevalence of DRA in the community may be either inaccurate or reported unreliably due to the present methods used to diagnose the condition (Mota et al 2012, Mota et al 2013). To date, the most commonly used assessment methods to evaluate IRD in physiotherapy clinical practice are calipers (Boxer and Jones 1997, Hsia and Jones 2000) and palpation (Boissonnault and Blaschak 1988, Boxer and Jones 1997, Bursch 1987). Recent studies have advocated the use of ultrasound imaging (USI) to assess IRD as advancement from traditional techniques. Chiarello and McAuley (2013) investigated the construct validity between ultrasound imaging (USI) and calipers when measuring IRD. Their results depicted a strong correlation at the supra-umbilical (SU) location, however, IRD at the infra-umbilical (IU) level tended to be overestimated using the calipers (Chiarello and McAuley 2013). de Almeida Mendes et al (2007) found no

significant difference between the values at the SU and IU levels obtained by USI compared to the intra-operative measurements during surgery for abdominoplasty.

There is scope to utilise USI in clinical practice for assessment of IRD in people with DRA. USI has been proposed as the gold standard in the assessment of DRA, with a growing body of literature reporting it as an accurate method to measure DRA above and at the level of the umbilicus (Barbosa et al 2013, Chiarello and McAuley 2013, Mota et al 2013). Although USI is relatively inexpensive when compared to other imaging techniques, there remain several issues in regard to appropriate equipment and adequate training. Diagnostic USI requires high-resolution equipment to afford the clarity of ultrasound image necessary for clinical diagnosis. Widespread interest in the use of USI has led to improvements in technology and the development of more portable, less expensive machines with improved resolution (Ghamkhar et al 2010, Hing et al 2009). For rehabilitative USI, it is reasonable to use low-resolution machines for many practical purposes, for example examination of muscle morphology and activation (Hides et al 1998). With an adequate level of anatomical knowledge, it is reasonable to assume that physiotherapists trained in using USI could use this tool to quantitatively assess muscle morphological and functional issues such as DRA.

Therefore, the present study had two aims. The first aim was to establish and then compare the intra-session and inter-session reliability of an experienced versus a novice sonographer to measure IRD in healthy participants. The second aim was to also establish and then compare the intra-session reliability of using a high-resolution versus a low-resolution ultrasound machine to measure IRD in healthy participants.

METHODS

Design

A cross sectional, observational study.

Participants

Thirty healthy males and females (nulliparous, primiparous and multiparous) over the age of 18 years were recruited for this study. Participants were recruited, using advertisements, from the AUT University physiotherapy clinic and AUT University Campus.

Participants met the inclusion criteria if they were healthy individuals over the age of 18 years, could participate in at least one testing session, and were able to perform the required abdominal contractions in supine lying. Participants were excluded if they had neuromuscular or joint disease; significant spinal abnormality (eg, scoliosis); inflammatory, rheumatologic or connective tissue disease; or any medical condition which would prohibit active abdominal muscle contraction i.e. recent abdominal or gynaecological surgery. This study was approved by the Auckland University of Technology Ethics Committee (AUTEC) (Authorisation reference 13/132). Signed written informed consent was obtained before participation in this study.

Instrumentation and examination

Two independent examiners: a novice sonographer (an undergraduate fourth year physiotherapy student) and an experienced sonographer (eight years' sonography experience) performed sixteen measurements of the IRD on the same participant, using both low-resolution USI (Chison ultrasound machine) and high-resolution (Phillips iu22 machine) USI.

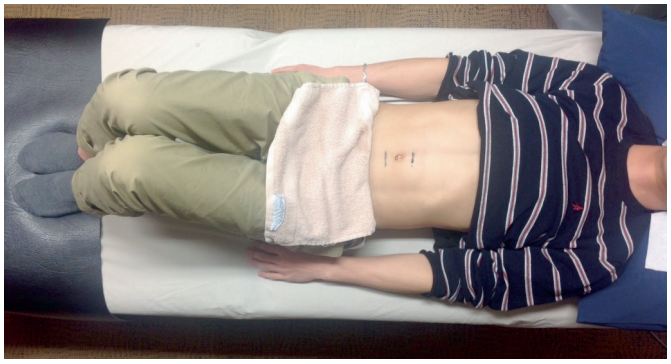
Prior to the first scanning session, the novice sonographer attended two, two hour training sessions held by the experienced sonographer. These sessions consisted of basic training in the use of USI and identification of abdominal anatomy, and measurement of IRD.

Procedures and IRD measurement

Using both the high-resolution and low-resolution machines, IRD measurements were taken at two locations (above and below the umbilicus) under two conditions (abdominal muscles at rest and contracted). The initial measurements occurred during a single session performed on the same day, as per the protocol described by Chiarello and McAuley (2013).

The desired measurement locations were marked with a marker pen at 2cm above the umbilicus (supra-umbilical, SU) and at 2cm below the umbilicus (infra-umbilical, IU) (Figure 1). The measurement points were marked on the participant's abdomen prior to the examination session to ensure standardised positioning of the ultrasound transducer placement between the two examiners (Mota et al 2012). These anatomical locations have previously been reported and have been established as having high intra-rater and inter-rater reliability in the quantification of IRD using USI (Boissonnault and Blaschak 1988, Chiarello et al 2005, Chiarello and McAuley 2013, Chiarello et al 2012).

Figure 1: Measurement location 2cm above and 2cm below the umbilicus



Previous investigation of DRA using USI have measured IRD with the abdominal muscles at rest (Gilleard and Brown 1996, Mota et al 2013) and contracted (Chiarello and McAuley 2013, Mota et al 2013). To measure the IRD with the abdominal muscles at rest; each participant was positioned lying supine, knees bent to 90 degrees, arms alongside the body, and feet resting on the plinth (Figure 2). A pillow was placed under the participant's head for comfort during the procedure (Mota et al 2012). To measure the IRD with the abdominal muscles contracted, each participant crossed their arms over their chest and raised their head until the scapulae were raised off the plinth surface (Figure 3). The participants maintained this partial curl-up while the examiner measured the IRD with the USI.

To avoid order effects, randomisation of the following conditions was achieved for all participants from rolling a dice: 1) novice versus experienced sonographer, 2) high-resolution versus low-resolution USI, 3) rested versus contracted abdominals, and 4) SU versus IU measurement location.

Figure 2: Abdominal resting position

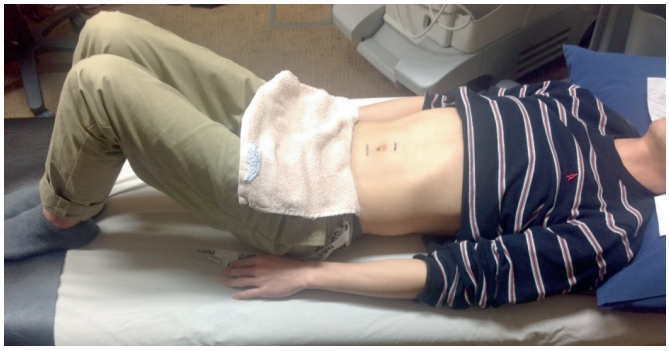
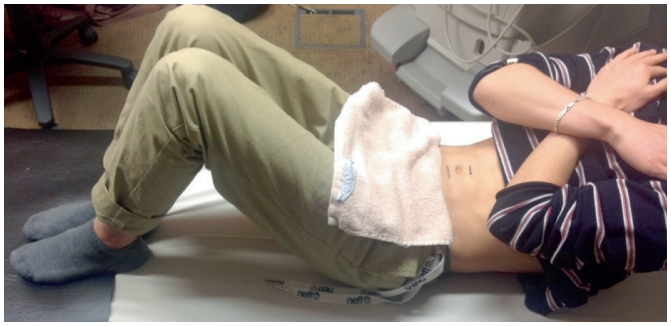


Figure 3: Abdominal curl-up contraction



Ten participants returned for testing in order to assess between-session reliability. There was a five week period between the initial measurement and follow up session.

Ultrasound imaging

All IRD measurements were attained using a Chison 8300 Deluxe (Chison Medical Imaging Co. Ltd., China) ultrasound machine (low-resolution) and Phillips iU22 (Royal Philips Electronics, The Netherlands) ultrasound machine (high-resolution). Although the use of both curvi-linear transducers (Chiarello and McAuley 2013) and linear transducers (Barbosa et al 2013, Mota et al 2012, Mota et al 2013) have been reported for IRD measurement, it was decided to use linear transducers as these gave the clearest images during pilot testing. A 12-5 MHz linear transducer was used for the high-resolution scanning whilst a 7.5 MHz linear transducer was used for the low-resolution scanning.

The linear transducer was aligned over the marking made on the participant's abdomen. The examiners adjusted the orientation of the transducer and positioned this on the participant's abdomen until the medial borders of both rectus abdominis muscles were clearly visualised (Mota et al 2012) (Figure 4, Figure 5). Ample amounts of transmission gel was applied by the sonographer to ensure that the least amount of transducer pressure was used in order to clearly visualise the medial borders of both rectus abdominis muscles. Once the examiner was satisfied, a static image was captured, allowing calculation of the IRD using the digital measurement caliper setting on the machine (Figure 4, Figure 5).

Two images were captured for each of the testing conditions. There was a one minute rest period between the two images captured. All images were captured at the end of expiration for both the rested and contracted conditions. The focus, depth,

Figure 4: Inter-recti distance (IRD) as seen with low-resolution ultrasound imaging

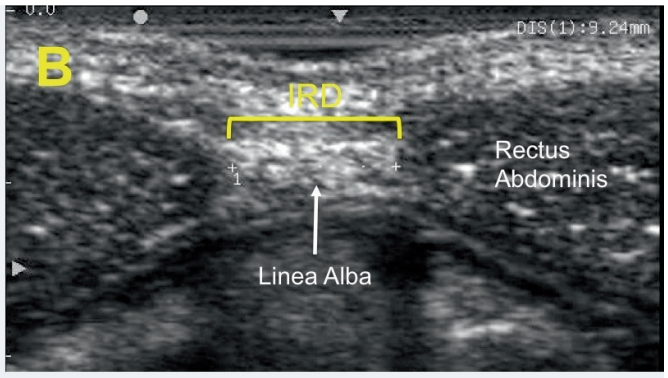
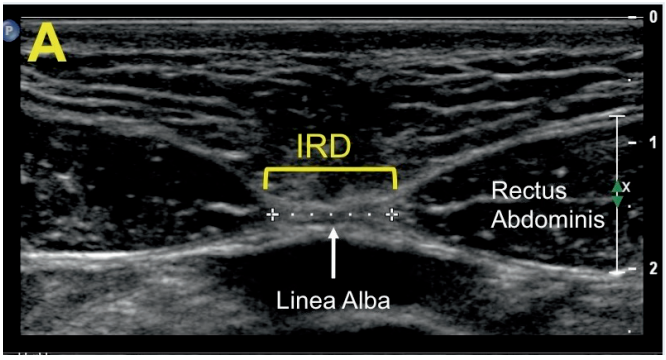


Figure 5: Inter-recti distance (IRD) as seen with high-resolution ultrasound imaging



and contrast settings were manipulated individually to increase image clarity of the rectus abdominis borders and IRD and to differentiate from surrounding anatomical structures.

Statistical analysis

In order to allow ease of comparison of reliability studies which examine USI, it has been advocated that the following statistical analyses are performed: intra-class correlation coefficients (ICC), standard error of measurement (SEM), minimal detectable change score (MDC) and Bland-Altman plots (Whittaker and Stokes 2011, Whittaker et al 2007).

The first aim of the present study was to establish the intra-session and inter-session reliability of an experienced versus a novice sonographer to measure the IRD. For the measurement of intra-session reliability of the experienced and novice sonographer individually, two-way random, single measures ICC (2,1), with 95% confidence intervals (CI) were calculated. Standard error of measurement (SEM) ($SEM = StandardDeviation_{pooled} \times \sqrt{1-ICC}$) and minimal detectable change (MDC) at the 95% CI ($MDC = 1.96 \times \sqrt{2} \times SEM$) were also calculated. These calculations were made across the different variables: high-resolution versus low-resolution USI; SU versus IU IRD; and rested versus contracted state.

The second aim of the present study was to establish the intra-session reliability of using a high-resolution versus a low-resolution ultrasound machine to measure the IRD. To achieve this two-way random, average measures ICC (2,k) (therefore taking into account both sonographers), with 95% CI were calculated. SEM and MDC values were also calculated as previously described.

For qualitative assessment of the reliability results, ICC values of less than 0-0.5 represent very low reliability, 0.5-0.7 low, 0.7-0.9 high, and greater than 0.9 represent very high reliability (Hides et al 2009, Mota et al 2012).

As a measure of construct validity, student t-tests were conducted to conclude if there were statistical differences in IRD measurements, 1) between the experienced and novice sonographer and, 2) between the high-resolution versus a low-resolution USI. The statistical significance level was set $p < 0.05$.

Bland-Altman plots were used to provide a graphical representation of some of the key reliability findings (Bland and Altman 1986). All statistical analysis was performed using SPSS statistical software package, version 21 (SPSS Inc., Chicago, IL, USA).

RESULTS

Thirty healthy volunteers (14 male and 16 female) participated in this study (Table 1). The mean age and body mass index (BMI) of all participants was 24.37 years (range 20-53 years) and 23.89 kg/m^2 respectively. Of the 14 male participants, the mean age was 24.21 years (range 20-53 years) with a BMI of 24.38 kg/m2. Of the 16 female participants, three had had previous pregnancies (range 1-4 children), mean age of 36 years (range 27-43) and mean BMI 21.47 kg/m2. The additional 13 participants were nulliparous females, mean age of 21.85 years (range 20- 26 years) and mean BMI of 23.92 kg/m2.

Table 1: Demographic information

	All (n=30)	Men (n=14)	Female (Nulliparous) (n=13)	Female (Postpartum) (n=3)
Age (years)	24.37 SD 7.40	24.21 SD 8.35	21.85 SD 1.88	36 SD 6.68
Height (cm)	173.13 SD 8.26	178.73 SD 5.98	168.66 SD 7.39	166.33 SD 0.47
Weight (kg)	72.02 SD 12.33	78.21 SD 11.37	68.28 SD 10.49	59.37 SD 6.45
BMI (kg/m^2)	23.89 SD 2.76	24.38 SD 2.5	23.92 SD 2.81	21.47 SD 2.44

Note. BMI = Body mass index, n = participant numbers; [a]Data are mean and standard deviation (SD).

Table 2: High and low Resolution USI of IRD at rest (Pooled Data)

	SU IRD (cm)	95% CI (cm)	ICC(2,k) (95% CI)	IU IRD (cm)	95% CI (cm)	ICC(2,k) (95% CI)
HRUS	1.46 SD 0.57	1.36 - 1.56	0.97 (0.94-0.98)	0.53 SD 0.28	0.48-0.58	0.98 (0.96-0.99)
LRUS	1.47 SD 0.57	1.37 - 1.57	0.97 (0.94-0.98)	0.59 SD 0.32	0.53-0.65	0.76 (0.58-0.87)
T-test	0.91*			0.11*		

Note. SU = supra umbilicus. IU = infra umbilicus. IRD = inter recti distance. HRUS = high-resolution ultrasound. LRUS = low-resolution ultrasound. CI = confidence interval. ICC = intraclass correlation coefficient; [a]Data are mean and standard deviation (SD), except where otherwise indicated. * p<0.05

Ultrasound Measurements at Rest and During Concentric Contraction

Pooled data (i.e. for both sonographers) for the high-resolution ultrasound (HRUS) and low-resolution ultrasound (LRUS) measurement of IRD at rest at both the SU and IU locations are presented in Table 2. There was no significant difference seen when comparing high- versus low-resolution USI (SU p=0.91, IU p=0.11) at both anatomical locations (Table 2).

Pooled data of the HRUS and LRUS machines in the measurement of the IRD at the SU and IU locations during the concentric contraction are presented in Table 3. There was no significant difference seen when comparing high- versus low-resolution USI (SU p=0.35, IU p=0.68) at both anatomical locations.

Intra-rater, within-session reliability

Generally the intra-rater, within session reliability of measuring IRD, irrespective of the condition (i.e. novice versus experienced sonographer, SU versus IU measurement, rest versus contracted), was very high (ICC>0.91). The exception was the reliability of the novice sonographer measuring IRD at the IU location with the LRUS, which showed good reliability (ICC=0.89) (Table 4).

Confirmation of the excellent levels of reliability recorded were the small measurement error that was evident with small SEM values (range 0.02cm - 0.17cm) and MDC values (0.05cm - 0.48cm) indicating good precision. In order to assess whether there was a difference in mean measures between the novice's and experienced sonographer's, student t tests (p<0.05), were calculated for the different conditions. These results demonstrated no significant differences between the novice's and experienced sonographer's measurements across all conditions (p>0.14) (Table 4).

Bland-Altman plots representing some of the key within-session analyses (comparing the difference between the results, plotted against their average) are shown in Figures 6, 7, 8 and 9.

Intra-rater, between-session reliability

The ICC values representing intra-rater, between-session reliability of measuring the IRD at rest and during contraction

Table 3: High and low Resolution USI of IRD whilst contracted (Pooled Data)

	SU IRD (cm)	95% CI (cm)	ICC(2,k) (95% CI)	IU IRD (cm)	95% CI (cm)	ICC(2,k) (95% CI)
HRUS	1.40 SD 0.54	1.30-1.50	0.94 (0.90-0.97)	0.84 SD 0.48	0.76-0.93	0.80 (0.65-0.90)
LRUS	1.33 SD 0.51	1.24-1.42	0.92 (0.86-0.96)	0.82 SD 0.38	0.75-0.89	0.91 (0.84-0.95)
T-test	0.35*			0.68*		

Note. SU = supra umbilicus. IU = infra umbilicus. IRD = inter recti distance. HRUS = high-resolution ultrasound. LRUS = low-resolution ultrasound. CI = confidence interval. ICC = intraclass correlation coefficient; [a]Data are mean and standard deviation (SD), except where otherwise indicated. * p<0.05

Table 4: Intra-rater, within-session reliability of measuring IRD at rest and contracted (HRUS vs. LRUS) (n=30)

Location	Sonographer	Mean IRD SD (cm)	ICC (2,1)	ICC 95% CI	SEM (cm)	MDC (cm)	T-test
SU rest							
HRUS	Experienced	1.49 SD 0.65	0.97	0.94-0.99	0.11	0.31	0.57*
	Novice	1.43 SD 0.59	0.98	0.97-0.99	0.07	0.19	
LRUS	Experienced	1.46 SD 0.56	0.92	0.84-0.96	0.16	0.45	0.85*
	Novice	1.48 SD 0.56	0.95	0.90-0.98	0.13	0.35	
IU rest							
HURS	Experienced	0.50 SD 0.37	0.98	0.96-0.99	0.05	0.14	0.34*
	Novice	0.55 SD 0.11	0.98	0.96-0.99	0.02	0.05	
LRUS	Experienced	0.61 SD 0.46	0.96	0.92-0.98	0.08	0.23	0.20*
	Novice	0.63 SD 0.17	0.89	0.78-0.95	0.06	0.16	
SU contracted							
HRUS	Experienced	1.47 SD 0.61	0.96	0.91-0.98	0.12	0.34	0.15*
	Novice	1.33 SD 0.46	0.96	0.92-0.98	0.09	0.25	
LRUS	Experienced	1.36 SD 0.56	0.91	0.82-0.96	0.17	0.47	0.53*
	Novice	1.3 SD 0.44	0.95	0.89-0.97	0.10	0.28	
IU contracted							
HRUS	Experienced	0.91 SD 0.57	0.91	0.81-0.95	0.17	0.48	0.14*
	Novice	0.78 SD 0.33	0.93	0.86-0.97	0.09	0.25	
LRUS	Experienced	0.84 SD 0.44	0.92	0.84-0.96	0.12	0.34	0.53*
	Novice	0.79 SD 0.31	0.94	0.89-0.97	0.08	0.21	

Note. SU = supra umbilicus. IU = infra umbilicus. IRD = inter recti distance. HRUS = high-resolution ultrasound. LRUS = low-resolution ultrasound. cm = centimetres. SD = standard deviation from the mean. CI = confidence interval. ICC = Intra-class correlation coefficient. SEM = standard error of measurement. n = participant numbers; * For differences in mean values, p<0.05

(HRUS vs. LRUS) are presented in Table 5. There was a five week period between the initial measurement and follow up session. Ten participants attended the first and second testing sessions for between-session analysis.

The between-session reliability of measuring IRD, irrespective of condition, for the experienced sonographer demonstrated good to very good levels of reliability (ICC 0.79-0.98) with a low SEM (0.09-0.30cm) and MDC (0.25-0.82cm). However, the novice sonographer demonstrated between low to high reliability (ICC -0.51-0.88) for

Figure 6: Bland-Altman graph (difference versus average) for both sonographers (pooled data) for measurement of the IRD at the supra-umbilical location during the rested condition using high-resolution USI. Hashed line indicates bias. Solid lines indicate limits of agreement (95%)

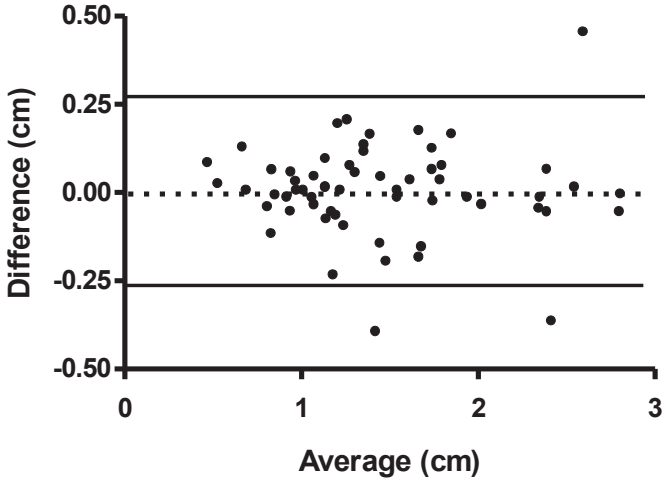
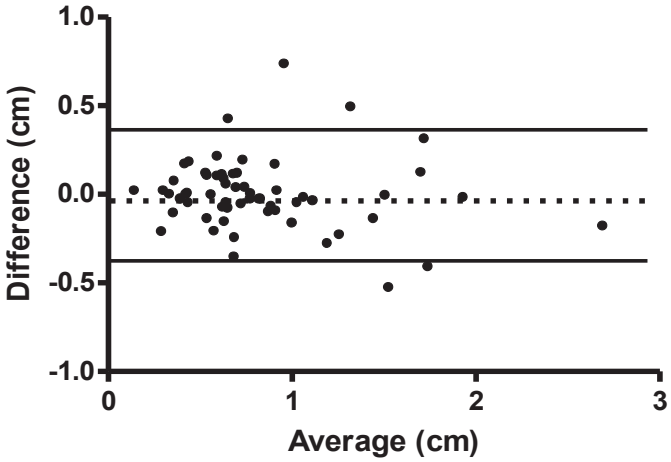


Figure 7: Bland-Altman graph (difference versus average) for both sonographers (pooled data) for measurement of the IRD at the infra-umbilical location during the contracted condition using high-resolution USI. Hashed line indicates bias. Solid lines indicate limits of agreement (95%)



IRD measurements depending on the different conditions (Table 5). Furthermore, the SEM (0.15-0.95cm) values for the novice sonographer's measurements of the IRD illustrated greater variance compared to the experienced sonographer (Table 5). For the mean IRD measurement, no significant differences between the novice's and experienced sonographers' measurements across all conditions were seen (p>0.17) (Table 5).

Inter-rater, Between-session Reliability

The ICC values representing inter-rater, between-session reliability of measuring the IRD at rest and during contraction (HRUS vs. LRUS) are presented in Table 6. The results for both high- and low-resolution USI, demonstrated excellent reliability for the SU and IU IRD measurements (Table 6). The low SEM values (HRUS 0.14-0.27 and LRUS 0.07-0.60) indicate low measurement error (Table 6). At the SU location measurements

Figure 8: Bland-Altman graph (difference versus average) for both sonographers (pooled data) for measurement of the IRD at the infra-umbilical location during the contracted condition using low-resolution USI. Hashed line indicates bias. Solid lines indicate limits of agreement (95%)

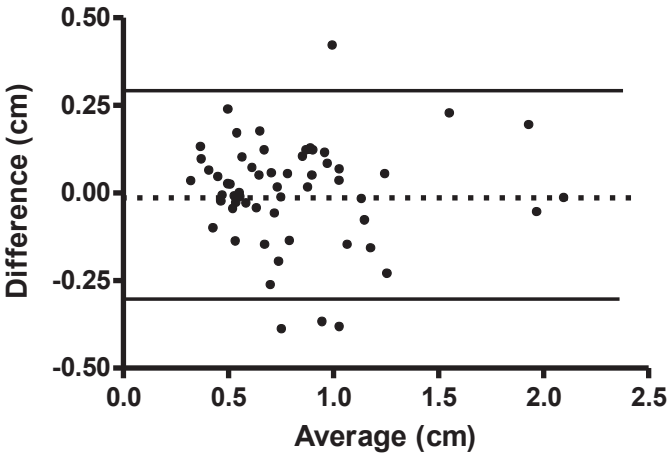
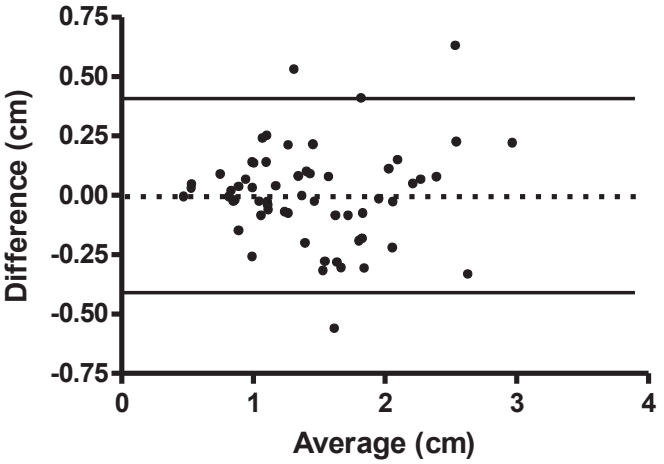


Figure 9: Bland-Altman graph (difference versus average) for both sonographers (pooled data) for measurement of the IRD at the supra-umbilical location during the rested condition using low-resolution USI. Hashed line indicates bias. Solid lines indicate limits of agreement (95%)



demonstrated excellent reliability (ICC >0.94) for high- and low-resolution USI (Table 6). At the IU location measurements demonstrated moderate to high reliability (ICC range 0.65-0.83) for high- versus low-resolution USI.

DISCUSSION

This present study examined many aspects of reliability of IRD measurement, in healthy participants, including the intra-session and inter-session reliability of an experienced versus a novice sonographer. The intra-rater, within-session reliability of measuring the IRD irrespective of the condition was very high. These results demonstrated no significant differences between both sonographers' measurements. Whereas the intra-rater, between-session reliability of measuring the IRD for the experienced sonographer demonstrated good to very good

Table 5: Intra-rater, between-session reliability of measuring IRD at rest and contracted (HRUS vs. LRUS) (n=10)

Location	Sonographer	Mean IRD SD (cm)	ICC(2,1)	ICC 95% CI	SEM (cm)	MDC (cm)	T-test
SU rest							
HRUS	Experienced	1.61 SD 0.66	0.93	0.75-0.98	0.17	0.48	0.72*
	Novice	1.54 SD 0.52	0.88	0.58-0.97	0.18	0.50	
LRUS	Experienced	1.53 SD 0.63	0.98	0.93-0.99	0.09	0.25	0.51*
	Novice	1.64 SD 0.59	0.88	0.59-0.97	0.20	0.56	
IU rest							
HRUS	Experienced	0.72 SD 0.52	0.79	0.36-0.94	0.24	0.66	0.87*
	Novice	0.71 SD 0.40	0.04	-0.32-0.54	0.39	1.08	
LRUS	Experienced	0.78 SD 0.54	0.97	0.87-0.99	0.09	0.25	0.53*
	Novice	0.68 SD 0.22	-0.51	-0.63-0.57	0.95	2.61	
SU contracted							
HRUS	Experienced	1.68 SD 0.65	0.94	0.78-0.98	0.16	0.44	0.25*
	Novice	1.46 SD 0.58	0.59	-0.07-0.89	0.40	1.10	
LRUS	Experienced	1.51 SD 0.59	0.87	0.57-0.97	0.21	0.59	0.96*
	Novice	1.51 SD 0.60	0.85	0.51-0.96	0.23	0.64	
IU contracted							
HRUS	Experienced	1.02 SD 0.74	0.92	0.7-0.98	0.21	0.57	0.17*
	Novice	0.78 SD 0.37	0.2	-0.17-0.65	0.33	0.91	
LRUS	Experienced	0.99 SD 0.65	0.79	0.36-0.94	0.30	0.82	0.22*
	Novice	0.82 SD 0.35	0.26	-0.4-0.75	0.30	0.83	

Note. SU = supra umbilicus. IU = infra umbilicus. IRD = inter recti distance. HRUS = high-resolution ultrasound. LRUS = low-resolution ultrasound. cm = centimetres. SD = standard deviation from the mean. CI = confidence interval. ICC = Intra-class correlation coefficient. SEM = standard error of measurement. n = participant numbers; * For differences in mean values, $p<0.05$

levels of reliability, the novice sonographer demonstrated low to high reliability with a greater variance.

Furthermore, our study examined the intra-session reliability of using high-resolution versus low-resolution USI to measure IRD. The results for both resolution qualities, demonstrated excellent reliability for the SU and IU IRD measurements. Pooled data for both sonographers for measurement of IRD during the resting and contracted conditions at both locations (SU and IU) revealed strong agreement between both HRUS and LRUS for both anatomical positions tested. No significant differences were recorded for the SU and IU locations.

In this present study, measurement of the IRD at the SU location revealed very high intra-session and inter-rater reliability (ICC 0.91-0.98). The intra-rater, within session IU ICC values were very good (0.89-0.98) but slightly lower than SU measurements. These findings are consistent with those of previous studies measuring IRD using USI (Liaw et al 2011, Mota et al 2012, Mota et al 2013). Mota et al (2012) demonstrated excellent reliability 2cm above the umbilicus (ICC 0.87) and moderate-good reliability at 2cm below the umbilicus (ICC 0.78). Further to this finding, de Almeida Mendes et al (2007) have stated that it is more difficult to attain clear, consistent measures of the IRD at the IU location with USI. This decreased accuracy at the IU location has been suggested to occur due to the constitution of the rectus sheath affecting the formation of the linea alba and making identification of the borders more challenging (Barbosa et al 2013). It has also been suggested that at the IU location there is reduced definition of the posterior layer of recti muscles and the presence of large abdominal laxity. For example, amongst humans there is typically greater subcutaneous fat in this region (Barbosa et al 2013, de Almeida Mendes et al 2007). The fatty deposits at the IU location may attenuate the sound beam more, which can lead to reduced clarity of image.

In this present study we found that there were no significant differences for the measurement of IRD, across all conditions, between the high and low-resolution USI, both demonstrated good to very good reliability. In regard to the comparison of high-resolution versus low-resolution USI, Hing et al (2009) demonstrated similar results. They found that LRUS is an

Table 6: Inter-rater, between-session reliability of measuring IRD at rest and contracted (HRUS vs. LRUS) (n=10)

Location	ICC(2,1)	95% CI	SEM (cm)	MDC (cm)
SU rest				
HRUS	0.94	0.85-0.98	0.14	0.40
LRUS	0.99	0.96-0.99	0.07	0.20
IU rest				
HRUS	0.65	0.08-0.90	0.27	0.75
LRUS	0.65	0.09-0.90	0.60	1.67
SU contract				
HRUS	0.94	0.84-0.98	0.11	0.31
LRUS	0.97	0.73-0.97	0.10	0.28
IU contract				
HRUS	0.83	0.56-0.95	0.24	0.67
LRUS	0.83	0.56-0.95	0.22	0.60

Note. SU = supra umbilicus. IU = infra umbilicus. HRUS = high resolution ultrasound. LRUS = low resolution ultrasound. CI = confidence interval. ICC = Intra-class correlation coefficient. SEM = standard error of measurement. MDC = minimal detectable change. n = participant numbers

effective and reliable tool for measuring lower extremity muscle parameters. These authors reported very good within-session reliability for all lower limb measurements of dorsal plantar thickness and medial-lateral length of abductor hallucis, using similar machines for both HRUS (ICC 0.95-0.99) and LRUS (0.92-0.99). Regardless of the type of resolution quality, intra-tester reliability was found to be very high (Hing et al 2009).

Our results demonstrated very good intra-rater, between-session reliability for the experienced sonographer for IRD measurement. However; the intra-rater, between-session reliability of IRD measurements by the novice sonographer ranged from low to high and were not consistent for the rest and contracted conditions (Table 5). The lack of precision and wide 95% confidence intervals confirm the low intra-rater, between-session reliability of the novice sonographer for these measurements. Hides et al (2007) demonstrated similar findings for novice sonographers. The reliability of measuring the slide of the anterior abdominal fascia by the novice sonographer was poor within-session (ICC=0.44) and between-session (ICC =0.36) (Hides et al 2007). In addition to this, Teyhen et al (2005) reported very good intra-rater reliability for measurement of two ultrasound images of the transverse abdominis and a combined measure of the antero-lateral abdominal muscles. However the novice sonographer demonstrated variable reliability for attainment of images and subsequent measurement at both rest and contraction (Teyhen et al 2005).

Hides et al (2007) suggested these poor reliability results were a reflection of the amount of training undertaken by the novice sonographer. In their study, the novice sonographer received eight hours of training of the anterolateral abdominal muscles with USI (Hides et al 2007). Inconsistencies in the pattern of results suggest that for a novice sonographer, this training was inadequate. Our study suggested that the amount of training received by the novice sonographer may not have transferred well across the five week delay between testing sessions. Although previous studies (Hides et al 2007, Teyhen et al 2005) used novice sonographers in conducting abdominal measurements, we acknowledge that these are very different measurements from ours.

The implications of this present study include the potential of utilising low-resolution USI in the clinical environment more regularly. The results of this present study indicate that images obtained from both the high-resolution (Phillips IU22) and low-resolution (Chison) machines displayed consistent, highly comparable results across all measurements examined. There was no significant difference calculated for the measurement of IRD between the machines, therefore validating the use of either ultrasound machine within the clinical setting for examination of muscle morphology and activation.

There were several limitations to this study that should be considered. We recruited a convenience sample of healthy participants with a small number of postpartum women being examined. It may be more challenging to reliably measure the IRD of symptomatic participants with abdominal impairments. Future research should include testing a wide spectrum of participants, as results illustrated in this study may not necessarily generalise to pathological populations.

A potential source of error was the performance of the abdominal contraction during the "contracted" IRD measurements. Although the instruction of how to perform the abdominal contraction was standardised, the end position was not standardised. The performance may have varied due to factors such as participant motivation, motor control, and skill during the curl-up contraction. The intensity of abdominal contraction and varied effort made by the participants may have induced movements under the transducer and may have varied the relevant morphology of the underlying abdominal musculature and linea alba. For example, during the curl-up contraction the contours of the abdominal wall may have varied between participants. Accurate IRD interpretation depends upon maintaining a relatively stationary transducer position during abdominal contraction. To mitigate some of the potential sources of error, the transducer location on the abdominal wall, room temperature, position of the participant on the plinth were standardised.

CONCLUSION

Low-resolution USI has shown promise as a reliable and valid tool for measuring the IRD in healthy participants. Low-resolution USI has advantages as a cost-effective, portable, safe and clinically accessible method of examination for static and dynamic muscle assessment. There is growing access to low-resolution USI and burgeoning evidence in support of its use by physiotherapists in clinical practice. While the experienced sonographer maintained high between-session reliability, the novice sonographer was unable to maintain this over time. Inconsistencies in the novice sonographer inter-session results suggest that revision of ultrasound training should be undertaken to ensure the consistency of IRD measurements remains high. The potential benefits of low-resolution USI are appealing, and the results of the present study indicate its potential to be implemented clinically in the future.

KEY POINTS

- Both low-resolution and high-resolution USI demonstrate good to very good reliability in the measurement of IRD in healthy participants. There does not appear to be differences in IRD measurements between both resolution qualities. This is of benefit to clinicians where access to low-resolution USI is greater.
- Novice and experienced sonographers demonstrate good to very good reliability in the measurement of IRD within a single scanning session
- Although the reliability for the experienced sonographer remained high across scanning sessions, the reliability for the novice sonographer decreased. This indicates that ultrasound training for the novice sonographer needs to be maintained across time to potentially improve reliability.

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PERMISSIONS

This study was approved by the Auckland University of Technology Ethics Committee (AUTEC) (Authorisation reference 13/132). Signed written informed consent was obtained before participation in this study.

The photographs used do not identify the participant as all facial features have been removed.

DISCLOSURES

No specific funding was sought for this project. No conflicts of interest have been identified for this research.

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The feasibility and acceptability of using mobile methods for capturing and analysing data about dog-walking and human health

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ABSTRACT

The aim of this study was to assess the feasibility and acceptability of Mobile Methods to capture and analyse data relating to a test research question: "How does dog-walking influence health and well-being?" in healthy dog walkers. Eleven self-reported healthy adults from the Otago region of New Zealand were interviewed twice between 18/3/13 and 12/6/13. One of the interviews took place during their regular dog-walk. In *Design One* a walk-along interview was followed by a participatory analysis session and in *Design Two* a sit-down interview was followed by a walk-along interview. Qualitative analysis of the feasibility and acceptability of Mobile Methods was guided by a general inductive thematic approach. Four themes were identified: 1) Walk-along interviews are dynamic in nature; 2) Walk-along interviews generate enriched data; 3) Sharing ideas; and 4) Logistical challenges of walk-along interviews. Memory triggers, human-dog interactions, and environmental connections provided enriched qualitative data in *Design One*. For future dog-walking research we recommend using familiar route(s), during daylight hours, with data recorded by head-mounted video cameras and supplemented with field notes.

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INTRODUCTION

Mobile Methods is a collective term for strategies designed to collect data about movement within the social world (Büscher et al 2010; Ross et al 2009), for example, 'go-along' interviews involve collection of data 'on-the-move' in order to observe interactions between the participants and their environment (Kusenbach 2003). The use of Mobile Methods is expanding in response to the emergence of the 'mobilities paradigm' (Sheeler and Urry 2006), an intellectual movement which recognises the inseparable nature of movement (or lack of movement) with every day experiences. These methods are increasingly utilised in multi-disciplinary fields (Anderson 2004; Carpiano 2009; Hall et al 2008; Ross et al 2009) and, it is proposed that these facilitate greater insight into movement-related activities compared to traditional seated interviews (Carpiano 2009; Trell and Van Hoven 2010). Data generated by Mobile Methods are analysed in a spirit of collaborative participation between participant and researcher (Brown and Durrheim 2009; Garcia et al 2012).

Physical activity involves bodily movement through space, making it an appropriate topic for go-along interviews. It is well documented that higher levels of physical activity are linked to long-term health and longevity (Hardman and Stensel 2013; Powell et al 2011). Dog ownership might be one way to support increased levels of physical activity.

There is growing evidence that dog ownership increases physical activity, psychological health, and community participation in the general population (Christian et al 2013; Johnson and Meadows 2010, Cangelosi and Sorrell 2010). Little is known, however, about how these health benefits are achieved (Headey 2003; Utz 2013) and further investigations of this complex relationship are warranted.

Data from dog-walking studies have been captured through both quantitative and qualitative methodologies. Within the qualitative paradigm, dog walking experiences have been captured through seated interviews, focus groups and surveys (Peel et al 2010; Utz 2013; Wharf-Higgins et al 2013). It is possible that Mobile Methods might more fully capture how

dog-walking might impact upon the health and well-being of the human.

As far as we are aware, no published studies have used Mobile Methods to explore dog-walking as it relates to the health and well-being of the human. Therefore, the focus of this study was to investigate the feasibility and acceptability of Mobile Methods for capturing data relating to the human-animal interaction of dog-walking. To provide a worked example, a specific test research question was applied: "How does dog-walking influence a dog-walker's health and well-being?"

The specific objectives of this study were to: (1) determine the pragmatic feasibility of capturing data via audio and video-recorded walk-along interviews, (2) compare the nature of data collected between a seated interview and a walk-along interview, and (3) determine how the participatory philosophy of Mobile Methods influences the direction of analysis.

METHODS

Participants and Recruitment

Ethical approval was obtained from the University of Otago School of Physiotherapy Ethics Committee (SoP/EC/2013/02). We recruited participants (University employees and/or their relations) via advertisements placed on campus notice-boards. Adults aged 18 years or older who considered themselves healthy and walked a dog at least three times per week were eligible for inclusion.

Design

In order to best answer the study objectives, data were collected and analysed through two study designs, both involving a walk-along interview.

Design One: Mobile Methods

Participants in design one (n=7) first completed a walk-along interview, followed on a subsequent date by a participatory analysis session. Prior to this session, participants were invited to read the verbatim transcript from their walk-along interview. Those participants who had been video-recorded (n=3) were also able to view (in advance) and comment on their video clips. At the analysis session participants were asked which aspects of their transcript and video recording they thought best answered the research question. Participants were also encouraged to expand and clarify anything they felt necessary and, offer their opinions on the acceptability of the Mobile Method approach.

Design Two: Walk-along interview last

Participants in design two (n=4) completed a sit-down interview followed by a walk-along interview on a subsequent date. Two walk-along interviews in this design were video-recorded by author 2 with a hand-held camera. This design helped us to determine the pragmatic feasibility of capturing data via audio and video-recording during walk-along interviews; and to compare the richness of data collected between design one and two.

Methods used in both Design One and Design Two

Interviews in both design one and design two were semi-structured. The interviews included an open-ended questioning technique relating to health and well-being, dog walking, and the environment. Interviews began with questions about the dog's characteristics and their ownership history, followed by questions relating to the research topic (eg "How do you think dog walking influences your health and well-being?"). Follow-up questions were developed based on analysis of completed interviews (Thomas 2006). All interviews were audio-recorded using a lapel microphone and audio recorder. Author 1 transcribed all audio-recordings verbatim. Transcripts were checked for accuracy by author 2. Other data captured in transcription included the interviewer's senses (smell, touch, sights), pauses in the narrative, encounters with the dog, pedestrians, and the environment, the dogs' behaviours, and communication (verbal and non-verbal) between the participant and dog and any additional event. This additional data were added in italics and bracketed for the purpose of identification, for example: *[dog barking]* or *[affectionate]*.

Walk-along interviews were conducted during the participant's usual dog-walk, whilst the sit-down and participatory interviews were usually held during working hours at a mutually agreed location. Written consent was obtained from each participant before commencement of his or her first interview.

Participants were encouraged to lead and talk about aspects of the walk. The interviewer tried to minimise the impact on participants' 'normal walk' by minimising contact with the dog and allowing the participant to freely communicate with the dog, other pedestrians and/or situations throughout the interview.

Both interviewer and videographer independently documented their reflections of the interview process on a secure computer, the same day following each interview. The reflections were guided by a set of pre-determined questions which are listed in Box 1.

Box 1. Researcher reflective questions

- How did I feel audio-recording and/or video recording this person walking their dog?
- Did I influence the usual course of the walk?
- How did audio-recording and/or video recording influence the usual course of the walk?
- How rich were the data gained from this method?
- Were the difficulties worth the enriched data?
- How could I modify this method to make the process run more smoothly?

ANALYSIS

A general inductive thematic approach guided data analysis of both interview design transcriptions and the researchers' reflections (Thomas 2006; Braun and Clarke 2006). Analysis followed an iterative process, moving back and forth between data collection and analysis (Thomas 2006). The interviewer (author 1) began dual coding the transcripts in response to A) the test question and B) aspects of feasibility and acceptability, by constructing separate documents with quotes under headings of identified preliminary themes. After preliminary analysis of four interviews, three other researchers reviewed the transcripts. At this stage the analysis of test question themes ceased and the analytic focus shifted towards answering the primary research question about the feasibility and acceptability of Mobile Methods. Throughout the study all researchers discussed the interviews through group meetings and emails.

A description of each theme was established by collapsing codes found within researchers' reflections, along with explicit examples from the interview narrative. Links identifying differences and commonalities within and across reflections of design one and design two were established to construct themes.

RESULTS

Thirteen people volunteered for the study: one did not meet inclusion criteria (self-reporting an on-going health condition) and another withdrew due to time restraints. The 11 participants (nine women, two men) ranged in age between 25 and 64 years. Three participants had two dogs, and eight had one dog. Time between first and second interviews ranged from four to 56 days (median ten days).

Four themes relating to the feasibility and acceptability of Mobile Methods were identified: Theme one: '*Walk-along interviews are dynamic in nature'* explained how the moving nature of data collection and human-animal interaction added context and explanation. Theme two: *'Walk-along interviews provide enriched data'* demonstrated how the act of walking combined with open-ended questions, triggered thoughts, perceptions, interpretations and memories for participants. Theme three: *'Sharing insights'*, highlighted advantages of participant-researcher analysis of the walk-along interview through the use of transcripts and video clips and, appeared to facilitate more equitable power dynamics between interviewer and interviewee. Theme four: *'Logistical challenges of walk-along interviews'* facilitated practical recommendations for other researchers considering these methods. These four themes will be explained in greater detail in the following sections.

Researchers' written reflections (interviewer 'I' and videographer '*V*') and field notes are documented in italics. Non-italicised 'I' and 'P' numbers' (for example P7) identify the interviewer's voice and participants' voices respectively. All dogs have been given a pseudonym to enhance confidentiality. Extracts of the narrative are contained within quotation marks and regular print.

Theme One: Walk-along interviews are dynamic in nature

Two subthemes were identified which highlighted the contribution of the dynamic nature of the walk- along interview experience. Firstly, in 'My dog, My Patch', the researcher was introduced to the participant, their dog, and their environment. Secondly, 'Dog on the move' entailed the added dimension of watching dogs and their behaviour and interactions with owners.

My Dog. My Patch

Participants were eager to show the researcher their dog-walking route and introduce the interviewer to their canine companion. Participant 1 enthusiastically described her dog, Goofy:

> P1: "You know he is 10 months old his birthday is going to be in April."
>
> I: "Oh right, what type of dog is he?"
>
> P1: "He is a German Short-haired Pointer, we went to the breeder. I have had one before and I just thought she was such a lovely nature, you know?"

The participant guided the researcher through a regular walk, which involved activities such as stopping to talk to other walkers; attending to their dog's needs, or, disciplining them. For example, Participant 4 engages with Swamp-Monster and Wriggle-Butt:

> P4: "Come on. [*Laughs]*. So … ah… Swamp-Monster, come on! Sit! Wriggle-Butt, come on, sit! Good boy [*biker goes past*] [*barking*] come on! It's just good manners for them to sit when they see a bike… Swamp-Monster! Heel! [*Dog panting*] Swamp-Monster, come on! [*Heavy breathing – dog and owner]* Heel… heel… [*Dog barking*] … go for it! Phft! [*Laughs*].

The ever-changing environment along each route led to few breaks in conversation and, follow-up questions, the dog, fellow dog walkers/pedestrians or the surrounding area initiated conversation throughout the walk.

Dog on the move

The addition of a dog further enhanced the dynamic nature of the interview process. At times the dog(s) appeared more in control of their owner than their owner was of them. One such incident occurred before commencing the walk, as reflected by the interviewer: *"When I first came to the participant's house the dog's excitement got the best of him. He jumped up on me numerous times and as a researcher in her house I did not feel as if I was to be the one to tell him off. The participant did make an effort to control him but it was not very successful/ persistent."* (I).

In most cases the dog(s) was permitted to be off the lead, and allowed to roam. Some dog(s) misbehaved in the middle of asking or answering a question, resulting in lost train of thought. However, the impact of the dog(s) on the interview process was expected and encouraged, in keeping with the spirit of walk-along interviews.

Walk-along interviews captured emotional interactions such as affection, anxiety, enjoyment, and laughter between the participant and their dog, and these emotions were not so apparent during sit-down interviews. For example, Participant 5 demonstrated panic and then relief when she realised her dog, Weasel, was out of sight during the walk through a bush-filled park:

> P5: "Oh isn't it gorgeous? [*P5 realises Weasel is out of sight*] "Weasel! Weasel! Weasel, come!" (*Authoritative*) [*We stop*] Ah I have to go up… [*She backtracks our steps up a small hill*] "Where are you Weasel? Weasel? (*Affectionate*) Weasel!" (*Clap hands*) "Weasel, come! (*Authoritative*) Come! Come here! Hey!" (*Clap hands*) "Weasel… come… here! Weasel! Come Weasel this way!" (*Affectionate when Weasel obeyed*)

The presence of the videographer at times influenced the dog's usual behaviour and in one case resulted in the dog disobeying commands to 'sit'. As Participant 7 reflected:

> P7: "I think that it was pretty good actually, that didn't really impact it a lot apart from Tyler chasing the videographer all the time sort of thing, so that it was probably the third person that made her more anxious yeah… following behind her is perhaps what did spook her a little bit because she wasn't sure who was behind us."

Theme Two: Walk-along interviews provide enriched data
This theme describes how walk-along interviews elicited participants' memories during their regular walk. The environment appeared to trigger more participant memories than a seated interview. These memories facilitated rich descriptions and encouraged further lines of enquiry. For example, whilst watching her dog Elvis, Participant 9 revealed:

> P9: "When we lived in France I was unemployed for a while, and some days would only leave the house because the dog had to be walked. Looking back, I'd say I was a bit depressed, and if it were not for Elvis I would have never left the house, would not have gotten any exercise, and my well-being would have been much worse."

During walk-along interviews, participants described how they connected positively with the environment. For example, Participant 6 explains:

> P6: "I really like as soon as it starts getting into the fields and seeing what's happening up there and kind of monitor the seasons as well. You know you can sort of tell or you know which trees come out early. There's a, a red tree down there *(she points back towards a tree)* that's always the first one to go in autumn, the first one to get buds on in spring and yeah I kind of liked that… So you get to know things in greater detail. And I really like that. Just gives you a bit of sense of place."

Theme Three: Sharing Insights
This theme comprises two subthemes. Sharing ideas in the participatory process led to new insights for both researcher and participant, under the subtheme 'Dual Analysis'. The subtheme 'Equality of Power' helps to explain how power seemed more equitable between the researcher and the participant in the participatory analysis.

Dual Analysis
The participatory interview required the participant to be actively involved in the analytical process. This proved beneficial to the researcher: *"I found it helpful that Participant 1 was able to go through the transcript beforehand, and really give some feedback on it, it stimulated memory recall of events that happened and allowing the participant the opportunity to explain her reasoning."* (I).

Some participants responded best to the video clips, whilst others made greater use of their transcript. This was illustrated by the researcher's reflection after Participant 3's second interview: *"I obtained a lot of additional information, through the use of video clips as well as verbal reflections of the walk-along. The video clips did evoke more responses and triggered more memories from the participant." (I).* The participant described new insights while partaking in the analysis process of *Design One* (Mobile Methods).

P3: "It's quite interesting watching them cos I'm seeing them from a different perspective than I would normally see, which from a dog-owner's point of view, is an advantage of doing this."

Equality of power
The Mobile Methods design appeared to facilitate equity of power between interviewer and interviewee because the setting of the walk-along interview was more informal than that of the sit-down interview. The participant and interviewer met at an agreed location and the participant directed the dog-walk. In the following sit-down participatory interview the intention of interaction was not that of asking set questions, but to fully engage, share and compare ideas and reflections. For example, after Participant 10 was given a transcript to review prior to the participatory interview he sent through an email summary of what he thought were the most important points discussed from our walk-along interview.

P10: "I have tried to edit my responses to your questions so they make more sense. If I could sum up what owning a dog means to me in one sentence it would be: 'nothing makes me more happier than making Maxine happy'."

This participant felt comfortable enough to analyse the test research question data and highlight concepts that he felt as most important. This was not observed during any of the initial sit-down interviews in *Design Two*. Consequently the participatory interview appeared to address equality of power through joint analysis in a mutual non-threatening environment, which resulted in benefits pertinent to both participant and researcher.

Theme Four: Logistical Challenges
This theme outlines challenges experienced during walk-along interviews, including difficulties capturing and processing data and safety issues including weather and location.

Muffled narrative, loud background sounds such as streams or traffic, and the audio recorder being caught on external objects or falling out of pockets during running resulted in data that were difficult to transcribe. In addition, two recordings were lost due to connection problems between the lapel microphone and the audio-recorder. Whilst frustrating "*Observations and note taking by the researcher was still helpful and provided an opportunity to learn from this incident to hopefully minimize the chance of the recording failing in the future."* (I).

Without video, author 1 had to begin transcription immediately in order to accurately recall and insert contextual information (eg dog(s) behaviour, sights, sounds, smells). In order to describe observations and interactions without the aid of a video camera, the interviewer recorded field notes, and incorporated these into the transcript after conducting the interview. In interviews where the videographer was present, videography facilitated recall of interviewer's observations. An advantage of *Design One* (with follow-up participatory analysis session) was the opportunity to repeat questions; whereas in *Design Two* lost narrative generally resulted in lost data.

Video recording dog-walks was challenging for both videographer and interviewer. Inexperienced videography, in combination with unsuitable equipment, resulted in flat batteries, excessive download time, darkness, and shaky video recordings.

Being videoed caused the interviewer to feel self-conscious and distracted. This lead to *"trouble concentrating on the interview questions, and listening to the participant's responses, as well as trying to observe interactions between the participant and the environment" (I)*. This response subsided with additional interviews.

One participant politely and repeatedly tried to include the videographer in the interview process. *"I kind of felt that the participant did not want to leave me out during the interview, especially on the way back, I felt that she wanted to include me and she was making space for me on the sidewalk when we were walking."* (V).

Dark streets, frosty sidewalks, narrow footpaths close to traffic, and unfamiliar routes resulted in feelings of compromised safety for the researchers. Adverse weather resulted in postponement of dog-walking interviews. Locating the starting point of a walk was occasionally challenging in rural or remote areas.

DISCUSSION

This study examined the feasibility and acceptability of Mobile Methods, specifically video-recorded and audio-recorded walk-along interviews and participatory analysis sessions as a way of capturing the experiences of dog walking and health. Findings suggest that walk-along interviews are a viable and dynamic method of data collection for dog walking activity, generating rich, in-depth data. However, several logistical challenges to collecting data on-the-move were identified. Power relations between the researcher and the participant were found to be more equitable during both data collection and the analytic process.

Garcia et al (2012) suggested the use of Mobile Methods to investigate protective factors and resources associated with health promotion. Our study embodied these two concepts; i.e. dog walking walk-along interviews can be used to investigate aspects of health and well-being via inquisition and exploration of participants' perceptions of, or engagement with, their dog-walking environment.

Previous studies have highlighted the dynamic, multi-sensory nature of walk-along interviews (Garcia et al 2012; Sheller and Urry 2006; Law and Urry 2004). Furthermore, they have suggested that the distractions and natural interruptions caused by environmental stimuli result in a more comfortable and "free flowing" conversation (Ross et al 2009; Lee and Ingold 2006). Our study suggests that the presence of a dog during a walk-along interview promotes this "productivity of distraction" (Ross et al 2009, p. 620) through unpredictability, liveliness, and owner-pet interaction.

In our study, observation of human-animal-environment interaction and the elicitation of memories resulted in enriched data. Authors who have used walk-along interviews to investigate people's perceptions of their immediate environment (familiar or unfamiliar) or community (Brown and Durrheim 2009; Garcia et al 2012; Kusenbach 2006; Kusenbach 2003), suggest that familiar surroundings are more useful for memory elicitation and this might be a useful strategy for future researchers to consider.

Observation of interactions between owner and dog uncovered possible areas where dog-walking might influence health negatively. For example, Participant 5 displayed anxiety when their dog Weasel disappeared into the bushes and, through memory, related this event to another where Weasel had become sick following that disappearance. Barring dog-bites and accidental trips, little is known about the negative influences of dog-walking and ownership on human health (Orritt 2014).

In our study, participatory analysis sessions proved a useful way of encouraging participants to contribute in an equitable way towards answering the research question. The advantages of this participatory analysis component have been discussed in previous studies (Brown and Durrheim 2009; Ross et al 2009; Miaux et al 2010) and enable participants to validate insights and experience(s) that they found most relevant throughout the walk-along interview (Miaux et al 2010). Additionally, it has been observed that the location of the interview has a noteworthy effect on the power relationship between interviewer and interviewee (Elwood and Martin 2000). It is recommended that participant and researcher mutually agree on a suitable location (Elwood and Martin 2000; Carpiano 2009) and in our study this was often the work office or home of the participant.

Logistical challenges were similar to those already documented in the literature (Carpiano 2009; Garcia et al 2012; Kusenbach 2003; Evan and Jones 2011; Hein et al 2008; Miaux et al 2010). These included difficulties with regards to audio and video-recording, transcription, safety, environmental conditions, and location of the interview. A checklist is recommended for researchers conducting walk-along interviews (see Table 1), which provides more specific information for dog-walking research following that outlined by Garcia et al (2012). In addition to the points on this checklist, we make the further recommendations in the following section.

Video-recorded walk-along interviews should ideally be conducted in daylight hours to avoid lost footage due to reduced visibility. The use of a participant head-mounted camera is recommended (Mackenzie and Kerr 2012) to minimise difficulties with video-recording and furthermore, placing a camera on the interviewer could capture further descriptive data such as body language and facial expressions. Lastly, it is advisable to establish the approximate duration of the walk, as well as the general route prior to the walk (Miaux et al 2010). This will aid time management; optimise safety; and guide the questioning process throughout the walk. Also, if a dog owner has several walking route options, opt for quieter routes to minimise excessive sound (eg traffic noise) on recordings.

In our study, participant diversity was not purposively sampled with regards to gender, age, ethnicity or cultural background and this may limit the relevance of results (particularly to men) with regards to both feasibility and acceptability of this approach. Future studies might benefit from a sampling strategy that aimed to capture demographic diversity.

The study was conducted in an urban area potentially limiting the transferability of results to more rural settings. In rural areas dog(s) may be allowed to freely roam, thus reducing the owner's need to walk the dog(s) for the animal's benefit (Brown and Rhodes 2006).

CONCLUSION

Mobile Methods are an acceptable and feasible way to investigate the perceived effects of dog ownership and dog walking on health and well-being among healthy adults. This approach generated enriched data through observation of

Table 1: Checklist for Dog-walking Interviews
(Expanded and adapted from Garcia et al 2012)

Prior to the interview:
☐ Ensure up-to-date tetanus injection > 2 weeks prior
☐ Carry small, portable first aid kit
☐ Avoid contact with other animals shortly prior
☐ Sufficient supply of batteries/fully charged devices (have spare microphone and recorder at hand)
☐ Ensure each device is working – turn on/off
☐ Dog treat or other form of remuneration for the dog/ owner
☐ Bring spare satchel bag in case participant has no pockets for audio-recorder
☐ Be familiar with planned semi-structured questions
☐ Be familiar with route and duration of dog-walk
☐ Gain written and verbal consent
☐ Review ethics of confidentiality with participant
At the commencement of the interview:
☐ Attach lapel microphone securely to participant, avoiding friction-prone areas
☐ Check that the recording device(s) is recording
☐ Place recording device on 'hold' to secure recording status
☐ Review procedure of walk-along interview with participant allowing usual human-animal interactions, human-human interactions
During the interview
☐ Avoid interfering with participant's usual routine (participant-led interview)
☐ Subtly monitor status of recording device eg connection between microphone and recorder
After the interview:
☐ Document environmental factors (weather conditions), senses (sights, smells, touch, sounds), non-verbal communication
☐ Upload and check interview recordings onto secure system
☐ Document any technological difficulties
☐ If narrative is lost, immediately construct memos and reflections to outline discussion
☐ Delete data from devices as soon as possible after download

human interactions with both their dog, their community and their environment and, through elicitation of memories.

We recommend pragmatic strategies, which minimise the logistical challenges of this approach. Purposeful sampling strategies in future studies with regards to gender, ethnicity, and age might further enrich data relating to dog-walking and health.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest with regards to this study.

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Sexual wellbeing for people with chronic obstructive pulmonary disease: relevance and roles for physiotherapy

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ABSTRACT

Chronic obstructive pulmonary disease (COPD) is the fifth leading cause of disability worldwide. The purpose of this article is to provide an overview of current knowledge on sexual wellbeing in people with COPD, with particular attention to the possible role of physiotherapy in helping address problems with sexuality resulting from the condition. People with COPD experience more sexual problems on average than the general population, with these issues arising from hormonal, physiological, psychological, sociological and pharmaceutical factors. Physiotherapists can provide specialist support for people with COPD regarding their sex lives through the provision of exercise therapy, advice on positioning to maximise breathing efficacy and minimise energy expenditure during sexual activity and via patient education on chronic condition management. The PLISSIT model provides a robust framework for helping physiotherapists clarify their scope of practice when engaging with people who have COPD on matters to do with sexuality. Regardless of age or severity of symptoms, people with COPD are capable of leading full and satisfying sex lives should they wish to do so. Physiotherapists can contribute information and solutions to support them in this endeavour.

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Key words: Pulmonary disease, Chronic obstructive; Sexuality; Sexual dysfunction; Dyspnoea; Exercise

INTRODUCTION

Sex is an important part of life, self-identity and general wellbeing for the majority of people. It is well established that many adults maintain sexually active lives well into their older years (Lindau et al 2007, Matthias et al 1997, Nicolosi et al 2004). While sexual activity and sexual interest do tend to decline with age, even very elderly people can enjoy sex and include it as part of their intimate relationships. One relatively recent US study found that 38.5% of men and 16.7% of women in the 75-85 year old age group had participated in sexual activity with a partner in the previous year, with 54% of those who were sexually active engaging in sexual activity more than two or three times a month (Lindau et al 2007).

At all ages, however, sexual activity and sexual satisfaction is negatively influenced by poorer health status (Lindau et al 2007, Matthias et al 1997). This has been the subject of a body of research, guidelines and systematic reviews for a number of conditions including cardiovascular disease (eg Steinke et al 2013), diabetes (eg Pontiroli et al 2013, Vardi and Nini 2007), and cancer (eg Miles et al 2007). Arguably less research or clinical guidelines have been published on the topic of sexual health for people with chronic obstructive pulmonary disease (COPD). In preparing this paper, only one randomised controlled trial (Svartberg et al 2004) and no systematic reviews were identified on the topic of management of sexual dysfunction for people with COPD. This is significant because, according the World Health Organizations' Global Burden of Disease study, COPD is currently the 5th ranked cause of years with disability worldwide (Vos et al 2013) – a more significant contributor to years with disability in fact than ischaemic heart disease (ranked 21st), diabetes (ranked 9th) or all cancers (ranked below 25th). Furthermore, there is growing evidence that COPD is frequently associated with sexual dysfunction for many people (Collins et al 2012, Fletcher and Martin 1982, Kahraman et al 2013, Kaptein et al 2008, Karadag et al 2007, Köseo˘glu et al 2005, Schönhofer et al 2001, Schouten et al 2007) but as noted above there appears to be very little experimental research into strategies to help people with COPD deal with issues related to their sexual wellbeing.

The purpose of this paper, therefore, is to provide an overview of current knowledge on sexual dysfunction and sexual health in people with COPD, with particular attention to the possible role of physiotherapy in helping people with COPD maintain or regain an active and enjoyable sex life should they choose to do so. It is argued within this paper that physiotherapy has the potential to make a unique contribution to this area of clinical practice because of expertise in chronic condition management, exercise conditioning and use of positioning to enhance the efficiency of breathing in people with COPD.

Definitions and assumptions

Sexual activity should be considered a broad term referring to a wide range of personal interactions and behaviours including, but not limited to, sexual intercourse. For the purposes of this paper, a modified version of a definition promoted by Lindau et al (2007) will be used: specifically, the term 'sexual activity' (to be considered synonymous with 'sex') will be used to refer to 'any mutually voluntary activity with another person that involves sexual contact, whether or not intercourse or orgasm occurs or any solitary sexual self-stimulation for pleasure'. Neutral terminology has been used throughout this paper regarding sexual orientation, except in situations describing research studies that specified the gender of people in relationships under investigation. Specific issues relating to transgender people, however, are outside the scope of this paper due to restrictions on article length.

Prevalence of sexual dysfunction in people with COPD:

The majority of empirical research on sex and COPD to date has focused on the prevalence of sexual dysfunction in COPD populations. Sexual dysfunction can include problems with erectile dysfunction or premature ejaculation in men; difficulties with vaginal lubrication for women; or lack of interest in sex, inability to achieve orgasm, pain during sex, anxiety about performance or sex not being pleasurable for either men or women.

In men with COPD, erectile dysfunction (i.e. difficulty getting or maintaining an erection) has been identified as one of the most common problems with sexual performance. Estimates of prevalence of erectile dysfunction in men with moderate to very severe COPD have ranged from 72% to 87% (Collins et al 2012, Kahraman et al 2013, Karadag et al 2007, Köseoğlu et al 2005). This can be compared to a prevalence of 9-22% for erectile dysfunction that has been reported in the 50-70 year old age group in a large, international, population-based study of sexual dysfunction (Laumann et al 2004, Nicolosi et al 2004). Some of these differences in reported prevalence could be explained by differences in the categorisation and measurement of erectile dysfunction. However, studies which have compared men with COPD against age-matched controls (using the same measurement tool for both) have also found significant differences in prevalence between these groups. Kahraman et al (2013) found varying degrees of erectile dysfunction in 79% of 70 men with COPD in comparison to 56% of 68 age-matched controls, with men who had COPD generally reporting more severe problems. Similarly, comparing 95 men with stable moderate-to-severe COPD to 30 age-matched controls, Karadag et al (2007) found 21% of those with COPD to have 'severe' erectile dysfunction and 36% to have 'moderate' erectile dysfunction versus 10% of the controls for both 'severe' and 'moderate' erectile dysfunction. Furthermore, in a population-based study of erectile dysfunction in the Netherlands involving 975 men aged 50-75, COPD was found to be one of five independent determinants for risk of erectile dysfunction (Schouten et al 2007).

In comparison to age matched norms, significantly more men with COPD have also been found to report reduced sexual desire and lower frequency of sexual intimacy; with their sexuality more often negatively influenced by low self-esteem and with an overall lower sense of satisfaction with their sex lives (Kaptein et al 2008). Collins et al (2012), in a study of 90 men with stable moderate-to-severe COPD, found 74% had at least one sexual problem. In additional to erectile dysfunction, many of these men also reported lack of sexual interest (37%), inability to achieve orgasm (42%), and difficulty with finding sex pleasurable (28%). Furthermore, these issues were most often described as 'very much of a problem' or 'somewhat of a problem' for these men (Collins et al, 2012).

In comparison, sexual dysfunction in women with COPD has yet to be investigated in depth. One exception has been a study of sexual dysfunction in people with COPD or asthma, in which ten women with COPD provided information on their experiences and feelings regarding sexuality and intimate relationships (Kaptein et al 2008). This study found that, when compared to age-matched controls, women with COPD reported a significantly lower frequency of sexual intimacy, but no significant differences were reported for other aspect of sexuality, eg physical problems reducing sexual desire, problems with self-esteem influencing sexual activity or problems with general sexual satisfaction (Kaptein et al 2008). However, given the very small sample size, it is highly questionable whether this study was sufficiently powered to detect such differences if they existed.

One additional study has investigated sex behaviour and sexual functioning in 383 men and women who used noninvasive mechanical ventilation in the home. This study combined findings from people with COPD (45% of the total study population; 173/383) with those who had chronic respiratory failure due to other causes (Schönhofer et al 2001). Thirty-four percent of these respondents reported being sexually active and 61% were not (5% did not answer this question). Sexually active people were more likely have better lung function (higher vital capacity, better force vital capacity, and higher partial pressure of oxygen in arterial blood at rest), were more likely to be married or have a partner and were more often younger. However, no statistically significant differences were noted between men and women in this study; both groups were equally likely to be sexually active at all ages.

Notably, in this study, while older people were less likely to be sexually active, 20% of those over 70 years on noninvasive mechanical ventilation still reported continuing to have an active sex life (Schönhofer et al 2001). Furthermore, while 36% of respondents reported a decrease in their sexual activity after initiating home-based mechanical ventilation, 12.6% of respondents reported their sexual activity had increased as a result of the introduction of ventilatory support. In other words, it is a mistake to assume age or severity of respiratory impairment necessarily limits people's capacity or enthusiasm for sexual activity.

Returning to the subject of gender differences, it has been suggested that COPD presents less of a problem for female sexuality than male sexuality. One view is that male sexual activity is generally more dependent on health status than female sexual activity, and that for women, 'the existence of a sexually interested partner and a pleasurable sexual biography are even more important' (Schönhofer et al 2001, p.1612). Another view has been that male sexuality is more vulnerable to dyspnoea and loss of self-esteem resulting from impaired physical performance (Pietropinto and Arora 1989). However, it is important to note that all of these viewpoints and perspectives have arisen from expert opinion and anecdote; detailed studies on the effect of COPD on women's sexuality have yet to be conducted.

Causes of sexual dysfunction in people with COPD:

The interaction of variables contributing to sexual dysfunction in people with COPD is complex, but broadly speaking problems can arise from a combination of hormonal, physiological, psychological, sociological and pharmaceutical factors.

Hormonal factors

With respect to hormonal issues, it has been established that men with COPD have lower total testosterone levels than men without COPD. A recent systematic review involving a meta-analysis of data from nine case control studies found that men with COPD have on average 3.21 nmol/L (95% CI 1.23 to 5.18 nmol/L) less total testosterone than age-matched men without COPD (Atlantis et al 2013). Testosterone contributes to muscle mass and the body's response to exercise, but is also directly

associated with sexual functioning in men. In Collin et al's (2012) observational study, adults with COPD who had low free serum testosterone levels were over three times more likely to have erectile dysfunction than adults with COPD who did not have low testosterone levels.

Physiological factors

COPD is also of course associated with reduced exercise capacity secondary to hypoxaemia, dyspnoea and general physical deconditioning. This too can be a reason for problems with sexual functioning (Karadag et al 2007, Schönhofer et al 2001, Steinke 2013). If a person is becomes too breathless or fatigued during sexual activity, or finds his or her limited exercise capacity worrying, embarrassing or disempowering, then difficulties both with sexual arousal and sexual performance can result. Sexual intercourse is often compared to an exercise workload of 3-4 metabolic equivalents (METS) (Collins et al 2012, Steinke et al 2013). One MET is defined as the amount of oxygen consumed while sitting at rest: specifically 3.5 ml of oxygen per kg of body weight per minute of activity (Jette et al 1990), with 3-4 METS being equivalent to walking on a treadmill at 5-7 kph (i.e. a brisk walk). For this reason, in people with heart disease (where concerns can exist regarding the likelihood of sexual activity causing a myocardial infarct) individuals are usually advised that if they can achieve an energy expenditure of ≥ 3-5 METS on formal exercise testing without exhibiting symptoms of ischaemia, then it should be very safe for them to resume their normal sexual activity (Steinke et al 2013).

One of the original studies that is often cited to justify this figure of 3-4 MET is an observational study involving ten healthy, married couples, aged 25-43, in which heart rate and oxygen consumption were measured during sexual intercourse (Bohlen et al 1984). In fact, in this study, physiological responses were recorded only for the male partner, and the figure of 3-4 METs was only achieved during the penetration and orgasm stages of sex if using the 'man-on-top' position for intercourse. Other types of sexual activities, however, were associated with lower maximum energy expenditure: an average of 1.4 METs (95% CI 1.2 to 1.6 METs) during foreplay; 1.7 METs (95% CI 1.3 to 2.1 METs) during orgasm when the woman was stimulating the man without intercourse; 1.8 METs (95% CI 1.5 to 2.1 METs) during orgasm when the man was stimulating himself without intercourse, and 2.5 METs (95% CI 1.8 to 3.1 METs) when having intercourse in the 'woman-on-top' position (Bohlen et al 1984)[1]. The figure of 3-4 METs therefore is conservatively high, appropriate to use perhaps when advising people about risk of myocardial infarct, during sex, but potentially misrepresentative of the level of exercise capacity that is necessarily required for an enjoyable sexual encounter. For this reason, de Araújo (2009) has suggested that instead of using the analogue of a 'brisk walk', sexual activity could be more usefully compared to 'a relaxed walk for a few blocks, interspaced by ascending one or two flights of stairs at moderate and, most importantly, at a very much individual pace' (p.1034).

Along with exercise deconditioning, people with COPD are also more vulnerable to changes in oxygenation as a result of changes in body position. In COPD, the position of the body (eg supine lying, prone lying, sitting or standing) can influence the position and mechanical efficiency of the diaphragm, the availability and mechanical efficacy of accessory muscles for breathing, the synchronicity of thoracic and diaphragmatic movements, the energy (and therefore oxygen) required to maintain the position, and, particularly significantly, ventilation/perfusion matching (Cavalcanti et al 2014, Dean 1985, Heijdra et al 1994, Jones et al 2003). Ventilation/perfusion matching refers to the efficiency and adequacy of air in the alveoli (ventilation) reaching lung tissue that is sufficiently serviced by blood from the pulmonary artery (perfusion). Of note, the physiological response of individual people with COPD to changes in body position can be very idiosyncratic; influenced by factors such as degree of hyperinflation, asymmetry in lung tissue damage, the presence of sputum in the airways, distribution of body mass and state of arousal or relaxation.

As an illustration of this point, the only observational study to date on the effect of sexual activity on gas exchange in the context of COPD (albeit based on a single case study) reported the unexpected finding that, rather than dropping, oxygen saturation rose during sex, peaking during the 10 minute period after intercourse (Polverino et al 2008). The 'case' in this study was a 63 year old man with severe but stable COPD, engaging in sex in 'comfortable' positions. The authors of the study speculated that oxygen saturation may have risen during sex for this man because the positions used (in this case, standing or in the 'woman-on-top' position) resulted in improved ventilation/perfusion matching in comparison to breathing at rest, without significant additional energy expenditure for muscle activity. However, as noted above, cardiorespiratory responses to body position can differ for individual people with COPD, which means that sex positions that work for one couple may not be suitable for another. Individual assessment of physiological response to different body positions may be warranted.

Psychological and sociological factors

In addition to physiological consequences of lung disease, COPD is also associated with psychological and sociological responses which can negatively influence sexual interest, arousal and behaviour. Collins et al (2012), for instance, suggested that physical limitations arising from COPD may make men take a much more passive approach to sexuality or to avoid sexual activity altogether. They also reported that, despite continuing to desire an active sex life, the most commonly perceived reasons for decreased sexual activity among the 90 men with COPD in their study was the participants' belief that they were 'too old' or 'too sick'. For both men and women, symptoms of COPD such as breathlessness, coughing and sputum can contribute to feeling unattractive and to loss of self-esteem, which can affect both attitudes towards sex and physical responses during it (Steinke 2013). Fear and anxiety about dyspnoea can result in stress associated with sexual activity, reducing enjoyment and willingness to participate in it (Steinke 2013). Mood disorders such as depression, which are known to be significantly more of a problem for people with COPD than the general population (Di Marco et al 2006, Schneider et al 2010), can also negative impact on sexual desire and performance.

Furthermore, changes in a person's physical body and sexual performance often require couples to develop a renewed understanding of their sexual roles and relationship. This requires open, honest and caring communication. If either

[1] Average METs and 95% CI were calculated from the means and standard deviations for oxygen consumption (VO_2) for sexual activity reported in Bohlen et al (1984), using the conversion value of 1 MET to 3.5mL/min/kg VO_2.

or both partners within a couple are unable or unwilling to discuss such matters, sexual wellbeing can suffer. In one unique study of COPD and intimate relationships, Ibáñez et al (2001) interviewed 49 men with severe COPD and their partners (all female) separately but concurrently. Sixty-seven percent of the men reported some type of sexual dysfunction, mostly involving less-than-preferred sexual desire or erectile dysfunction; while 94% of their female partners reported noticing changes in the men's sexual behaviour. Thirty-three percent of the women also reported that they had noticed negative changes in their partners' communication levels since the onset of COPD and/or home oxygen use, with the women who reported such communication problems being significantly more likely to be dissatisfied in their partners in general than those who did not. Of note, fear of causing an exacerbation in their husband's condition appeared to have resulted in over a third of the women reducing their willingness to engage in sexual activity in this study population.

Pharmaceutical factors

Outside the scope of physiotherapy, but still important to know about, is the influence of pharmaceuticals on sexual functioning. A number of drugs can contribute to sexual dysfunction in both men and women. Medications commonly known to reduce sexual desire or sexual performance include diuretics and beta-blockers for high blood pressure; anti-depressant, anti-anxiety, and anti-psychotic medication for mental health conditions; anti-epileptic drugs; steroidal medications such as prednisone; and some medications for Parkinson's disease and cancer treatments (Collins et al 2012, Conaglen and Conaglen 2013, Schouten et al 2007). As COPD is frequently associated with co-morbidities, the possibility that people with COPD may be on medications such as these needs to be taken into consideration.

Incorporating sexual wellbeing in physiotherapy for COPD

Even when physiotherapists agree that sexual function is an important area of health and wellbeing, making decisions about how to include it (if at all) as a subject for clinical intervention or patient education can be difficult. Like all health professionals, physiotherapists can feel poorly equipped to address sexuality in clinical practice, can have concerns about making their clients uncomfortable or feel uncertain about the ethical implications associated with broaching the topic of sex in the clinic or hospital.

One useful framework for guiding health professionals when integrating interventions for sexual wellbeing into regular practice is the PLISSIT model. Originally proposed as a guide for sex therapists in the 1970's (Annon 1976), the PLISSIT model has subsequently been applied in a range of different health contexts (Jaarsma et al 2010, Marsden and Botell 2010, McBride and Rines 1999, McLeod and Hamilton 2012). It has been promoted as a model appropriate for interprofessional teams (Dunn 1997), and already been used in at least one New Zealand rehabilitation service for this purpose (Simpson et al 2006).

PLISSIT is a mnemonic which stands for permission (P), limited information (LI), specific suggestions (SS), and intensive therapy (IT). These four terms relate to four levels of engagement that a health professional can take with any client when considering the topic of sexual functioning and wellbeing. They also correspond to increasing levels of intimacy when discussing sexuality in the clinical setting and so can be used to align a health professional's level of training, scope of practice and degree of comfort in discussing sexual matters with the type and extent of involvement in interventions for addressing sexual health needs.

Within this model, 'permission' refers simply to letting patients and their partners be aware that it is perfectly acceptable and appropriate to raise questions or express concerns regarding issues to do with sexuality. This can be done overtly or covertly. Indirect methods for giving permission might include having information brochures on sexual health and COPD visible and accessible in waiting rooms or clinic areas. Direct methods might include validating sexuality as a legitimate topic for discussion if it should arise during clinical interaction, or by specifically inviting people to raise it for discussion. For example, if a patient were to make a half-joking reference to 'problems in the bedroom' when discussing respiratory symptoms, the physiotherapist could respond by saying: 'yes, sexual function is something that can be affected by COPD, and this might be something you would like to discuss further with me or your general practitioner (GP)'.

Giving a person permission to raise issues to do with sexual function does not mean that physiotherapists are then required to address those issues in full by themselves. If the subsequent issues raised are more specific than the physiotherapist is able to deal with, a suitable response would be to say: 'Yes, that is a valid concern. However, what you are discussing is outside of my particular training. Would you like me to raise this in a referral letter to your GP or respiratory consultant?' The potential benefit of simply normalising sexuality as a valid topic for discussion in the health context should not be underestimated.

'Limited information' is the next level of engagement with patients on matters to do with sexuality. It involves giving general information about sexuality and sexual function, tailoring this information to specific health conditions where appropriate. This includes, for instance, providing education on sexuality to groups of people as part of a pulmonary rehabilitation programme or providing general information to individuals in a clinical session, drawing on standard information brochures or letting people know about other clinical or information services relevant to sexuality that are available to them.

Providing limited information stops short of discussing individual people's actual sex life and instead couches sex interventions within the context of general information that has been helpful for many people in similar kinds of situations. Within the context of an interprofessional team it is usually ideal that all team members are sufficiently comfortable with the topic of sexual health, and with their own sexuality, to work with any patients at the 'permission' and 'limited information' level of the PLISSIT model (Sipski and Alexander 1997).

At the 'specific suggestion' stage of the PLISSIT model, assessment of issues and provision of interventions occurs at the individual patient level. In terms of physiotherapy, this might including making recommendations regarding positioning to minimise dyspnoea and maximise body movements with minimum energy expenditure during sex. It might also involve advice regarding management of home oxygen and ventilators to support sexual activity. Generally speaking, this level of engagement with patients and their partners is likely to require some degree of postgraduate training and should be accompanied by close professional supervision.

The 'intensive therapy' level of the PLISSIT model refers to the type of professional input that is usually only provided by trained relationship counsellors, sex therapists, or physicians. It might include 'psychotherapy; intensive or prolonged marital relationship counselling; counselling and therapy for battering, sexual abuse, or rape; surgical or invasive procedures… or medical management of infertility; childbirth; hormonal imbalances; or severe behavioural or psychiatric problems' (Dunn 1997, p. 398). As such, this level of engagement with patients and their partners is useful to know about, but is generally outside the scope of practice of physiotherapists, except for a few specific topics within specialist areas (eg perhaps within women's health physiotherapy).

Interventions for sexual dysfunction for people with COPD: For the purpose of this paper, interventions for sexual dysfunction can be divided into those that can be provided by physiotherapists and those which need input from other specialist health professionals. In terms of physiotherapy, interventions for improving sexual satisfaction for people with COPD might include:

Advice on cardiorespiratory training to improve general exercise capacity (with exercise also potentially resulting in improved mood and self-esteem);

Training of people with COPD in sputum clearance techniques (eg postural drainage and active cycle of breathing), with advice to use these techniques prior to engaging in sexual activity so as to minimise coughing and maximise lung capacity during sex;

Advice regarding use of bronchodilators, where these have been prescribed, prior to engaging in sexual activity;

Advice regarding fatigue management, including preparing for sexual activity through use of relaxation techniques and by picking times when feeling well rested;

Assessment and training of people with COPD in the use of positioning to maximise ventilation/perfusion matching, maximise capacity for movement with minimum energy expenditure and minimum dyspnoea during sexual activity;

Encouraging people with COPD and their partners to talk to one another about their changing bodies, what they find easy or difficult to do, what they still find pleasurable and enjoyable and to explore new ways of physically interacting with one another for pleasure;

Reminding people the full range of sexual activities that are open to them, reinforcing the notion that sexual activity is not just limited to intercourse, but can involve other activities too, such as kissing, cuddling and touching (activities which are not only enjoyable in themselves, but which can also be a good way of building up tolerance for other activities in the future).

In terms of positioning for sexual intercourse, there are a number of factors likely to contribute to increased dyspnoea for people with COPD and so should be avoided, particularly if respiratory symptoms are severe. These include lying completely flat in supine, being in a position that requires high levels of energy expenditure to maintain (eg sustaining a prone lying position, propped up on arms, such as when lying on top of one's partner), having a weight (eg one's partner) on one's chest, or prolonged activities involving the mouth (eg prolonged kissing or giving oral sex). Figure 1 provides examples of some sexual positions that have been reported to be effective for people with COPD (Polverino et al 2008, Stitik and Benevento 1997).

People with COPD and their partners can be encouraged to make use of aids to reduce the physical demand of sexual activity. This includes making use of sex toys such as vibrators (which can be privately purchased online) as well as medical devices to reduce the work of breathing. If using supplementary oxygen or ventilators at home, people with COPD should be encourage to use these during sex too, adjusting ventilators settings to compensate for increased breath frequency and tidal volumes within comfortable limits (Schönhofer et al 2001).

Outside the scope of physiotherapy are medical interventions to compensate for sexual dysfunction. These include, for instance, the use of phosphodiesterase inhibitors (eg Sildenafil citrate; sold as Viagra), hormonal therapy in the case of hypogonadism (Svartberg et al 2004), or vacuum pumps and penile implants to treat erectile dysfunction (Hackett et al 2008). Psychosexual counselling, relationship counselling and cognitive behaviour therapy interventions may also be helpful for dealing with psychological and social issues related to sexual functioning (Steinke 2013), although access to these type of therapies may be restricted by cost. While not directly involved in the provision of these interventions, physiotherapists can play a role in raising the possibility of them to people with COPD.

CONCLUSIONS

A pleasurable and satisfying sex life is important to many people with COPD regardless of age or severity of impairments. Factors contributing to problems with sexual functioning are complex and interrelated, but in the presence of COPD sexuality can be affected by hormonal dysfunction, exercise deconditioning, exertional dyspnoea, the psychological and sociological consequences of having a chronic condition and by the side-effects of common medications. Physiotherapy has a role to play in the management of problems with sexual function in COPD, providing guidance in the restoration of exercise capacity, the use of positioning to maximise efficiency of breathing and movement and in the everyday management of respiratory disability.

KEY POINTS

- A pleasurable and satisfying sex life is important to many people with COPD regardless of age or severity of impairments.
- COPD can have a negative influence on sexuality due to hormonal, physiological, psychological and social consequences of the disease.
- Physiotherapy can play an important role in helping people with COPD and their partners deal with issues to do with sexuality.
- The PLISSIT model provides a framework to help physiotherapists decide what level of involvement they should have regarding interventions for improving a person's sexual wellbeing.

Figure 1: Sex positions for people with COPD and their partners

Figures 1a-1d provide examples of sex positions reported to be effective for people with COPD. While only one of the partners in these illustrations is presented as having COPD, these positions are suitable if either partner has COPD. People with COPD should be encouraged to make use of pillows during sex for comfort, to elevate parts of the body and to support limbs.

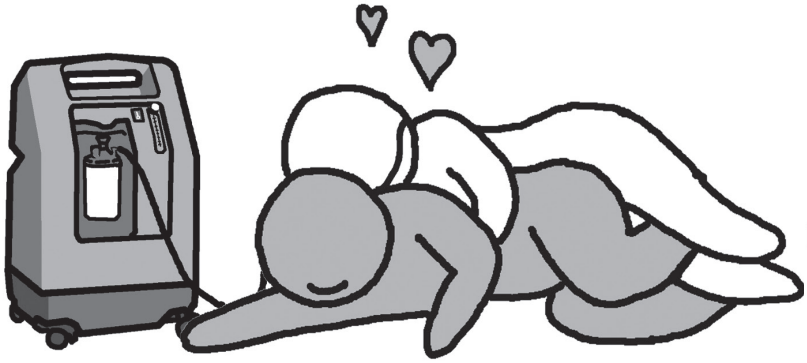

Figure 1a: Side lying

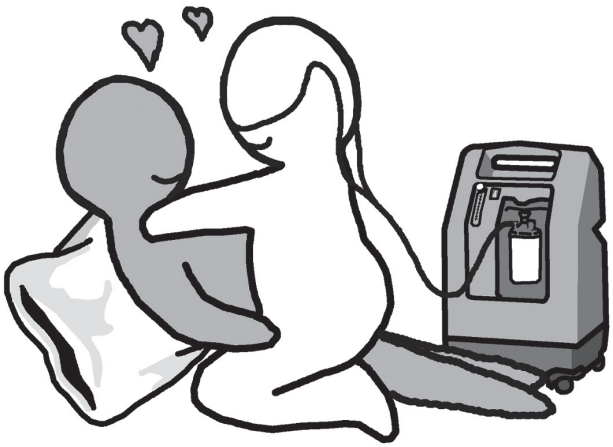

Figure 1b: Recline lying

Figure 1c: Standing

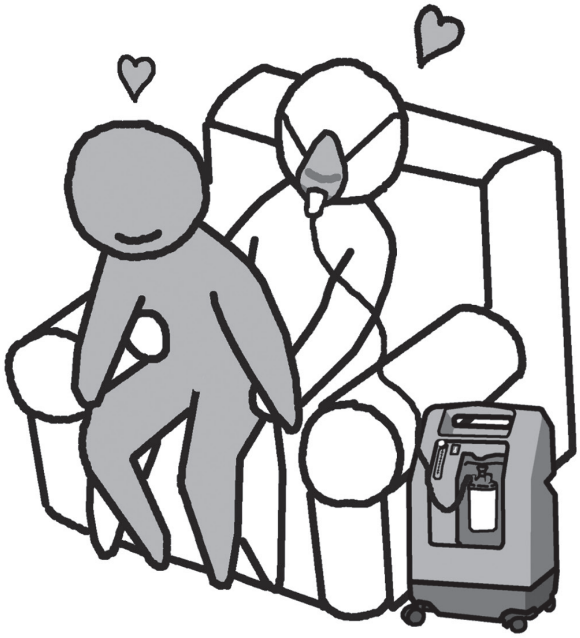

Figure 1d: Seated

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DOI: 10.15619/NZJP/42.3.08

Randomized trial of trigger point acupuncture treatment for chronic shoulder pain: a preliminary study

Itoh K, Saito S, Sahara, Naitoh Y, Imai K, Kitakoji H (2014) Randomized trial of trigger point acupuncture treatment for chronic shoulder pain: a preliminary study. Journal of Acupuncture and Meridian Studies 7:59-64. (Abstract prepared by Michelle Hall)

Aim

The aim of this randomised and sham controlled, clinical trial was to determine if trigger point acupuncture is an effective treatment for chronic shoulder pain.

Methods

Eighteen patients (15 men, 3 women; 42-64 years of age) with at least a 6 month history of shoulder pain of non-neurogenic, cervicogenic or systemic origin, were randomised into two groups (a trigger point group or a sham acupuncture group) and administered treatments on 5 occasions over 5 weeks. Outcome measures included the visual analogue scale (VAS) for pain intensity and the Constant-Murley score (CMS) for shoulder function, and were assessed at varying time points over the 20 weeks following the first treatment.

Results

Significant differences were found in favour of trigger point acupuncture, at the conclusion of 5 weeks of treatment, for both the VAS and CMS. Significant improvement in pain reduction continued in the trigger point group for a further 5 weeks following cessation of treatment; however, improvement in function was no longer significant at this stage. At the week 10 and 20 post-treatment assessments, there were no significant improvements in either shoulder pain or function.

Conclusion

Trigger point acupuncture appears to have short term benefits for chronic shoulder pain and dysfunction when compared to sham treatment.

Commentary

The use of acupuncture is becoming increasingly popular as an alternative therapy and is commonly used by physiotherapists to treat musculoskeletal pathologies such as myofascial pain; however, evidence regarding the effectiveness of such treatment is controversial (Tough et al 2009). Chronic shoulder pain is usually multifactorial and myofascial pain is often a feature. Myofascial trigger points are defined as hyperirritable points located in taut bands of skeletal muscle or fascia which when compressed cause local tenderness and/or referred pain (Simons 2002, Tough et al 2009, Yap 2007). One of the effects of needling a trigger point is to reduce the localised muscle contraction, which is thought to happen following a local twitch response; the "sparrow pecking" technique was used in this study to try and elicit this response and then the needles were left in for 10 minutes.

The choice of which acupuncture points to use is an important factor affecting the outcome of treatments and clinical trials (Tough et al 2009). In this study, the points in both the sham and acupuncture groups were individually chosen by an experienced acupuncturist, by palpating for the most comparable trigger points around the neck and upper arm. The mean number of points used was 4.1. The choice of different points for different patients did not compromise the validity of this research as the same method of choosing points was used for both groups. Interestingly, the most commonly chosen trigger points were within the four rotator cuff muscles, which are known to have an important role in controlling glenohumeral movement, and may be associated with glenohumeral impingement syndromes, and adhesive capsulitus (Simons 2002).

The sham acupuncture technique used in this study seems to have been successful. Blunt needles that did not penetrate the skin, were pretended to be inserted over the chosen trigger point sites, and their removal was simulated after 10 minutes. Participants in both groups wore blind folds. The effectiveness of this blinding technique was evaluated and was effective, with 78% of the trigger point group perceiving that the needle had penetrated the muscle compared to 75% of the sham group. The assessors of the outcome measures were also blinded to which group the patients were in and therefore the potential for bias was minimised (Hopton and MacPherson 2011).

The outcome measures chosen in this study were a 100mm VAS for pain, and the CMS for shoulder function. The CMS provides an overall shoulder functional assessment score that is easy to use and clinically relevant (Constant and Murley1987). Scores are given for activities of daily living, degree of flexion, abduction, internal and external rotation, and pain level; these are then combined to attain an overall score for shoulder function.

The trigger point acupuncture group showed a significant improvement in pain intensity at the 4th and 5th treatment, and the follow-up assessment at week 10. A significant improvement in shoulder function, was also apparent at the completion of treatment (week 5); however, this improvement did not maintain significance from week 10 onwards. As a physiotherapist, shoulder pain and dysfunction would not normally be solely treated with acupuncture but would usually include other modalities such as exercises and mobilisation. If indicated, stretching of muscle groups and normalising muscle control around the shoulder should be included in clinical practice, so that the treatment effect is more likely to be maintained (Yap 2007). Individual data within the CMS testing process were not documented, and therefore it is unknown whether there were other significant improvements in measured parameters, such as shoulder range of movement (Constant and Murley 1987).

This study by Itoh et al (2014) confirms that trigger points may be a contributing factor in the aetiology of chronic shoulder pain and dysfunction. The results also demonstrate that trigger point acupuncture maybe a valuable treatment modality for chronic shoulder pain, when myofascial pain is identified and the needles are inserted effectively, to produce a local twitch response.

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ACSM's sports medicine: a comprehensive review

Francis G O'Connor , Douglas J Casa, Brian A Davis, Patrick St Pierre, Robert E Sallis, Robert P Wilder (Eds) Lippincott Williams & Wilkins 2013. Printed in China. ISBN 9781469827605 RRP $152.00. Soft Cover 859 pages, online access code specific to each individual text.

The American College of Sports Medicine 's (ACSM) aim was to provide a comprehensive yet focused text to address the lack of publications available to students preparing for the US medical subspecialty board examination. As stated by the editors in the text preface, physicians are the intended targets for this text. However, the content is relevant to all professionals working with athletes of any age, level, in any sport, with or without underlying pathology.

The text is divided into seven sections; general considerations, evaluation of the injured athlete, medical problems in the athlete, musculoskeletal problems in the athlete, principles of rehabilitation, sports specific populations and special populations. Whilst the text takes into consideration athletes of all ages, there are specific sections dedicated to the paediatric and geriatric population. It also takes into consideration the novice versus elite athlete.

In addition to the 859 page text there is an online resource of nearly 1,000 US medical board type questions. The editors selected contributing authors from sports physicians through to physical therapists and sports trainers. The text has extensive referencing; however, there is a lack of contemporary literature (within the last 5 years), particularly in the section 'Medical problems in the athlete'.

The text is well laid out with bullet points, clear heading and tables. There are few images in the text, with even fewer image examples of radiological scans. These images, particularly photographs, are of an average standard and as a consequence mostly appear blurred. Anatomical drawings are basic but clear.

Whilst the breadth of topics in this text is comprehensive, the depth is lacking. The text provides a good overview, covering injury and pathology for a significant number of sports and specific body parts, however the detail is relatively sparse. Superior texts do exist in the literature, if specific detail is required on a particular injury.

As a quick reference for a vast array of sports medicine related to specific body regions or sport, this book would be useful. The text is probably most useful for the undergraduate physiotherapy student, but may also be useful to the post-graduate professional, as an addition to more specific text such as Bruckner and Khan's Clinical Sports Medicine.

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Therapeutic exercise for physical therapist assistants, techniques for intervention. Third edition

William D Bandy and Barbara Sanders (Eds) 2013, Lippincott Williams & Wilkins, ISBN 978-1-60831-420-1, softcover, 538 pages. RRP: approximately $78.

This textbook is the third edition of this text, aimed specifically at the physiotherapy assistant. The authors of this book strive to give prospective physiotherapy assistants a very comprehensive background on interventions, the rationale for these interventions, and a broader scope of clinical reasoning.

The authors begin at the very basics with a review of orthopaedic tissues and joint functions. The reading quickly progressing into a listing of treatment modalities used, and familiarizes the reader with treatments such as ice massage, ultrasound and electrical stimulation, and the relation of each intervention to the aforementioned connective tissues. While the authors are careful to note that modalities are to be used in complement to other mobilizations and exercises, the provided supporting evidence for the modalities is rather dated.

Initially it is clear that this book is written for an American audience with Chapter 2 relating heavily to American regulations for the physiotherapy assistant. However, past Chapter 2, the book does progress in a very logical order beginning with low-level joint mobilizations and reviewing arthorkinematics for common mobilizations. Further chapters go through a variety of therapeutic exercises ranging from low-level exercises suitable for a home-exercise programme all the way up to the moderate-to-higher level athlete. The authors make use of a variety of exercise types ranging from those with merely gravity as resistance all the way up to weighted exercises and plyometrics.

This book is also not confined to orthopaedics and sports injuries as Chapters 13 and 14 also cover cardiac rehabilitation and respiratory therapy. With regards to the cardiac summary, the information is thorough in both training targets, as well as strong emphasis on safety precautions.

Chapter 17 also demonstrates other therapies which a physiotherapy assistant and physiotherapists may be lesser familiar with, such as techniques of aquatic therapy. While the chapter is heavier on theory and the aquatic forces relating to each exercise, the principles are well illustrated with several pictures of exercise techniques.

The style and voice of this book makes it easy read, and numerous pictures throughout each chapter demonstrate ideas and key points. But even though the title of this book implies a physiotherapy assistant audience, the content is explained in detail up to the education level of a new-graduate physiotherapist. But this comprehensive approach also ensures that the reader (regardless of their professional role) has a firm understanding of why a particular treatment and progression is appropriate. Each chapter is also concluded with a self-quiz, and an information box regarding age-appropriate considerations and often a case-study pertaining to each chapter. For these reasons, this book would be a great addition to any early physiotherapy or physiotherapy assistant curriculum. However, this book is likely too basic for a quick-reference for the more advanced clinician.

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Typical and atypical motor development clinics in developmental medicine

David Sugden and Michael Wade 2013, Mac Keith Press, London. ISBN: 978-1-908316-55-4. Hardcover; pages: 384. RRP: $259 (www.fishpond.co.nz)

The latest book by Sugden and Wade; Typical and Atypical Motor Development combines both previous texts by the authors: Movement skill Development (1985) and Problems in Movement Skill Development (1990) to cover typical development and atypical development in one inter-related format.

The book's main focus is the development of the child and compares typical and atypical progress. This provides an important contrast that benefits a better understanding of both groups of children. The authors focus on the 'what' and 'how' of motor development and descriptions of motor development from conception through to emerging adult, comparing how children acquire their changing and growing repertoires of movement with the resources that they have.

The authors provide an up to date contemporary view of child development while acknowledging previous perspectives, and identifying future areas for research.

The book is set out in a logical organised manner, and in two parts which are both complementary and inter-linked, Chapters 1-6 present material on typically developing children and the latter half of the book Chapters 7-12 examines a number of circumstances demonstrating how development can change as the resources of the particular child vary.

The first chapter – An introduction to Motor Development sets the scene for the rest of the book, exploring development and movement and the resources of the child as well as interactions among the child, the task, and the environment when examining functional motor skill. This is followed logically by chapters on Biological Influences on Developmental Change, Development Models and Theories, and then subsequent chapters on Movement Development from Birth to the Young child, where chapters are separated related to age; Birth to 24 months, 2 to 7 years of Age, and 7 years to Puberty. The second half of the book is divided into chapters on Cerebral Palsy, Developmental Co-ordination Disorder, Children with Intellectual Disability, Children with other developmental disorders and Children with visual impairments. The final Chapters on Assessment and Intervention for Children with Movement Difficulties and Perspectives on Typical and Atypical Development conclude the book with completeness.

The chapters are extremely comprehensive and in-depth. The chapters are scattered with schematics, photos, figures and graphs throughout, in addition most chapters have boxed 'methodological' sections titled 'A closer examination' which authors have used to look at how experimental work in the different areas was undertaken and how the data that was used to support the conclusions was derived. The chapters examine past and present research, models, theories and experiential perspectives related to the content, while identifying areas for future study to provide a well balanced perspective. Evidence is well cited throughout the chapters with an extensive reference list per chapter.

The authors intended audience is for occupational therapists, physiotherapists, paediatricians and teachers. Previous medical knowledge would be advantageous when reading this book.

The book would be of great benefit to physiotherapists and undergraduate students interested or working in the area of paediatrics and child development.

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