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Hong Kong Physiotherapy Journal

Aims & Scope

The Hong Kong Physiotherapy Journal (HKPJ) is the official peer-reviewed, Open Access (OA) publication of the Hong Kong Physiotherapy Association.

HKPJ publishes papers related to all areas of physiotherapy (education, research, practice, policies) and is committed to facilitating communication among educators, researchers and practitioners in the field with the aim of promoting evidence-based practice.

We are particularly interested in publishing randomized controlled trials, systematic reviews and meta-analyses. Animal studies are also welcome if the study question and findings have important relevance to physiotherapy practice.

HKPJ welcomes submissions from all over the world in the form of original research papers, reviews, editorials, treatment reports, technical notes, and correspondence.

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Assessing effective communication skills in students during clinical education

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Physiotherapists help their clients recover from injury and improve functional mobility and capacity, through participation in appropriate exercise. Physiotherapists must work with their clients. The success of most physiotherapy interventions depends on positive motivation of the client and compliance with the prescribed exercise program. Motivation needs to be effectively communicated. How a question is phrased during a patient interview effects whether a patient listens, understands what is required, is convinced of the benefit of the exercise, and is prepared to comply with the protocol as instructed. This process underpins the success of the physiotherapy program. Development of a student's ability to communicate effectively is a vital component of the entry-level physiotherapy curriculum.

The recent article published in the Hong Kong Physiotherapy Journal entitled "Physiotherapist-patient communication in entry-level physiotherapy education: A national survey in Nigeria"[1] alerts physiotherapy educators to the importance of maximising clinical communication skills in students. This is a well-written article which reports the frequency and assessment methods adopted by entry-level physiotherapy programs in Nigeria, to evaluate clinical communication skills in physiotherapy students. A questionnaire modelled on the "National survey of clinical communication assessment in medical education in the United Kingdom"[2] was modified and sent to all physiotherapy schools in Nigeria. Data were collected from six physiotherapy programs. Results showed that all programs conducted formal assessment of student clinical communication skills approximately three times a year, commencing in the second year of the program. The assessments were in various formats including Objective Structured Clinical Examination (OSCE) with actors or real patients, case reports, charts, short written answer tests and mini clinical evaluation exercises. This article also discussed the challenges associated with the assessment of clinical communication, including the "validity of method of assessment, inadequate resources, inexperienced examiners and content integration."

The most frequent methods of assessment of student clinical communication skills reported in Nigeria was the OSCE, followed by written reports. Surprisingly, OSCE is more frequently used in Nigeria than in the UK. The authors explain that the UK programs concentrate on theoretical knowledge over practical and experiential learning.[3] In my personal experience at the University of Queensland, physiotherapy students must pass an OSCE in cardiopulmonary, musculoskeletal and neurological domains using standardised patients, before being allowed to participate in clinical placements. OSCE with a standardised patient was the assessment format introduced into China in 2014 for the two-yearly National Physiotherapy Student contest, and subsequently a few physiotherapy programs in China, successfully accredited by WCPT, use OSCE for their preclinical examination.

It is impressive that the majority of physiotherapy programs in Nigeria have placed such emphasis on teaching and assessing student communication skills, and as well as adopting contemporary methods of assessment.

Effective communication underpins successful physiotherapy intervention and while appropriate communication skills are emphasised in all physiotherapy curricula, appropriate assessment of this vital skill must be undertaken in parallel.

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Research Paper

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Health professionals' referral practice and related healthcare utilization for people with low back pain in Singapore: A retrospective study

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Background: Low back pain is a common musculoskeletal disorder that can incur high financial burden. A significant proportion of this burden may be incurred from referrals to health services and subsequent healthcare usages. Patients' overall experience of pain and its related life interferences may also have some relevance to this usage. **Objective:** This study aimed to examine the referral practices and subsequent health service utilization of patients with LBP within a tertiary specialist clinic setting. A secondary objective was to explore potential associations between primary independent variables of pain and life interferences with health service utilization. **Methods:** Participants were patients with low back pain, who completed a set of self-reported low back pain measures. These included measures for pain intensity, pain interference, disability and quality of life. The participants' back pain-related referral and health service utilization in the subsequent 12 months were recorded. **Results:** A total of 282 patients completed the full measures. Of these, 59.9% were referred for physiotherapy, 26.3% for diagnostic imaging and 9.2% for interventional procedures. Compared to patients who were referred from tertiary care, those from primary care had lower pain intensity ($p = 0.001$), pain interference ($p = 0.002$), disability ($p = 0.001$), but better physical and mental quality of life ($p < 0.001$, $p = 0.017$). High pain interference was a common factor among patients who were referred on to other services after first consultation. Levels of medical utilization and physiotherapy utilization were both associated with pain intensity ($F = 2.39$, $p = 0.027$ vs $F = 3.87$, $p = 0.001$), pain interference ($F = 5.56$, $p = 0.007$ vs $F = 4.12$, 0.01) and disability ($F = 5.89$, $p = 0.001$ vs $F = 3.40$, $p = 0.016$). Regression analysis showed that the source of referral contributed to 6% of the variance in medical utilization and 3% of the variance in physiotherapy utilization. After controlling the

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demographic variables and referral sources, none of the independent variables added any significant variance to medical utilization. Only pain intensity contributed an additional 2% variance to physiotherapy utilization.
Conclusion: Referral patterns and practices appear similar to those reported in other studies. Higher levels of pain intensity, interference, disability and quality of life appear to influence the referral to different health services and subsequent treatment utilization.

Keywords: Low back pain; referral and consultation; pain measurement.

Introduction

Low back pain (LBP) is a common musculoskeletal condition worldwide.A systematic review of studies reporting incidences of LBP, conducted in Canada, United Kingdom (UK), Denmark, Israel and Kuwait, suggested an annual incident estimate of 1.5–36% for LBP.[1] The annual estimate of new incidences of LBP was reported to range from 6.3% to 15.4% in these countries. A recent large survey, conducted in the UK with 15,000 people with LBP, reported a one-month prevalence rate of 28.5% for this condition. Incidences of severe LBP were shown to increase with age, with these incidences peaking in the 41–50 age group.[2] A systematic analysis for the Global Burden of Disease Study 2013 ranked LBP as the leading cause of years lived with disability.[3]

The global economic burden of LBP is also high. A systematic review on the global cost of LBP, between 1997 and 2007, estimated the annual cost of illness to range from US$1.2 billion to US$25 billion.[4] Cost of illness calculation includes three main types of costs: (a) direct (medical and non-medical) costs; (b) indirect costs; and (c) intangible costs. These different categories of costs make the accurate estimation of the cost of illness of LBP rather challenging. As such, studies have instead focused on direct costs of LBP, which mostly comprised medical healthcare-related costs.

The reported annual medical cost for LBP in the US was US$70 million.[5] More recent studies estimate direct healthcare costs to be €2.6 billion in Switzerland or 29% of the total cost of illness of LBP.[6] In France, 25% of the total direct costs are related to therapeutic and hospital care or rehabilitation care for LBP.[7] Results from a retrospective cohort study in the UK demonstrated that general healthcare costs for people with chronic LBP were three times greater than those without this condition.[8] Healthcare costs of chronic LBP were also found to be twice as high compared to those with acute LBP.[7]

Medical comorbidities, such as hypertension and coronary heart diseases commonly found in LBP sufferers as well as depression and anxiety disorders, appear to contribute to increased healthcare costs.[5,8] High disability and limitation in function from chronic LBP could increase subsequent direct healthcare costs by up to fivefolds.[7] A study of the trend of health expenditures, healthcare utilization and health statuses of people with spine problems in the US showed an increasing trend in these areas.[9]

A key systematic review of eight population-based studies, conducted from 1995 to 2005, indicated that the prevalence of care-seeking among LBP sufferers was 58%(10). Further, a population-based mailed survey of the epidemiology of LBP in Australia reported 44.5% prevalence in care-seeking behavior,[11] while a similar survey conducted in the United States reported a higher prevalence rate at 67.4%.[12] While one in three adults in the UK suffers from LBP, it was found that only about 20% of these sufferers would consult their General Practitioner (GP).[13] People with greater disability were more likely to seek care (OR: 3.87), with other factors such as gender, previous LBP history and poor general health also influencing care-seeking behavior.[10] A prospective cohort study of LBP in a hospital-tertiary setting suggested that healthcare utilization was also mediated by physical functioning and social stresses.[14]

It is a common healthcare practice for individuals with LBP to be referred on to further healthcare services such as diagnostic imaging, specialist care and therapy services after their first healthcare professional consultation. However, the decision to refer patients for subsequent healthcare services does not appear to be governed by specific treatment guidelines. A study of referral patterns by primary care physicians demonstrated that the decision to refer to specialty care including physiotherapy was influenced by the characteristics within the healthcare system, the physician and

the patient.[15] Referral rates were higher for individuals with higher education, employer or insurance coverage, and in specific geographical locations.[16–18] The odds of seeking care from a physiotherapist were 65% higher in females, and these individuals were twice as likely to be in the higher income category (OR: 2.09).[12] Other patient-related factors influencing referral decision was related to the presented LBP problem. Specialist care was found to be the strongest predictor of individuals with LBP receiving subsequent diagnostic imaging, physiotherapy and other healthcare services.[19]

Studies have shown that referrals to diagnostic imaging for LBP were related to patient–physician interactions and expectations rather than a purely medical consideration.[20] This discordance was also observed in a survey of GPs in Australia where 25.3% of individuals with acute LBP were referred for imaging, contrary to the established LBP treatment guidelines.[21] Specific to physiotherapy referrals, a cross-sectional analysis of Spine physicians in the US suggested that certain spinal diagnoses, surgeries, injections and multiple tests were negatively associated with such referrals.[16] Higher disability was also found to be negatively related to physiotherapy referrals[16] with referrals to physiotherapy related to lower self-rating of health status (OR 1.93).[12]

There is limited data on the referral practices and health service utilization in LBP within Southeast Asia. In a recent epidemiological study, LBP was ranked as the leading cause of years lived in disability in Southeast Asian countries, such as Indonesia, Malaysia, Philippines and Vietnam.[3] Work-related LBP's Daily Adjusted Life Years (DALYs) lost in Southeast Asia, after taking socioeconomic situations into consideration, was still found to be higher here than in other parts of the world.[22] Documenting the referral practices and subsequent health service utilization and their relation to pain and life interference could be a start towards building understanding of the healthcare burden of LBP in Southeast Asia.

The primary purpose of this study was to examine the referral practices and utilization of healthcare services in patients presenting with LBP and referred to a tertiary pain clinic setting in Singapore. We were also interested to explore associations between primary independent variables of pain and life interferences with healthcare utilization. Results can help guide the future design of triage and interventions that may potentially address such levels of healthcare utilization.

The study protocol was approved by the National Healthcare Group Institutional Review Board, Singapore (NHG DSRB Ref: 2012/00364). Waiver of Informed Consent was approved and observed for all the participants involved in the study.

Material and Methods

Design

This was a retrospective cohort study of LBP patients from a Singapore tertiary care hospital.

Participants

Participants were patients, who were referred for complaints of LBP and had their first consultations between January and December 2011 at the pain clinic. Patients were included if they were (a) between 18 and 65 years, (b) presented with a primary complaint of LBP at first consultation, (c) able to complete a full set of standardized measures in either English or Mandarin. Patients were excluded if they were presented with some form of cognitive impairment or mental health condition diagnosis that affected their ability to complete a full set of standardized measures.

Procedures

Patients who attended their first consultation at the pain clinic were asked to complete a set of standardized self-reported LBP measures on arrival at the clinic. Patients were reviewed by the respective pain specialists upon completion of these measures. Every patient underwent a comprehensive assessment including history taking, physical examination and electronic notes review as part of the standard pain consultation. The specialists would diagnose and establish management plans with the participants with the option of referring to their self-reported standardized measures as part of their assessment. The management plans could include referrals for further diagnostic imaging, consultations with other disciplines, interventional procedures and rehabilitation services as well as follow-up consultations. The above processes were documented in standard medical case records. In the case of referrals to other health services, appointments to the relevant services were made after the consultation. Changes in

management plans were also similarly documented and followed up.

LBP diagnoses

The diagnosis of LBP was determined by the respective pain specialists examining the cases. The diagnosis of LBP was classified according to the "Classification of Chronic Pain (Second Edition)", as set out by the International Association for the Study of Pain (IASP).[23] Specifically, the patients presented with one of the following diagnoses contributing to a broad category of low back pain: (1) Lumbar spinal or radicular pain attributable to a fracture (XXVI-1), (2) Lumbar spinal or radicular pain attributable to arthritis (XXVI-5), (3) Lumbar spinal pain of unknown or uncertain origin (XXVI-9), (4) Lumbar spinal or radicular pain after failed spinal surgery (XXVI-10), (5) Lumbar discogenic pain (XXVI-11), (6) Lumbar zygapophysial joint pain (XXVI-13), (7) Lumbar instability (XXVI-21), (8) Prolapsed intervertebral disc (XXVI-23), (9) Spinal stenosis: Cauda Equina lesion (XXVII-6), (10) Sacral spinal pain of unknown or uncertain Origin (XXVII-9), (11) Sacroiliac joint pain (XXVII-10). All participants had a chronic low back pain onset of more than 3 months. Case notes and documentations were inspected retrospectively to verify that each participant had a primary LBP diagnosis and that clinic visits, procedures and hospital admissions were related to the treatment of LBP.

Referral Practice and Utilization Data

The referral and healthcare utilization data on LBP were tracked for 1 year subsequent to the first consultation. Healthcare utilization was defined as the number of visits made by the patient to each health service discipline. These included the number of visits to the doctors, physiotherapists and psychologists, the number of interventional procedures and diagnostic imaging conducted, as well as the admissions to hospital (inpatient admission) relating only to the diagnosis of LBP. The case notes inspection included those from orthopaedic, rheumatology, neurosurgery, rehabilitation medicine and pain management clinics. The data on referral patterns were inferred from visits to other services subsequent to the primary medical consultation.

Measures

Demographic measures which included age, gender, race, marital status, education level and occupation were recorded.

Pain intensity and pain interference

Self-reported pain intensity and pain interference were measured using the Brief Pain Inventory (BPI).[24] Pain intensity was measured on a 0 (no pain) to 10 (worst pain possible) scale. Pain interference was assessed across seven domains, namely, general activity, mood, walking, normal work, relations with other persons, sleep and enjoyment of life. The BPI was found to have acceptable levels of reliability and validity in the assessment of pain intensity and pain interference in patients with non-malignant pain. The Cronbach α internal coefficient was 0.85 for the intensity scale and 0.88 for the interference scale.[25]

Disability

Self-reported disability was measured using the Oswestry Disability Index (ODI).[26] The ODI is one of the two widely used disability measures in LBP population.[27] It comprises 10 sections, covering 10 aspects of abilities. In each section, respondents choose 1 of 6 choices that each carried a score ranging from "0" (able to perform without limitation) or "5" (totally unable to perform). The final score is tabulated as a percentage of the total possible score of the relevant sections.[26]

Quality of life

The self-reported quality of life (QoL) was measured using the Medical Outcome Study (MOS) 36-items Short Form Health Survey (SF-36).[28] The SF-36 consisted of 36 questions that measure the health concepts of physical, role, social functioning, mental health and general health perception, bodily pain and vitality.[29] These domains were then grouped to form two health dimension scales: the physical and mental composite scores. The SF-36 served as a good QoL measure for people with low back pain.[27,29] In chronic pain, the SF-36 Mental Composite Score was shown to have positive predictive value for mood issues.[30]

Statistical Analysis

Pain intensity was computed taking the average of worst, least and average pain intensities on the BPI to form one composite pain intensity score. This score was used in all subsequent analysis. The ODI scores were originally categorized as mild (0–20%), moderate (21–40%), severe disability (41–60%), crippled (61–80%) and bed bound (81–100%).[31] To account for skewness of the data, the categories of 'Severe disability", "Crippled" and "Bed bound" were re-computed as a single"Severe disability" (41–100%) component.

The SF-36 physical composite score (physical QoL) and mental composite score (mental QoL) were computed from the SF-36 questionnaire and used in the subsequent analysis. A secondary analysis was performed, which focused on examining the relationship between pain intensity, pain interference, disability and physical and mental quality of life with healthcare utilization. The between-group differences were examined with independent, two-tailed t-test and analysis of variance (ANOVA). Homogeneity of variances was tested and in cases where the assumption of the homogeneity of variance was violated, Welch's ANOVA was applied to adjust for this violation. Post hoc Games-Howell analyses were used to examine the between-group differences, when there were more than two groups of variables. Hierarchical regression models were calculated to examine the possible predictors for medical and physiotherapy utilization, when demographic variables were controlled for. The data were analyzed using SPSS for windows, version 21.

Results

A total of 298 patients completed the full measures, with 282 (94.6%) participants having a primary LBP diagnosis. Out of these, 138 (48.9%) were referred from primary care, and 144 (51.1%) were referred from tertiary care. The mean age was 46 years (SD = 18.2), with males making up 52.8% of the total number of patients. The baseline demographic characteristics and LBP diagnoses of patients are summarized in Table 1.

Table 1. Demographic characteristics and LBP diagnoses of study sample ($N = 282$).

Demographic characteristic	n (%)
Gender (male)	149 (52.8)
Race	
Chinese	217 (77.0)
Malay	19 (6.7)
Indian	27 (9.6)
Others	19 (6.7)
Marital Status	
Married	161 (57.1)
Divorced/Separated	14 (5.0)
Single	90 (31.9)
Widowed	14 (5.0)
Unknown	3 (1.0)
Years of education	
More than 12 years	104 (36.9)
12 years	19 (6.7)
10 years	61 (21.6)
Less than 10 years	39 (13.9)
Other qualifications	53 (18.8)
Unknown	6 (2.1)
Occupation	
Non Physical Work	156 (55.3)
Physical Work	28 (10.0)
Housewife	33 (11.7)
Student	24 (8.5)
Retiree	22 (7.8)
Unemployed/Unknown	19 (6.7)
Clinical Diagnosis of LBP	n (%)
Lumbar Spinal or Radicular Pain Attributable to a Fracture (XXVI-1)	3 (1.1)
Lumbar Spinal or Radicular Pain Attributable to Arthritis (XXVI-5)	1 (0.4)
Lumbar Spinal Pain of Unknown or Uncertain Origin (XXVI-9)	176 (62.4)
Lumbar Spinal or Radicular Pain after Failed Spinal Surgery (XXVI-10)	2 (0.7)
Lumbar Discogenic Pain (XXVI-11)	19 (6.7)
Lumbar Zygapophysial Joint Pain (XXVI-13)	23 (8.2)
Lumbar Instability (XXVI-21)	7 (2.5)
Prolapsed Intervertebral Disk (XXVI-23)	16 (5.7)
Spinal Stenosis: Cauda Equina Lesion (XXVII-6)	15 (5.3)
Sacral Spinal Pain of Unknown or Uncertain Origin (XXVII-9))	15 (5.3)
Sacroiliac Joint Pain (XXVII-10)	5 (1.8)

Patients who were referred from tertiary care were older (50.11 ± 18.23 years) than those referred from primary care (43.22 ± 18.0 year; $F = 10.21$, $p = 0.002$). Patients who were subsequently referred for interventional procedures after medical consultation were also older (54.60 ± 18.66 years versus 45.91 ± 18.22 years; $F = 5.52$, $p = 0.019$), as were patients who had recorded hospital admissions (61 ± 19.42 versus 45.98 ± 18.08 years; $F = 9.38$, $p = 0.002$). There were no other baseline between-group differences in demographic characteristics between patients included in this study. Patients referred from tertiary care

Table 2. Mean scores and between-group differences of self-reported LBP measures and healthcare utilization (medical and physiotherapy) of patients referred from primary care and tertiary care settings.

	Primary care Mean ± SD (95%CI)	Tertiary care Mean ± SD (95%CI)	*P*-value
Age	43.22 ± 18.0 (40.19–46.25)	50.11 ± 18.23 (47.11–53.11)	0.002**
Self-reported LBP Measures			
Pain intensity	4.20 ± 1.59 (3.93–4.46)	4.86 ± 1.64 (4.59–5.13)	0.001**
Pain interference	4.09 ± 2.38 (3.69–4.49)	5.00 ± 2.41 (4.60–5.40)	0.002**
Disability	25.03 ± 15.33 (22.45–27.61)	34.79 ± 19.37 (31.6–38.00)	< 0.001***
Physical quality of life	51.96 ± 21.23 (48.39–55.54)	39.85 ± 21.91 (36.24–43.46)	< 0.001***
Mental quality of life	61.63 ± 21.83 (57.96–65.30)	55.04 ± 24.30 (51.04–59.04)	0.017*
Health service utilization			
Medical utilization	2.72 ± 2.09 (2.37–3.07)	4.44 ± 3.90 (3.80–5.09)	< 0.001***
Physiotherapy utilization	2.30 ± 3.15 (1.77–2.83)	3.44 ± 4.99 (2.61–4.26)	0.023*

Notes: SD: standard deviation; CI: confidence interval. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. Data was adjusted for non-homogeneity of variance.

had higher medical ($p < 0.001$) and physiotherapy utilization ($p = 0.023$).

Health service referrals and self-reported LBP measures

Results showed that patients referred to the clinic from tertiary care had higher pain intensity ($p = 0.001$), pain interference ($p = 0.002$), disability ($p = 0.001$), and poorer physical and mental QoL ($p < 0.001$, $p = 0.017$). Table 2 shows the mean scores and between-group differences of self-reported measures in patients referred from primary care and tertiary care.

Patients who were referred to physiotherapy (59.92%) were found to have higher pain interference ($p = 0.0018$) and poorer physical QoL ($p = 0.04$). Those referred for diagnostic imaging (26.24%) also reported higher pain interference ($p = 0.04$), disability ($p = 0.03$), and lower mental QoL ($p = 0.01$). Patients referred for interventional procedures (9.22%) not only reported higher pain interference ($p = 0.003$) and disability ($p = 0.001$) but also lower levels of both mental ($p = 0.013$) and physical QoL ($p = 0.001$). Patients who had subsequent hospital admissions (4.96%) were worse on all self-reported measures ($p < 0.05$). Data on the referrals to different health services and their respective scores on the LBP measures are provided in Table 3.

Health service utilization and self-reported LBP measures

Patients attended an average of 3.60 ± 3.26 medical visits, with those referred to physiotherapy attending 4.81 ± 4.53 visits. An average of 1.36 ± 0.93 imaging studies were performed for those referred to diagnostic imaging, and 1.04 ± 0.2 interventional procedures were completed. Between-group comparison of pain intensity, pain interference and disability with medical and physiotherapy utilization is provided in Table 4.

The medical utilization was found to be associated with pain intensity ($F = 2.39$, $p = 0.027$), pain interference ($F = 5.56$, $p = 0.007$), and disability ($F = 5.89$, $p = 0.001$). Post hoc Games-Howell analyses showed that medical utilization was significantly lower in patients with mild pain intensity ($p = 0.032$), low pain interference ($p = 0.006$), and mild disability ($p = 0.006$). Medical utilization was also lower in patients who were not referred to physiotherapy (2.31 ± 2.00; 95%CI 1.94–2.68) compared to those who were referred (4.46 ± 3.64; 95%CI 3.91–5.01; $F = 32.81$, $p < 0.001$).

Similar to the results obtained from ANOVA analysis of medical utilization, the physiotherapy utilization was also associated with pain intensity ($F = 3.87$, $p = 0.001$), pain interference ($F = 4.12$, $p = 0.01$), and disability ($F = 3.40$, $p = 0.016$). Post hoc analyses also showed that similar results in patients with mild pain intensity ($p = 0.006$), low pain interference ($p = 0.03$) and mild disability

Table 3. Referral to other health services and between-group differences in self-reported LBP measures.

Descriptor	Referred *n* (%)	Not referred *n* (%)	Referred mean (SD)	Not referred mean (SD)	Mean difference	95% CI	*P*-value
Physiotherapy	169 (59.92)	113 (40.07)					
Pain intensity			4.65 (1.65)	4.37 (1.64)	0.28	−0.11–0.67	0.16
Pain interference			4.84 (2.29)	4.12 (2.60)	0.72	0.12–1.31	0.018*
Disability			31.44 (16.73)	27.88 (19.99)	3.57	−0.92–8.06	0.11
Physical quality of life			43.56 (20.30)	49.09 (24.91)	−5.53	−10.85–(−0.20)	0.04*
Mental quality of life			57.14 (22.06)	59.96 (25.09)	−2.82	−8.40–2.76	0.32
Diagnostic imaging	74 (26.24)	208 (73.76)					
Pain intensity			4.63 (1.56)	4.50 (1.68)	0.12	−0.30–0.55	0.57
Pain interference			5.01 (2.19)	4.39 (2.51)	0.62	−0.02–1.27	0.04*
Disability			33.81 (17.04)	28.66 (18.38)	5.15	0.49–9.80	0.03*
Physical quality of life			41.81 (21.06)	47.19 (22.72)	−5.38	−11.13–0.38	0.07
Mental quality of life			52.26 (23.60)	60.40 (22.89)	−8.15	−14.42–(−1.88)	0.01**
Interventional procedure	26 (9.22)	256 (90.78)					
Pain intensity			4.86 (1.46)	4.51 (1.66)	0.35	−0.27–0.97	0.26
Pain interference			6.04 (2.43)	4.40 (2.40)	1.64	0.66–2.61	0.003**
Disability			41.62 (16.33)	28.87 (17.97)	12.75	5.82–19.67	0.001***
Physical quality of life			32.19 (16.52)	47.11 (22.49)	−14.92	−23.84–(−5.99)	0.001***
Mental quality of life			47.27 (22.08)	59.35 (23.23)	−12.08	−21.40–(−2.76)	0.013**
Inpatient admission	14 (4.96)	268 (95.04)					
Pain intensity			5.74 (1.72)	4.47 (1.62)	1.27	0.26–2.27	0.017*
Pain interference			6.50 (2.74)	4.45 (2.38)	2.05	0.45–3.65	0.016*
Disability			49.71 (16.62)	28.99 (17.66)	20.73	10.96–30.50	< 0.001***
Physical quality of life			24.71 (15.15)	46.88 (22.17)	−22.16	−33.98–(−10.35)	< 0.001***
Mental quality of life			36.21 (23.70)	59.42 (22.76)	−23.20	−37.09–(−9.32)	0.003**

Notes: SD: standard deviation; CI: confidence interval. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. Data was adjusted for non-homogeneity of variance.

($p = 0.043$) were more likely to have lower number of physiotherapy visits.

Correlation analysis showed only negligible to small relationships ($r = 0.05$–0.22) between healthcare utilization (medical and physiotherapy) and variables of pain intensity, pain interference, disability and QoL (physical and mental). Results of the individual analyses are not reported here.

Regression analyses were conducted to examine potential predictors for medical and physiotherapy utilization. Specifically, known confounders such as demographic variables of age, gender and education were controlled for in the first block, followed by referral source and pain intensity. Quality of life, disability and pain interference which are meaningful treatment outcomes in chronic pain management were subsequently added into the regression order.Pain interference is often a primary dependent variable that is examined in many pain studies. Hence, it was added in as the last block in the hierarchical regression. We were interested to examine whether pain interference would be able to account for the variance in medical and physiotherapy utilization in our sample of patients beyond the other dependent variables examined here. The results of the regression showed that the source of referral contributed to 6% of the variance in medical utilization and 3% of the variance for physiotherapy utilization. After controlling for demographic variables and referral sources however, none of the dependent variables of pain intensity, quality of life, disability or pain interference added any significant variance to medical utilization. Among the dependent variables, only pain intensity contributed an additional 2% variance to physiotherapy utilization. Table 5 shows the results of the linear regression models examining predictors for medical and physiotherapy utilization.

Discussion

This study presents a report of LBP-related healthcare referral and utilization within a cohort,

Table 4. Between-group comparison of LBP measures and number of physiotherapy and medical visits.

LBP measures	F-value	P-value	Severity (I)	Number of visits Mean ± SD (95% CI)	Severity (J)	Number of visits Mean ± SD (95% CI)	Between-group comparisons mean difference (I-J)	P-value
Medical Utilization								
Pain intensity	2.39	0.027*	Mild ($n = 58$)	2.91 ± 2.19 (2.34–3.49)	Mod ($n = 181$)	3.65 ± 3.55 (3.13–4.17)	−0.73 [SE: 0.39; CI: −1.66–0.19]	0.15
					Severe ($n = 43$)	4.33 ± 3.07 (3.38–5.27)	−1.41 [SE:0.55; CI: −2.73–(−0.10)]	0.032*
Pain interference	5.56	0.007**	Low ($n = 100$)	2.89 ± 2.93 (2.31–3.47)	Mod ($n = 111$)	3.63 ± 3.14 (3.04–4.22)	−0.74 [SE: 0.42; CI: −1.73–0.25]	0.18
					High ($n = 71$)	4.55 ± 3.67 (3.68–5.42)	−1.66 [SE: 0.52; CI: −2.90–(−0.41)]	0.006**
Disability	5.89	0.001***	Mild ($n = 106$)	2.75 ± 2.53 (2.27–3.24)	Mod ($n = 99$)	4.12 ± 3.89 (3.34–4.90)	−1.37 [SE: 0.46; CI: −2.46–(−0.27)]	0.01**
					Severe ($n = 77$)	4.09 ± 3.06 (3.40–4.78)	−1.34 [SE: 0.43; CI: −2.35–(−0.33)]	0.006**
Physiotherapy Utilization								
Pain intensity	3.87	0.001***	Mild ($n = 58$)	1.72 ± 1.86 (1.23–0.21)	Mod ($n = 181$)	2.98 ± 4.37 (2.34–3.62)	−1.26 [SE: 0.41; CI: −2.22–(−0.30)]	0.006**
					Severe ($n = 43$)	4.02 ± 5.47 (2.34–5.71)	−2.30 [SE: 0.87; CI: −4.40–(−0.20)]	0.029*
Pain interference	4.12	0.01**	Low ($n = 100$)	1.92 ± 3.57 (1.21–2.63)	Mod ($n = 111$)	3.39 ± 4.72 (2.50–4.28)	−1.47 [SE:0.57; CI: −2.82–(−0.12)]	0.03*
					High ($n = 71$)	3.45 ± 4.08 (2.49–4.42)	−1.53 [SE: 0.60; CI: −2.96–(−0.11)]	0.035*
Disability	3.40	0.016*	Mild ($n = 106$)	2.05 ± 2.93 (1.48–2.61)	Mod ($n = 99$)	3.44 ± 4.97 (2.45–4.44)	−1.40 [SE: 0.57; CI: −2.76–(−0.04)]	0.043*
					Severe (n =77)	3.31 ± 4.56 (2.28–4.35)	−1.26 [SE: 0.59; CI: −2.66–0.14)]	0.087

Notes: SD: standard deviation; SE: standard error; CI: 95% confidence interval. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. Data was adjusted for non-homogeneity of variance.

Table 5. Hierachical regression models examining predictors for medical and physiotherapy utilization.

		Medical utilization			Physiotherapy utilization		
Step		Adj. R^2	R^2	β	Adj. R^2	R^2	β
1		−0.01	0.01		0.00	0.01	
	Age			0.07			−0.08
	Gender			−0.02			−0.09
	Education			−0.02			−0.02
2		0.06	0.07		0.02	0.04	
	Age			0.01			−0.12
	Gender			−0.01			−0.09
	Education			−0.06			−0.04
	Referral Source			−0.27***			−0.16**
3		0.07	0.08		0.04	0.06	
	Age						−0.12
	Gender			−0.01			−0.07
	Education			−0.001			−0.02
	Referral source			−0.04			−0.13
	Pain intensity			0.10			0.15*
4		0.08	0.10		0.04	0.06	
	Age			−0.02			−0.13
	Gender			0.02			−0.07
	Education			−0.04			−0.02
	Referral source			−0.23			−0.11
	Pain intensity			0.03			0.12
	Physical QoL			−0.09			−0.13
	Mental QoL			−0.08			0.09
5		0.10	0.10		0.04	0.06	
	Age			−0.03			−0.14
	Gender			0.02			−0.07
	Education			−0.04			−0.02
	Referral source			−0.23			−0.11
	Pain intensity			0.01			0.11
	Physical QoL			−0.05			−0.10
	Mental QoL			−0.07			0.10
	Disability			0.09			0.06
6		0.11	0.11		0.04	0.07	
	Age			−0.02			−0.13
	Gender			0.02			−0.07
	Education			−0.05			−0.03
	Referral source			−0.23			−0.11
	Pain intensity			−0.01			0.09
	Physical QoL			−0.04			−0.09
	Mental QoL			−0.05			0.12
	Disability			0.06			0.04
	Pain interference			0.07			0.07

Notes: QoL: quality of life; Adj.: adjusted; β: standardized coefficients beta. *$p < 0.05$; **$p < 0.01$ and ***$p < 0.001$.

tertiary hospital clinic setting in Southeast Asia. Results showed that those referred from tertiary care had greater pain and life interference, and greater medical and physiotherapy utilization. Patients referred to physiotherapy had higher pain interference and poorer physical QoL. Those referred to diagnostic imaging, interventional procedures, and admitted showed more extensive pain and life interference. High pain intensity, pain interference, and disability were associated with medical and physiotherapy utilization. Source of referral significantly contributed to medical and physiotherapy utilization, while pain intensity was a significant predictor for physiotherapy utilization.

A total of 59.92% of patients were referred for physiotherapy. This referral rate was considerably

higher than the 38%–49% reported in studies in similar tertiary settings.[16,19] The relationship between physiotherapy referral and disability, as noted by Freburger *et al.*,[16] was not found here. The physicians in this study were specialists in pain management, unlike the spine surgeons or specialists from a variety of disciplines in both the studies. Physician specialties might be associated with different clinical practices when managing LBP. In addition, specific diagnoses of LBP, spinal surgeries, injections, multiple tests and the level of chronicity of LBP could also influence the rate of referral to physiotherapy.[16,32]

Referral rate for diagnostic imaging (26.24%) was lower than 32–46% reported in other studies within tertiary settings.[7,17,18] Patients referred to diagnostic imaging in this study reported higher levels of pain interference and disability, and lower levels of mental quality of life. Studies[19] have found low-functional capacity to be a strong predictor for referrals to imaging, and ordering of tests was highly influenced by factors related to the (1) attending physician, (2) psycho-social effects on the patients at the time of consultation and (3) the policy and practices of the healthcare organization.[20,33]

The mean medical utilization in this cohort study was 3.60 (SD = 3.26), which was lower than other cohort studies. The median number of specialist visit was 7 in the study by Chenot *et al.*, while those reported in a Japanese study were in the range of 6.46–11.44.[19,34] Physiotherapy utilization 4.81 (SD = 4.53) was lower compared to the 8.4 and 10.3 visits reported in tertiary settings.[32,35]

The healthcare system in Singapore is designed such that a referral gate control to specialist and therapy care is a common practice for subsidized care. The effectiveness and outcome of such a referral system in managing health usage, however, remains unclear. It would seem that although validated measures are available to capture health service utilization, patient outcomes and well-being, few of these have been used in specialty referral systems.[36] The presence of uniform medical insurance and ineffective referral gate-control mechanism was also found to be associated with higher healthcare usage.[6,37] This study noted that prior specialist care could be a predictor for greater medical utilization. Another earlier cohort study[19] has shown that specialist consultation was a stronger predictor for subsequent health service utilization than disease-specific factors. The structure of the healthcare system and funding could influence the lower medical and physiotherapy usage observed here.

The specialists and physiotherapists in this study appeared to adopt a stratified approach to reviewing patients. Patients presenting with low or mild levels of pain intensity, interference and disability had lesser utilization during the subsequent 1 year period. These patients were likely to have been reviewed less frequently, or discharged after a shorter review period. The utilization increased when the pain intensity, interference or disability increased to moderate or severe levels. There appears to be a slight variation in practices between medical specialists and physiotherapists. The specialists tended to review patients more frequently when the pain intensity, pain interference and disability were in the high or severe range, while physiotherapists did so, when they reached the moderate range. Specific to the specialists included in this study, this finding potentially implies that their choice to review patients at a higher frequency could be related to a focus on diagnosis and managing more complex and severe LBP. This will also include assessing and managing red flags presented at consultation.

Compared to patients who were referred from primary care, those from tertiary care were older and had significantly higher pain intensity, pain interference, disability and lower physical and mental QoL. Outcomes of referral to specialists included clinical tasks such as diagnosis and treatment.[36] It is possible that specialists in this study exercise greater diligence in assessing and managing these patients. It was not a surprise that the source of referral was presented as a significant contributor to the medical and physiotherapy utilization.

Based on the regression findings, pain intensity was found to be a significant contributor to overall physiotherapy utilization, albeit a modest one. It is possible that physiotherapists may focus on pain intensity as a guide when planning the frequency and length of review. The possible reasons and implications of this contributor require more studies and thought. Pain intensity has been found to be associated with other pain-related cognitive factors such as catastrophizing and functional self-efficacy.[38,39] In recent years, psychologically-informed physiotherapy practice has been advocated to be the new clinical framework, whereby the patient should be considered within the relevant

psycho-social-economic contexts before delivering appropriate care.[40]

Although it was expected that pain intensity, pain interference, disability and quality of life would contribute a significant amount of variance to healthcare utilization, we found that these independent variables contributed a total of 3–4% variance. This might mean that there were many other factors that could be predictors for medical and physiotherapy utilization. These could include other condition-specific or patient-specific presentations. Musculoskeletal and neuropathic pain conditions, sleep disorders, anxiety and depressions were found to be significantly higher in people suffering from chronic LBP.[41] The duration of the LBP episode and the history of recurrence of LBP, and pain areas would be the common aspects considered by the healthcare professions in clinical examination. Greater chronicity of LBP had been related to increased physiotherapy utilization.[32] A combination of self-reported and objective measures could provide information about the chances of recurrences of LBP with radiating symptoms and neurological findings, which had been noted as a possible factor in future health service utilization.[42–45]

Limitation of Study

This study was a retrospective cohort study that examined only one sample within one tertiary hospital. Including and comparing data from other tertiary pain centers could add greater dimension and completeness to the study results. This study did not include data on common psychosocial factors and comorbidities that had been previously found to be related to chronic LBP and health utilization, such as fear avoidance, hyper vigilance, depressive and anxiety disorders.[5,14,41] Data related to such factors were only collected from a small subset of patients seen at the pain clinic in this study, specifically those referred to the psychologist after their first visit to the clinic. The timeframe for referrals made to the psychologist from patient's first visit to the clinic were often inconsistent and sporadic. As such, these data were not included here. Information about these psychological factors may help explain the health utilization observed in this study. This can further clarify the contribution of pain intensity towards physiotherapy utilization.

The utilization of non-hospital-based therapy services, such as alternative complementary therapies and visits to the primary care physicians or other specialists, were not examined here. Inclusion of these via interviews would provide a more complete picture about the influence of LBP complaints on care-seeking and utilization prior to and during the course of the study.

The use and reliance on limited self-reported measures may contribute another study limitation. The LBP condition has been thought to be inherently complex in both presentation and the delivery of care.[46] In this aspect, the self-reported condition-specific measures would only form a small part of the doctors' and physiotherapist's clinical decision-making. Utilizing such measures alone and obtaining data from a limited number of measures would likely be inadequate to explain the trends and patterns in healthcare utilization. Future studies should consider the inclusion of common clinical presentation, comorbidities and associated healthcare services utilized since the onset of LBP to extend the current understanding in this area. Such understanding can guide more targeted research into more cost- and clinically-effective LBP treatments.

Recommendations

Based on the study findings, setting up a triage system for patients presenting with LBP at a tertiary care setting is potentially useful. Patients who are above 45 years of age, referred from tertiary care and presenting with high levels of self-reported pain intensity, pain interference and disability, can be given earlier appointment to see the specialist and physiotherapist. This would facilitate the process of specialized assessment, diagnosis and delivery of targeted intervention. The identified inadequacies of self-reported measures in predicting healthcare utilization, including examination of comorbidities such as depression, anxiety, sleep disorders, and presence of other pains in patient assessment, can add value to the model. Such data would be helpful in refining the triage system and empower patients in need of prompt specialist and physiotherapy care. Prompt and targeted care could be helpful in managing the chronicity of LBP and the subsequent burden on the patient.

Conclusion

This study presented the referral and utilization of medical and physiotherapy services, within a

tertiary setting, in Southeast Asia. Self-reported LBP measures in pain, interference and disabilities appeared to influence the frequency and length of follow-up reviews by the doctors and physiotherapists. The referral and utilization patterns, and variations appeared to loosely concur with those reported in the existing literature. Future studies to examine clinician-related factors, objective examinations, and broader psycho-social-economic factors could provide more information to the referral and utilization practices within LBP management in Singapore.

Conflict of Interest

The authors have no conflicts of interest relevant to this paper.

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Author Contributions

F.L. Loy	Conception and design of study, acquisition of data, analysis and interpretation of data, drafting of manuscript and approval of the version of the manuscript to be published.
S.Y. Yang	Conception and design of study, analysis and interpretation of data, revising the manuscript critically and approval of the version of the manuscript to be published.
J. Chemat	Conception and design of study, acquisition of data, revising the manuscript critically and approval of the version of the manuscript to be published.
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Sensitivity and specificity of normalized truncated navicular height in assessment of static foot posture in children aged 6–12 years

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Background: Normalized truncated navicular height (NTNH) is a non-invasive, easy to perform, and simple clinical measure of static foot posture. However, its sensitivity and specificity in evaluation of the static foot posture in children have not been investigated yet.
Objective: To investigate the intra-rater reliability, sensitivity, and specificity of NTNH in evaluation of the static foot posture in children using radiographic measure as a gold standard measure.
Methods: A cross-sectional study of a random sample of 300 school children aged 6–12 years old. Intra-rater reliability, minimal detectable change, sensitivity, and specificity of NTNH were investigated. NTNH as a clinical measure of static foot posture was calculated and compared to the radiographic measure and displayed on the receiver operating characteristic (ROC) curve.
Results: NTNH demonstrated an intra-rater reliability of ICC = 0.98. The sensitivity and specificity of NTNH were 88.1% and 99.5%, respectively. The optimal cutoff point for the diagnosis of flat foot using NTNH in children aged 6–12 years is NTNH $\leq$ 0.19.
Conclusion: NTNH is a sensitive and specific measure of static foot posture in the children aged 6–12 years. It is recommended to be used as a screening measure of static foot posture in children as it is easy, simple to perform, and a non-invasive clinical measure.

Keywords: Reliability; sensitivity; specificity; normalized truncated navicular height; foot posture; children.

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Introduction

Foot is a very complex structure that has to function as a rigid lever during the push-off phase of locomotion, while the foot needs to be pliable for shock absorption. The interaction that creates functional adaptability is accomplished by means of alignment of the bones, muscles, and tendons. The foot bones move in a triplanar direction to accomplish the locking and unlocking of the foot structure. The complexity of the foot makes the investigation thereof challenging.[1]

Medial longitudinal arch (MLA) is one of the most important foot structures related to these actions because it participates in the absorption of ground forces and as a result MLA height could be used for the evaluation of foot posture.[2] Without this arched configuration, the transmitted forces at the foot would exceed the physiological weight bearing capabilities of the tarsal bones.[3] The height of MLA has been considered to be a relevant factor in injuries in the lower extremity.[4,5]

Foot posture refers to a combination of static and dynamic measurements of the foot in order to describe the foot in an overarching fashion, relating the static foot measurements with the dynamic foot function.[6] Foot posture is therefore related to the anatomy of the foot as well as to its functional role. The MLA is a critical variable in determining the foot posture.[7]

There is no single definitive method used in the literature to evaluate foot posture.[8] There are two types of measurements used in the evaluation of static foot posture; either direct or indirect measurements. Direct measurements include radiographic or ultrasound evaluation.[9] Indirect measurements include visual observation,[10] rear foot angle measurements,[11] navicular tuberosity measurements,[12] and footprint parameters.[13] Many parameters can be obtained from the footprints, including arch angle (AA), arch index (AI), Chippaux–Smirak Index (CSI),[14] and Staheli Index (SI).[15]

Radiographic techniques are regarded as the gold standard measure for assessing the skeletal alignment of the foot in a static weight bearing position. So, it can be used for the validation of the clinical measures of static foot posture.[16–18]

Validity of clinical assessment measures can be defined as an evidence that a clinical measurement technique actually measures what it is supposed to measure. Thus, it is clear that validity is a fundamental prerequisite for the usefulness of a clinical measurement technique.[19]

Sensitivity and specificity are important measures of validity of a test. Sensitivity of a test is defined as its ability to obtain a positive result when the individual is truly diseased. Specificity of a test is defined as its ability to obtain a negative result when the individual is a truly non-diseased.[20]

In fact, the radiographic measures have specific limitations such as the harmful risk of radiation exposure especially for the pediatric population, the cost, and the need for specialized practitioners. So, the development of an inexpensive, simple, non-invasive, reliable, and valid clinical method for the evaluation of static foot posture that could be used instead of the more invasive and sophisticated radiographic measures is essential not only for clinical practice, but also for the research work.[21]

The major drawback for the researchers is that the available literature about validating the clinical measures of static foot posture is limited. Furthermore, some studies had investigated young to middle-aged adults or older populations,[13,16,18,22,23] while others had studied children of certain age using only one clinical assessment measure.[24] So, these results cannot assumed to be equally valid nor standardized for the pediatric population as the pediatric foot undergoes several age-related changes till it reaches full skeletal maturation.

Normalized truncated navicular height (NTNH) is a non-invasive, easy to perform, and simple clinical measure of static foot posture.[18] However, its sensitivity and specificity in evaluation of the static foot posture in children have not been investigated yet. Therefore, this study aimed to investigate the intra-rater reliability, sensitivity, and specificity of NTNH in the children aged 6–12 years.

Methods

Sample size calculation

The sample size was calculated with a confidence level of 95% [at 5% type-1 error ($p < 0.05$)], power level of 80%, a precision of ±5% and a standard deviation (SD) of navicular height (NH) (SD = 0.4) obtained from a previous study[26] using the below formula[27]:

$$\text{Sample size} = \frac{Z^2_{1-\propto/2}\text{SD}^2}{d^2},$$

where $Z_{1-\propto/2}$ is the standard normal variate with a value of 1.96 [at 5% type-1 error ($p < 0.05$)], SD is

the standard deviation of variable obtained from a previous literature or pilot study, and d is the absolute error or precision decided by the researcher. So the sample size calculation is as follows:

$$\text{Sample size} = \frac{1.96^2 \times 0.4^2}{0.05^2} = 245.$$

A sample of 300 participants was included in the study assuming any information loss.

Participants

A random sample of 300 healthy asymptomatic (without foot or ankle pain) children aged 6–12 years was recruited from ten schools in Cairo, Egypt, using stratified random sampling method. The parents were contacted by telephone in order to confirm the agreement about participation of their children in the study and to arrange for an appointment. Before participation in the study, the children and their parents were informed about the aims, methods, and time period of the study. The parents or caregivers gave a signed informed consent for the participation of their children in the study.

The participants were excluded if they have a history of neuromuscular disorders, structural lower limb deformities, joint rheumatic pathology, history of foot or ankle injury (such as fractures, etc.), genetic conditions or syndromes affecting the gait or posture (e.g., Down syndrome), history of major surgeries in the lower limbs, peripheral vascular disorders, history of foot or ankle surgical intervention, abnormal gait pattern, foot and ankle pain during walking, or abnormal body mass index (BMI).

The participants were stratified according to their age into two subgroups of equal size ($n = 150$) from both sexes (male and female) in each group as follows: Group A contains participants aged 6–9 years old and group B contains participants aged between 9 years, 1 day and 12 years old. This study was conducted in accordance with the Declaration of Helsinki and was approved by Cairo University Human Research and Ethical Committee, Cairo, Egypt.

Measurement

Demographic data

Each participant was given an identity (ID) number. Participant's age (in years), sex, height (cm), weight (kg), and body mass index (kg/m^2) were obtained. Both weight and height were measured with the children's shoes and socks removed. Body mass index was calculated using the standard Quetelet Index (body weight divided by height squared; in kg/m^2).[28] Only participants with normal BMI were included in this study, we had followed the BMI-based classification system of childhood obesity as proposed by the International Obesity Task Force (IOTF). IOTF developed specific percentile cutoff levels for BMI by age and sex in children. This approach is based on the fact that the BMI cutoffs define overweight and obesity in children as a function of age and sex.[29] Characteristics of the study participants were displayed in Table 1.

Table 1. Demographic characteristics of the study participants.

Characteristic	Group A (6–9 years) $n = 150$	Group B (9 years, 1 day–12 years) $n = 150$	Total $n = 300$
Age (years)	7.95 ± 0.92	10.93 ± 0.94	9.44 ± 1.76
Weight (kg)	27.53 ± 2.40	37.83 ± 4.33	32.68 ± 6.23
Height (m)	1.30 ± 0.03	1.45 ± 0.07	1.38 ± 0.09
BMI (kg/m^2)	16.23 ± 0.76	17.70 ± 0.64	16.96 ± 1.01
Male	73 (48.7%)	75 (50%)	148 (49.3%)
Female	77 (51.3%)	75 (50%)	152 (50.7%)
Normal foot	49 (32.7%)	48 (32%)	97 (32.3%)
Flat arched foot	101 (67.3%)	102 (68%)	203 (67.7%)

Data are presented as mean ± standard deviation for continuous variables and as number (percentage %) for categorical variables. BMI: body mass index.

Clinical measurements of static foot posture

Measurement of static foot posture was performed for each participant using NTNH. All clinical measurements were performed by the same examiner who was blinded to the participants' identity.

Direct measurement of the highest point of MLA in the sagittal plane is one of the simplest methods of providing the clinician with quantifiable information regarding foot structure. The prominent navicular bone generally represents the highest point of MLA.[18] With the participant standing in a relaxed position, the most medial prominence of the navicular tuberosity was palpated and marked with an ink marker pen. A steel ruler was used to measure the navicular height from the ground which is defined as the perpendicular distance from the marked navicular tuberosity to the ground.

NTNH is obtained by dividing NH by the truncated foot length (the distance from the first metatarsophalangeal joint line to the most posterior aspect of the heel)[18,21] as shown in Fig. 1. The navicular height and the truncated foot length in the current study were measured in centimeters. A lower normalized navicular height ratio indicates a flatter foot. In order to address the intra-rater reliability of NTNH, clinical measurement of static foot posture for all participants was repeated one week apart.

Radiographic measurements

Radiographic techniques are considered as the gold standard measure for the assessment of skeletal alignment of the foot in a static weight bearing position[21] for the reason that the skeletal components of MLA can be clearly imaged. Furthermore, the radiographic measurements have high reliability.[22,30] Lateral radiographic view of the foot from the static weight bearing position was obtained, the calcaneal inclination angle (CIA) and talus first metatarsal angle (T1MA) were measured. These angles are chosen to represent the foot posture based on ease of measurement, good reliability, and the degree by which they reflect foot posture in the sagittal view.[30]

Lateral radiographic view was obtained using the standard procedures as described by Benedetti *et al.*[31] Each participant was asked to stand with the knee extended and feet positioned in front of the cassette. The film cassette was held vertically in a groove and in contact with the medial border of the evaluated foot. A radiography tube was directed at 90° to the film, centered on talus and at a distance of 102 cm.

Meary's angle or lateral view T1MA has been used to identify the apex of deformity in patients with *pes cavus* (high arched foot) and *pes planus* (flat foot) on the lateral weight bearing radiograph. It is the angle between the longitudinal axes and talus and the first metatarsal bone. In the normal weight bearing foot, the midline axis of the talus lies in line with the midline axis of the first metatarsal bone (Fig. 2), while, in the pronated foot the talar axis does not come in line with the midline axis of the first metatarsal bone. The normal reference range of Meary's angle is between −4° and +4°; Meary's angle > 4° (convex upward) indicates *pes cavus*; Meary's angle > −4° (convex downward) indicates *pes planus*.[32] The participants were classified as normal and flat arched feet according to the Meary's angle (Table 1).

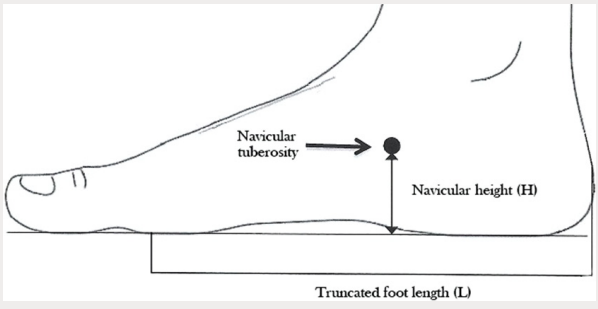

Fig. 1. Normalized truncated navicular height calculation. H: Height of the navicular tuberosity from the ground; L: truncated foot length; NTNH = H/L.

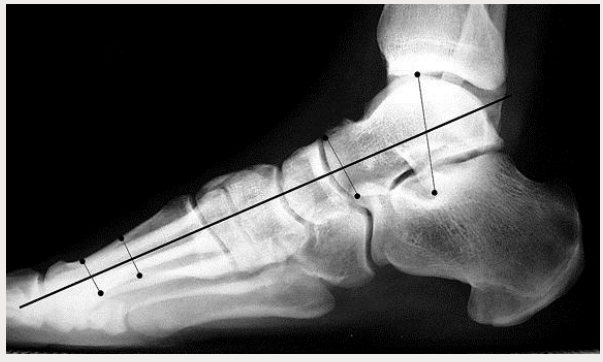

Fig. 2. Normal weight bearing lateral view talus first metatarsal angle the talar axis comes in line with the first metatarsal axis.

After obtaining the lateral radiographic view, the X-ray film was placed on the radiographic view box. A marker pen, ruler, and a protractor marked at one degree interval were used for the angular measurements. The radiographic angular measurements were done by an experienced radiologist.

Statistical analysis

To satisfy the independence assumption of statistical analysis, only a measurement from one foot was analyzed. This was confirmed by other studies[33–35] that had found no statistically relevant difference between right foot and left foot for children and adolescents as well as for adults. The right foot was chosen randomly and the measurements obtained from the right foot were analyzed for all participants.

Mean and SD were calculated for the quantitative variables, while the qualitative variables were expressed as an absolute value (n) and percentage (%). To determine the intra-rater reliability of NTNH, intra-class correlation coefficient (ICC) had been calculated (model 3,1) with 95% confidence interval (95%CI). Reliability was defined as excellent (0.75–1.00), good (0.60–0.74), fair (0.40–0.59), and poor (< 0.40).[36]

The minimum detectable changes (MDCs) at 95% confidence interval ($MDC_{95\%}$) of NTNH were calculated based on the reliability analysis. The MDC is the minimal amount of change that can be considered above the threshold of error expected in measurement. The below formulas[37] were used for calculation:

$$SEM = SD \times \sqrt{1 - ICC},$$

$$MDC_{95\%} = 1.96 \times SEM \times \sqrt{2},$$

where SEM is the standard error of measurement, ICC is the intra-class correlation coefficient value, SD is the standard deviation, and 1.96 is the value of Z-score associated with 95%CI.

Using the radiographic measure of the lateral view T1MA as a gold standard measure of static foot posture, the sensitivity and specificity of NTNH were calculated for the whole group of 300 participants.

The clinical measurement results of NTNH were displayed on the receiver operating characteristic (ROC) curve and the area under the curve (AUC) was computed. The AUC varies between 0.5 and 1 and it is commonly used as an index of the test's performance: high accuracy (> 0.9), moderate accuracy (0.7–0.9), low accuracy (0.5–0.7), or a result of chance (0.5).[23]

Another benefit of the ROC curve is helping in identifying the optimal cutoff point by balancing the sensitivity and specificity using the Youden Index. The Youden Index (J) is defined as the maximum vertical distance between the ROC curve and the chance line and is calculated from the following formula[28]:

$$J = \max[\text{sensitivity} + \text{specificity} - 1].$$

All statistical tests were conducted using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY). The statistical significance level was set at $p < 0.05$.

Results

Descriptive statistics for the studied clinical and radiographic measures are displayed in Table 2. Intra-rater reliability for NTNH was examined using ICC. NTNH demonstrated high intra-rater

Table 2. Descriptive statistics for the clinical and radiographic measures of static foot posture.

	Group A (6–9 years) ($n = 150$)		Group B (9 years, 1 day–12 years) ($n = 150$)		
Measure	Normal arched ($n = 49$)	Flat arched ($n = 101$)	Normal arched ($n = 48$)	Flat arched ($n = 102$)	Total ($n = 300$)
NH (cm)	2.4 ± 0.52	1.6 ± 0.41	3.5 ± 0.61	2.1 ± 0.11	2.4 ± 0.41
Truncated foot length (cm)	14.2 ± 2.22	14.1 ± 1.9	16.8 ± 2.13	17.1 ± 2.11	15.5 ± 2.09
NTNH	0.17 ± 0.03	0.12 ± 0.05	0.20 ± 0.04	0.12 ± 0.03	0.15 ± 0.03
T1MA (deg)	2.5 ± 1.1	−6.5 ± 2.3	3 ± 0.90	−7 ± 2.2	−2 ± 1.62

Data are presented as mean ± standard deviation. NH: navicular height; NTNH: normalized truncated navicular height; T1MA: talus first metatarsal angle (obtained from the lateral view).

Table 3. Intra-rater reliability, sensitivity, and specificity of normalized truncated navicular height.

Statistical parameter	NTNH ($n = 300$)
ICC (95%CI)	0.98 (0.97–0.99)
SEM	0.005
$MDC_{95\%}$	0.014
Sensitivity (%)	88.1
Specificity (%)	99.5
AUC (95%CI)	0.98 (0.97–0.99)
Cutoff point	≤ 0.19

ICC: intra-class correlation coefficient; 95%CI: 95% confidence interval; NTNH: normalized truncated navicular height; SEM: standard error of measurements; $MDC_{95\%}$: minimal detectable change at 95% CI; AUC: area under the ROC curve.

Table 4. Cross-tabulation of T1MA * NTNH for the study participants ($n = 300$).

			NTNH		
			N	P	Total
T1MA	N	Count	190	13	203
		% within NTNH	99.5%	11.9%	67.7%
	P	Count	1	96	97
		% within NTNH	0.5%	88.1%	32.3%
Total		Count	191	109	300
		% within NTNH	100.0%	100.0%	100.0%

TIMA: talus first metatarsal angle; NTNH: normalized truncated navicular height; P: positive result (abnormal); N: negative result (normal).

reliability with an ICC of 0.98 and 95%CI of 0.97–0.99. The SEM for NTNH was 0.005 and the $MDC_{95\%}$ was 0.014 (Table 3).

The sensitivity and specificity of NTNH were 88.1% and 99.5%, respectively, as shown in Table 3 and are illustrated in Table 4.

From the ROC curve of NTNH (Fig. 3), the AUC was 0.98 with 95%CI of 0.97–0.99. The optimal cutoff point for the diagnosis of flat arched foot in children aged 6–12 years is NTNH ≤ 0.19 (Table 3).

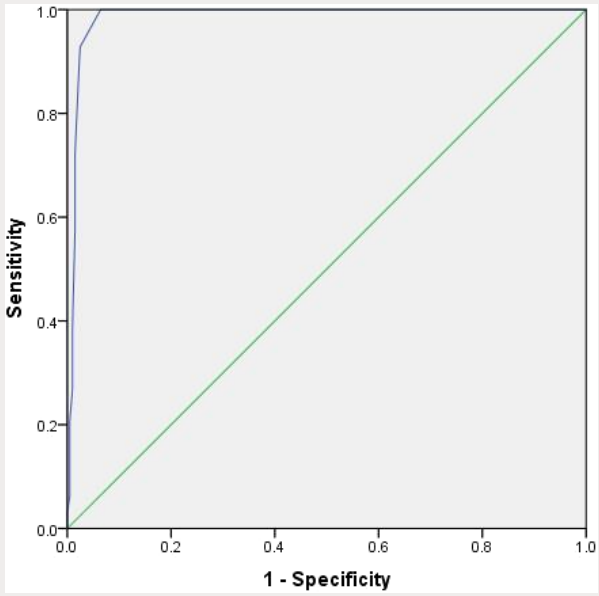

Fig. 3. ROC curve for NTNH.

Discussion

The main purpose of this study was to investigate sensitivity and specificity of NTNH as the clinical measures of static foot posture in children aged 6–12 years using the radiographic measure as a gold standard.

The first consideration before interpreting the results of sensitivity and specificity is to discuss the intra-rater (test–retest) reliability for NTNH.

NTNH had demonstrated excellent intra-rater reliability with an ICC of 0.98 and 95%CI of 0.97–0.99. The SEM for NTNH is 0.005 that indicates high reliability because SEM is an index to measure the expected variations in the observed scores due to measurement errors when repeated over time, so, the higher the reliability, the lower the SEM.[37] Moreover, the $MDC_{95\%}$ for NTNH was 0.014. Thus, a change in NTNH measurement of at least 0.014 needs to occur when the test is repeated at a confidence level of 95% such that it reflects the real NTNH measurement change and not a difference expected from measurement errors.

The current study results of intra-rater reliability were inconsistent with the previous study done by Menz *et al.*[38] in 2003; this is because they reported a moderate intra-rater reliability of normalized navicular height (NNH) with an ICC value of 0.76 in a sample of 31 participants aged 76–87 years. This could be attributed to different characteristics of the sample as they used a different age group and it is known that aging is usually associated with arthritic changes which could lead to development of foot deformities. Consequently, that should affect the foot posture.

Furthermore, Evans *et al.*[39] had reported moderate intra-rater reliability of navicular height with an ICC of 0.69 in a sample of 10 children aged four years. This may be due to the small sample size which could have an impact on the measurement results. In addition, the variable and formative nature of the navicular bone will seem to make it a difficult structure to be used in the assessment of foot posture in four-year-old children especially if the examiner was unfamiliar with the child's developing foot as the navicular bone is the last foot bone to ossify between the ages of 2 years and 5 years and navicular ossification is reported to occur later in boys than girls.[40] So, the certainty of correctly locating the navicular tuberosity in the pre-school children sometimes is adversely affected by the local soft tissue.

Xiong *et al.*[2] in 2010 had studied the medial longitudinal arch characteristics in a sample of adult participants from Hong Kong. They reported a good inter-rater reliability of NTNH with an ICC value of 0.9 which is consistent with the present study results.

To the best of our knowledge, there is a shortage of previous literature about the validity of clinical measures of static foot posture in children. The current study results revealed that NTNH is a sensitive and specific measure of static foot posture in children with a sensitivity of 88.1% and a specificity of 99.5%. Menze and Munteanu,[18] had stated that NTNH is a valid clinical measure as it demonstrated strong correlation (r-values ranges from 0.72 to 0.76) with the corresponding navicular height obtained from the radiographs in older population with a sample size of 95 participants. They based their decision upon the correlation, but they did not investigate the sensitivity, specificity, or predictive values of this clinical measure.

The ROC curve results indicates that NTNH has high accuracy level (AUC = 0.98) in the assessment of static foot posture. Moreover, the current study results demonstrated that the optimal cutoff point for the diagnosis of flat arched foot in children aged 6–12 years is NTNH $\leq$ 0.19.

The most important findings of this study are the ability to prove that NTNH can be introduced as a sensitive, specific clinical measure of static foot posture in children as well as the ability to detect the optimal cutoff point for the diagnosis of flat arched foot in children (6–12 years) using NTNH. Given our experience to date, we believe that it is much easier, more precise, and with fewer mistakes to calculate NTNH than to measure the axis of the talus, navicular, or calcaneus bone in a radiographic X-ray film.

Study limitations

The primary limitations of the current study are that a certain age group (6–12 years) in the pediatric population was studied; only participants with normal BMI were studied; also we did not investigate the inter-rater reliability, predictive values, and likelihood ratio of NTNH as clinical measures. So, these items should be addressed in the future research.

Conclusion

NTNH is a sensitive and specific measure of static foot posture in children. Therefore, NTNH can be used clinically as a screening tool for the evaluation of static foot posture or as a part of a comprehensive foot evaluation in children.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Author Contributions

Hoda A. El-Talawy, Faten H. Abdelazim and Fatma A. Hegazy conceptualized the study and substantially contributed to the design of the study, revised the manuscript, and provided the final approval of the version to be published. Emad A. Aboelnasr contributed to the design of the study, collected, analyzed, and interpreted the data, drafted the manuscript and revised it critically, and provided the final approval of the version to be published.

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Effects of muscle energy technique on pain, range of motion and function in patients with post-surgical elbow stiffness: A randomized controlled trial

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Background: Elbow is a very functional joint. Elbow stiffness is a significant cause of disability hampering the function of the upper extremity as a whole. Muscle Energy Techniques (METs) are relatively pain-free techniques used in clinical practice for restricted range of motion (ROM).
Objective: To study the effects of MET on pain, ROM and function given early in the rehabilitation in post-surgical elbow stiffness.
Methods: An RCT was conducted on 30 patients post elbow fracture fixation. Group 1 was given MET immediately post removal of immobilization while Group 2 received MET 1 week later along with the rehabilitation protocol. Pain (Visual Analogue Scale), ROM (goniometry) and function (Disability of Arm, Shoulder and Hand questionnaire) were assessed pre and post 3 weeks.
Results: Group 1 showed greater improvement than Group 2, mean flexion and extension change between groups being 11.7 ± 2.8, 95%CI(5.9,17.4) and 8.5 ± 2.0, 95%CI(4.4,12.7), respectively. VAS and DASH scores improved better in Group 1, mean change being 1.2 ± 0.2, 95%CI(0.6,1.8) and 18.2 ± 2.2, 95%CI(13.5,22.8) for VAS and DASH scores, respectively.

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Conclusion: MET can be used as an adjunct to the rehabilitation protocol to treat elbow stiffness and can be given safely in the early stages of post elbow fracture rehabilitation managed surgically with open reduction and rigid internal fixation.

Keywords: Muscle energy technique; range of motion; elbow stiffness.

Introduction

The elbow being a highly constrained synovial hinge joint has a high propensity for degeneration and stiffness. There could be functional losses seen with even less severe loss of range of motion (ROM) at the elbow. A stiff elbow has been defined as the one with loss of extension of greater than 30° and flexion of less than 120°.[1] Restriction of joint mobility is a common complication that is seen post elbow surgery.[2] This could be due to immobilization, pain, muscle guarding, etc. All these may lead to reduced joint function and may hamper the patient's ability to perform functional tasks, thereby affecting his activities of daily living.[3,4] There is controlled trauma to the tissues around the elbow post elbow surgeries. This could also cause stiffness post operatively.[1]

Anatomical reduction of the fractures should be done and active and active-assisted ROM should be initiated as early as possible so as to minimize the development of stiffness.[5] For allowing early ROM, rigid internal fixation is necessary.[6,7]

Distal humerus fractures account for 30% of all the humeral fractures.[6] Elbow stiffness could arise due to various reasons, trauma being the most common cause. There can be voluntary or involuntary muscle guarding of the elbow during motion due to prolonged pain. This could lead to contractures in the elbow joint capsule and also to the muscles around it.[1] Contractures which may develop post trauma can impair activities of daily living and may also cause functional limitations in children and adults.[8] The elbow has shown to have high chances to go into stiffness post elbow fractures. Hence, early mobilization should be encouraged for better outcomes post fracture fixation.[9]

There are different interventions which are practiced for the management of elbow stiffness which include therapeutic exercises, stretching, strengthening exercises, continuous passive motion (CPM), use of electrotherapeutic modalities, static progressive splinting, etc.[1,8,10–12] There is less evidence to support rehabilitation of elbow post elbow fractures.[12]

Effectiveness of Muscle Energy Technique (MET) and its therapeutic mechanisms lacks high quality research but recent evolving researches support the clinical use of this technique.[13] Hence, there should be additional evidence to support its therapeutic mechanism to apply this technique for various musculoskeletal conditions.

METs are soft tissue or joint techniques that are employed in the treatment of musculoskeletal dysfunctions. Post-operative pain is one of the factors that reduce the patient's compliance and does not allow optimal joint and muscle mobilization. Also, passive rehabilitation techniques may cause adverse effects to the fragile tissues in the post-operative period in elbow joint. METs are a group of relatively pain free mobilization techniques that are used to regain mobility, reduce tissue edema, reduce muscle spasm, stretch fibrous tissue and retrain stabilizing function of the intersegmentally connected muscles.[14]

According to Sherrington's law of reciprocal inhibition, hypertonic antagonists can reflexively inhibiting their agonist muscle. Therefore, in the presence of short and/or tight antagonist muscles, restoring normal muscle tone and/or length should be first addressed.[15]

MET involves the subject to voluntarily contract the muscle in a precisely controlled direction against the therapist's counter force. Its therapeutic effects are to reduce pain, reduce muscle tone, stretch tightened muscles, strengthen the weak muscles, improve local circulation and mobilize joint restrictions.[16] Johns and Wright in their study on anatomical structures that contribute to stiffness at the joint states that the joint capsule, surrounding inter-muscular fasciae and muscles, tendons and skin tissue account for restriction at the joint.[17]

Relaxation of the antagonist muscle occurs due to actively contracting the agonist muscle. This

facilitates mobility at the joint due to reciprocal inhibition.[18]

There was dearth in the literature on the use of METs in rehabilitation post elbow surgeries especially in the acute stage of rehabilitation. Hence, this study focused to see the effects with early intervention of MET and compared the effects with MET given 1 week later in the stage of rehabilitation on pain, ROM and function in patients with post-surgical elbow stiffness. Our research hypothesis was to investigate whether the group that received MET earlier did better or worse than the group which received MET later on the outcome variables in patients with post-surgical elbow stiffness.

Methods

A Randomized Controlled Trial was done in a period of 1 year and 6 months on subjects aged between 18–50 years who fulfilled the following criteria: (1) Patients with post-operative elbow stiffness after distal end extra-articular or intra-articular humerus fractures and/or proximal radius ulna fractures without any ligament injury. (2) Minimum immobilization period of 3 weeks. Patients who had pathological fractures, revision surgeries, associated ipsilateral injuries and neuro-vascular disorders were excluded from the study.

Ethical approval was sought by the Institutional Review Board of the hospital prior to the commencement of the study. A patient information sheet and an informed consent form were signed by the subjects.

Randomization

Subjects who met the inclusion criteria were randomly allocated to Group 1 or Group 2. The method of sampling used was stratified random sampling for group allotment using the chit method. Stratified randomization was done on the basis of the type of fracture. The subjects were divided into 2 strata — (1) Subjects with intra-articular fractures. (2) Subjects with extra-articular fractures. A random sample was then taken and allocated in the groups. The allocation was done by the primary investigator prior to the baseline assessment.

Outcome measures

The Visual Analogue Scale (VAS) was used to assess change in the pain intensity. Elbow ROM was measured using the universal half goniometer. Upper extremity function was assessed using the Disability of the Arm, Shoulder and Hand (DASH) questionnaire.

The VAS is a reliable and good tool and is widely used in clinical research to measure pain. Its usefulness has been validated by several researchers and is used for measuring both acute and chronic pain.[19–21]

To measure the ROM at the elbow, a universal goniometer is a simple and reliable clinical tool.[22]

The DASH is a self-administered questionnaire that can be used to measure the disability for any region in the upper limb.[23] It has an acceptable validity and sensitivity to change in case of elbow pathologies.[24]

Sample size

Sample Size was calculated using the formula[25]:

$$\text{Sample Size} = \frac{2\text{SD}^2(Z\alpha/2 + Z\beta)^2}{\delta^2}$$

SD — 3.71, Standard deviation from pilot study
$Z\alpha/2$ — 1.96 (from Z table) at type 1 error of 5%
$Z\beta$ — 0.84 (from Z table) at 80% power
$\delta^2 = 4.2$, effect size (difference between 2 mean values) from the pilot study.

$$\text{Sample Size} = \frac{2(3.71)^2(1.96 + 0.84)^2}{(4.2)^2} = 12.32$$

Thirty patients were included in the study. Fifteen patients were allotted to the Group 1 in which MET was started immediately post removal of immobilization. Fifteen patients were allotted to Group 2 in which MET was started after 1 week post removal of immobilization.

GROUP 1 Intervention: Total duration — 3 weeks, 6 days a week. Active and active assisted ROM exercises.[8,26] (1) Active flexion and extension in supine 10 repetitions × 2 sets. (2) Active assisted flexion and extension with wand 10 repetitions × 2 sets. (3) Active and active-assisted exercises for the wrist- flexion, extension, pronation, supination and shoulder flexion, extension, abduction, adduction and rotations 10 repetitions × 2 sets. (4) MET was given by a trained physiotherapist in the form of post isometric relaxation and/or reciprocal inhibition

for 6 days a week with 5–7 s hold for 8–10 repetitions followed by a gentle passive stretch post removal of immobilization.[14] Only 20% resistance was offered to the isometric contraction.

GROUP 2 Intervention: The same above-mentioned protocol was given along with MET which was started 1 week later, post removal of immobilization.

Patients were asked to report (if any) increase in pain and/or discomfort during the treatment in both the groups. A home exercise program was given to the patients of both the groups to be done twice a day.

Home exercise program

(1) Active flexion and extension in supine. (2) Active assisted flexion and extension with a wand. (3) Active and active-assisted exercises for the wrist-flexion, extension, pronation, supination and shoulder flexion, extension, abduction, adduction and rotations. All the exercises for 10 repetitions × 2 sets each.

The parameters were re-assessed pre and post 3 weeks. The assessor was blinded. Measurements were taken by another trained physiotherapist pre and post the intervention.

Statistical analysis

Data was analyzed using the IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY (IBM Corp). Level of significance was set at $p \leq 0.05$. A two-tailed test of significance test should be conducted. For pain (VAS) and function (DASH score), within the group analysis was done using the Wilcoxon Signed Rank Test and between the groups by the Mann Whitney U test. For ROM, within the group analysis was done using the paired t test and between the groups was done using the unpaired t test. The normality of the data was tested by the Kolmogrov–Smirnov test

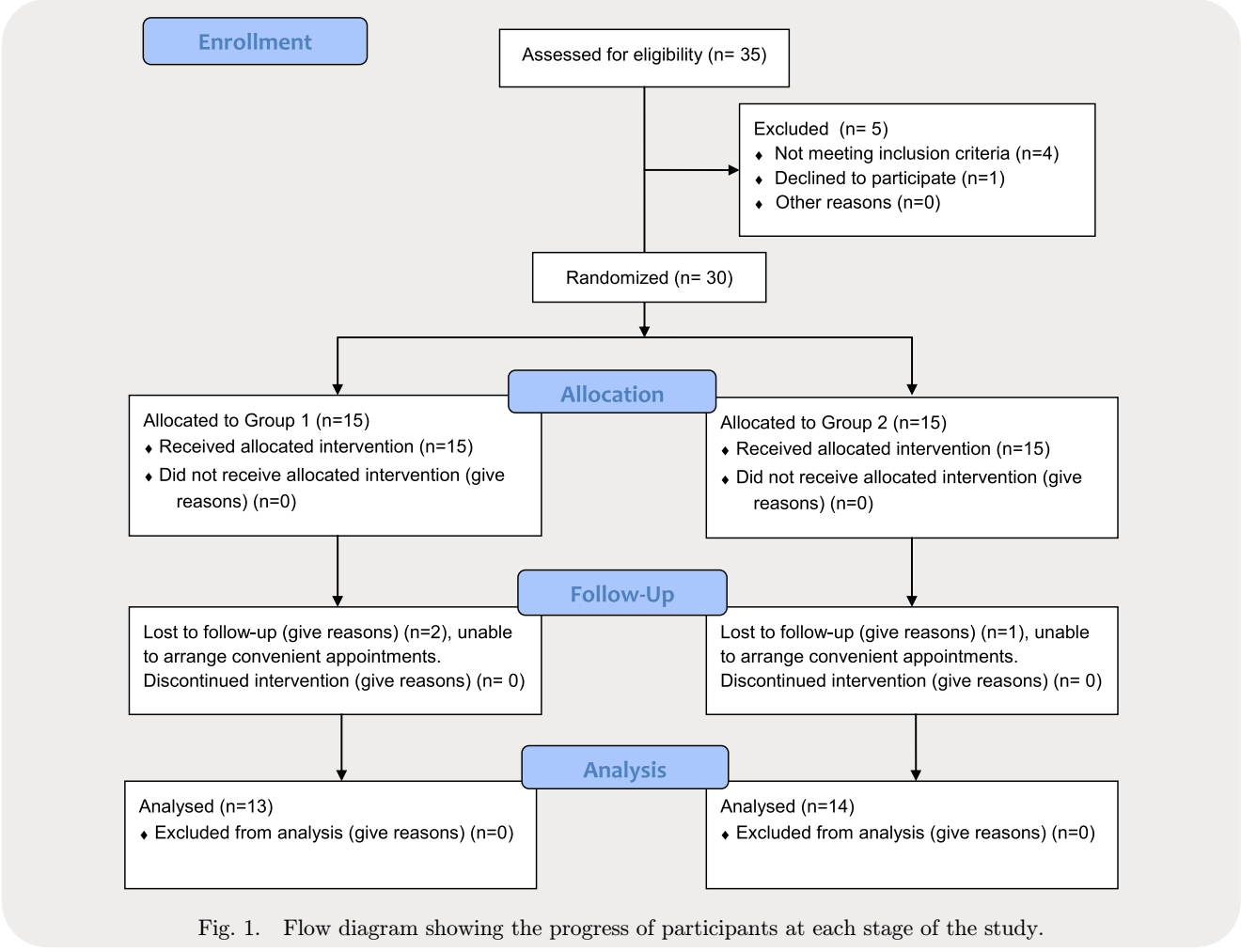

Fig. 1. Flow diagram showing the progress of participants at each stage of the study.

Table 1. Baseline characteristics of both the groups.

	Group 1 ($n = 13$)		Group 2 ($n = 14$)		
	mean	SD	mean	SD	p value
Pain (VAS)	6.6	0.7	6.9	0.9	0.2
ROM (flexion)	84.4	4.2	82.2	5	0.2
ROM (extension)	−46	7	−44	4.1	0.3
DASH score	81.9	7	87	6	0.0

Table 2. Change in pain intensity (VAS), range of motion (ROM) and function (DASH score) between the two groups.

Group	N	Mean	SD	Mean change (confidence interval)	Z value/t value	(2 tailed test) p value
Pain-group 1	13	5.6	0.9	1.2 ± 0.2, 95%CI(0.6,1.8)	−3.2	0.0013*
Pain-group 2	14	4.3	0.4			
ROM (Flexion)-group 1	13	47.8	5.7	11.7 ± 2.8, 95%CI(5.9,17.4)	4.1	0.0003*
ROM (Flexion)-group 2	14	36.1	8.4			
ROM (Extension)-group 1	13	−40.2	5.3	8.5 ± 2.0, 95%CI(4.4,12.7)	4.2	0.0002*
ROM (Extension)-group 2	14	−31.6	5.1			
DASH-group 1	13	45.9	6.7	18.2 ± 2.2, 95%CI(13.5,22.8)	−4.2	<0.00001*
DASH-group 2	14	27.7	4.7			

*$\alpha = 0.05$. The result is significant at $p < 0.05$.

and found that the data was normally distributed. Also, the Levene's test of homogeneity was used for the outcomes. The authors have used the per protocol analysis for interpreting the data.

Results

Figure 1 depicts the study profile. Thirty-five subjects were screened for eligibility. Thirty subjects were randomly assigned to Groups 1 and 2. There were 2 drop outs in Group 1 and 1 drop out in Group 2 as they could not arrange for convenient appointments. These data were not included for analysis. The intention to treat analysis was not used. Instead, per protocol analysis was used.

Table 1 represents the baseline characteristics of the groups. The groups did not differ much at the baseline.

Table 2 represents within group comparisons. There was an improvement in all the outcomes post 3 weeks in both the groups. ($p < 0.05$)

It also shows change in the pain intensity on VAS between the groups. The groups showed statistical significance with $p < 0.05$. The mean change was 1.2 ± 0.2, 95%CI(0.6,1.8) between the groups. The MCID for VAS is a 10 mm change on the 100 mm scale, thereby, showing clinical significance.[27]

Table 2 shows the change in the flexion and extension ROM between the groups. The groups showed statistical significance with $p < 0.05$. Group 1 showed greater improvement than Group 2 in ROM, mean flexion change being 11.7 ± 2.8, 95%CI(5.9,17.4) and mean extension change being 8.5 ± 2.0, 95%CI(4.4,12.7) which maybe clinically significant.

Table 2 shows the change in the DASH score between the groups. A statistical significant difference was seen with $p < 0.05$. The mean change for DASH was 18.1 ± 2.2, 95%CI(13.5,22.8) between the groups. The MCID for DASH is a 10.2 point change, thereby, indicating clinical significance.[28]

Hence, Group 1 showed greater improvement than Group 2 in pain, elbow ROM and DASH scores.

Discussion

The present study was undertaken to study the effects of MET when applied immediately post 3 weeks of immobilization and after 1 week post

removal of immobilization in elbow rehabilitation on parameters such as pain, elbow ROM and function in patients with post fracture elbow stiffness. MET was given to Group 2 after 1 week post removal of immobilization as per the protocol in the tertiary healthcare center.

MET has shown to be effective in various stages of rehabilitation. However, its application in immediate post fracture rehabilitation needed to be addressed.

In this study, during the intervention for both the groups, there were no adverse reactions i.e., increase in pain, discomfort, etc. reported on application of MET-immediate post removal of immobilization and 1 week later post removal of immobilization.

A prospective, double-blinded, randomized study was done to see the effect of isolytic contraction and passive manual stretching on pain and knee ROM post hip surgery by Parmar *et al.* MET was given as early as the 3rd post-operative day up till the 12th post-operative day along with other therapeutic exercises. The study concluded that MET was more effective in improving knee ROM in patients who had restricted knee ROM in the acute duration in post-operative hip fractures.[3] No adverse reactions were documented with application of MET in the immediate post-operative period in this study. Hence, it is safe to use MET in the early stages of fracture rehabilitation.

Effect of immobilization

In synovial joints due to deprivation of stress, there is alteration in their biomechanical, biochemical and morphological characteristics. The protean changes that saliently occur are fibrofatty proliferation of connective tissue in the joint space and its adherence to the cartilage surface, synovial fold adhesions, cartilage atrophy, cellular and fibrillar ligament disorganization, osteoclastic resorption of bone leading to weakening of the ligament insertion and Sharpey's fibers, etc.[29] The muscles surrounding the joint go into inhibition and are prone to develop tightness.

For the management of distal humerus fractures, open reduction and internal fixation are considered as the treatment of choice. Rigid internal fixation is required for allowing early ROM exercises.[6]

From this study, we infer that both the groups — Groups 1 and 2 showed improvement in the outcome variables.

Reduction in Pain

The pain intensity (VAS) reduced significantly, p value < 0.05 in both the groups pre and post 3 weeks as seen. The group in which MET was started immediately showed better improvement, p value $= 0.0013$ in the pain intensity (Table 2). The MCID for VAS is a 10 mm change on the 100 mm scale showing clinical significance. Hence, a mean difference of 1.26 observed between the groups and 5.61 and 4.35 in Groups 1 and 2 respectively is clinically significant.

The reduction in pain intensity in the groups is attributed to the hypoalgesic effects of MET which is explained by the inhibitory Golgi tendon reflex, activated during the isometric contraction that in turn leads to the reflex relaxation of the muscles. Also, the muscle and joint mechanoreceptors were activated leading to sympatho-excitation evoked by somatic afferents and localized activation of the periaqueductal gray matter. This plays a role in the descending modulation of pain.[3] On application of MET, there maybe a reduction in proinflammatory cytokines and it may also desensitize the peripheral nociceptors. Blood and lymphatic flow rates may also be affected due to rhythmic muscle contraction and there could be changes in the interstitial pressure and increase in the transcapillary blood flow.[13]

Also, the hypomobility associated with reflex muscle guarding due to pain reduced as pain reduces.

Tolerance to stretching increases as the individual's pain perception reduces on application of MET. When isometric contraction and stretching occur simultaneously, the muscle and joint proprioceptors and mechanoreceptors are stimulated more strongly than with stretching alone.[30] This could in turn possibly attenuate the sensation of pain and also make the consecutive stretch more tolerable.

Improvement in Range of Motion

This study concluded that there was an improvement in elbow ROM — both flexion and extension in both the groups.

There was a gain in the ROM for both the groups. However, Group 1 showed greater improvement than Group 2 in ROM, mean flexion change being 11.703 ± 2.80 and mean extension change being 8.587 ± 2.03 which maybe clinically significant. The p value was also < 0.05 showing statistical significance. (Table 2)

MET can be used to improve joint ROM and has an advantage over standard stretching techniques to gain early ROM in post surgically treated fracture cases.[14]

MET also showed better improvement in elbow ROM. This could be explained by the hypothesis suggested by Taylor *et al.* in their study done in 1997, suggested that a combination of contractions and stretches (as used in MET) might be more effective in producing viscoelastic changes than passive stretching alone, because the greater forces produce increased viscoelastic change and passive extensibility.[31,32] Applications of MET to increase myofascial tissue extensibility seem to affect the viscoelastic and plastic tissue property as well as the autonomic-mediated change in extracellular fluid dynamics and fibroblast mechanotransduction.[13]

Lendermanin (1997) proposed that passive stretching would elongate the parallel fibers but have little effect on the 'in series' fibers; however, the addition of an isometric contraction would place loading on these fibers to produce viscoelastic or plastic changes above and beyond that achieved by passive stretching alone.[33] Active muscle contraction has been shown to have neuro-physiological effects, including pain inhibition, thus allowing the muscles to be stretched further.[18,31]

Shyam and Parmar (2011) did various case studies in which MET was given in the rehabilitation of various types of fractures fixed with internal fixation around the elbow, wrist and knee. They had significant gain in the ROM for all the cases.[14]

Application of MET has also showed significant improvement in pain and functional status in patients with non-specific neck pain.[34]

Our results of ROM improvement are supported with a study done by Stephanie (2011) titled the immediate effects of MET on post shoulder tightness in which they concluded that a single application of MET provides significant improvement in shoulder adduction and internal rotation ROM.[35]

Active ROM, active-assisted ROM, passive ROM and stretching would have helped in improving the ROM. This is supported by MacDermid *et al.* (2015) in their study on rehabilitation post fractures around the elbow which concluded that active ROM exercises, active-assisted ROM exercises, passive ROM exercises and stretching have high consensus as components in the rehabilitation post elbow fractures.[12]

MET and active ROM exercises are one of the many treatment techniques which have been used for managing the stiff elbow.[36]

Phadke and Bedekar (2016) in their study on the effect of MET and static stretching on pain and functional disability in patients with mechanical neck pain concluded that MET was better than stretching technique in improving pain and functional disability in people with mechanical neck pain.[31]

Improvement in function

This study also states that there was an improvement in the upper extremity function in both the groups. However, there was a significant improvement in the function in Group 1 compared to Group 2 by the end of 3 weeks (Table 2). The MCID for DASH is a 10.2 change. Hence, a mean difference of 18.19 observed between the groups and 45.98 and 27.79 in group 1 and 2 respectively is clinically significant.

There was a significant reduction in pain in both the groups and improvement in elbow ROM that in turn could have improved the function of the upper extremity as a whole.

This could be supported by a study done by Sharma *et al.* in sacro-iliac joint dysfunction in which they state that MET was effective to reduce pain and reduce disability in such patients.[37]

A research done by Kucuksen *et al.* concluded MET was better than cortico-steroid injection to improve pain (VAS), pain-free grip strength and function (DASH scores) in patients with chronic lateral epicondylitis.[38]

MET has helped to reduce disability and improve function in various other conditions.[32,35]

This study suggests that MET can be used as an adjunct to the rehabilitation protocol to treat elbow stiffness and can be safely given in the early stages of post elbow fracture rehabilitation managed surgically with open reduction and rigid internal fixation.

In this study, long-term effect of the treatment intervention was not studied. Also, the authors could have used the intention to treat analysis for the lost data. Future studies can be directed to assess the long-term effect of the intervention on a larger sample size. The authors would suggest a longer duration of the intervention so as to maximize the treatment effect.

Conclusion

There was an improvement in pain, elbow ROM and function when MET was started immediately

post removal of immobilization and when MET was started a week later post removal of immobilization. However, the group in which MET was started immediately showed better improvement than the group in which MET was started a week later post removal of immobilization in pain, elbow ROM and function in post-operative patients of fractures around the elbow. MET can be used as an adjunct to the rehabilitation protocol to treat elbow stiffness and can be safely given in the early stages of post elbow fracture rehabilitation managed surgically with open reduction and rigid internal fixation.

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Conflict of Interest

The authors declare that there is no conflict of interest relavant to the study.

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Author Contribution

Study design and project management was contributed by Anood Faqih, Nilima Bedekar, Ashok Shyam and Parag Sancheti.

Data collection and analysis, manuscript writing, revision of manuscript were carried out by Anood Faqih and Nilima Bedekar.

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Quality of life after spinal cord injury in Thai individuals: A mixed-methods study

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Background: Patients with spinal cord injury (SCI) face various health-related difficulties. Physical limitations and health-related complications in individuals with SCI can lead to activity restrictions and lowering their quality of life (QoL). It is important to assess the QoL in population with SCI to gain more valuable insights into aspects of health-related QoL (HRQoL) that could play a key role in improving care for persons with SCI.
Objective: To quantitatively measure the QoL in persons with SCI in Thailand and expand the results through qualitative investigation to provide meaning, context and depth of "how" and "why" they rated, defined and addressed their QoL in that way.
Methods: The philosophical assumption of this study was set based on the post-positivist views using mixed-methods sequential explanatory design. The quantitative data were collected and analyzed in 101 Thai individuals with SCI using standardized Thai version of the Short Form Health Survey version 2 (SF-36v2), followed by the qualitative investigation of semi-structured interviews in 11 volunteers who participated in the SF-36v2 phase. Priority is given to quantitative data. The data integration occurred at the qualitative data collection through the data interpretation and discussion stage.

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Results: With regard to quantitative data, a recent study found a statistically significant difference ($p < 0.05$) in four domains for male and three domains for the female when comparing the SF-36 Thai normative data with SF-36v2 SCI data. Qualitative data revealed that the most salient themes of HRQoL in individuals with SCI were "supporting factors toward QoL" and "driving force post injury". The integration of the findings revealed that the qualitative data could individually explain and define QoL as well as support quantitative results. The connection of both findings indicated that the higher scores in psycho-social variables and lower scores in physical domains of SF-36v2 in Thai persons with SCI may be due to unique Thai family traditions and community values.
Conclusion: The scores on SF-36v2 and the replies in the qualitative investigation of QoL themes of Thai individuals with SCI were similar to those of other research, but this study is unique in that it specifically represents the Thai socio-environmental-cultural aspects.

Keywords: Spinal cord injury; mixed-methods research; quality of life; Thai.

Introduction

Patients with spinal cord injury (SCI) face various health-related difficulties.[1,2] These problems, including loss of sensation, the impaired function below the lesion to the spinal cord, increased rate of secondary complications (such as incontinence and pressure sores) and emotional problems (such as depression and anxiety),[2–4] affect them physically and mentally in all aspects of their lives.[1–4] Recent medical advancements and improved care mean that individuals with SCI have a greater life expectancy after injury[5]; consequently, the primary goal is to enable them to have a satisfactory quality of life (QoL).[6]

QoL is a complicated term, encompassing the individual's physical–psychological health and well-being, social participation, level of independence, and relationships with other people, as well as the substantial characteristics of the vicinities.[7] Because the different levels of physical limitations and related complications in individuals with SCI can lead to activity restrictions,[8] it is important to assess the QoL in this population. One of the health-related QoL (HRQoL) instruments most extensively used to evaluate the HRQoL in persons with SCI is the Medical Outcomes Study 36-item Short Form Health Survey, known as the SF-36,[9] which consists of 36 questions covering eight health domains: physical functioning, role limitations due to physical health problems, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems and mental health (psychological distress and psychological well-being).[10] These eight dimensions can be collapsed to create a psychometrically reached assessment based on the physical component score (PCS) and mental component score (MCS). This SF-36 has undergone extensive psychometric validation against different groups,[11] including patients with SCI.[12–15]

Many researchers have identified a complicated relationship between HRQoL and physical impairment, showing that there was a significant difference between individuals with SCI and the general population in terms of physical health; however, they found no large differences between these two groups when evaluating perspectives on QoL,[15] possibly because perspectives on physical health and QoL vary between healthy people and people with disability.[16] In addition, QoL in patients with SCI also has a significant association with the presence of secondary complications and the extent of societal participation but not with the level and completeness of injury.[17]

These findings suggest that QoL for patients with SCI seems to be a multidimensional structure (for example, personal to national level) influenced by several variables (for example, individual to socioeconomic factors).[16] Therefore, studies that have utilized a single method (qualitative or quantitative alone) to assess QoL in subjects with SCI have found a lack of information regarding some health aspects for subjects recruited in a clinical setting.[18–20] Quantitative data alone may only provide an overall statistical picture of QoL while qualitative investigation alone may only enable in-depth investigation of the reasons for QoL to be collected. It is clearly seen that there is a need for more research to bridge the gaps between these health issues using mixed-methods research,[21–23] in order to increase the comprehensiveness of the overall findings and gain more

valuable insights into the aspects of HRQoL and the interplay among psychosocial variables and physical functioning that could play a key role in improving care for persons with SCI.[1,18–20,24]

The mixed-methods sequential explanatory design was applied in this study which provides two specific benefits. First, if the quantitative findings yield unexpected results, then qualitative elaboration could be performed to explain those phenomena. Second, non-statistically significant findings from SF-36v2 are generally found between different demographics of interviewees. The research that uses SF-36v2 should be able to identify the reasons behind the difference of QoL scores. The best approach to capture aspects that influence the difference in their QoL scores is by adding qualitative methods into the study.[1,18–22,24,25]

The purposes of this work were to quantitatively measure the QoL in persons with SCI in Thailand using SF-36v2[25] and expand the results through qualitative investigation, using semi-structural interview, to provide meaning, context and depth of "how" and "why" they rated, defined and addressed their QoL in that way.

Methods

This study adopted the post-positivist views[23] as a philosophical assumption and used mixed-methods sequential explanatory design[21,22] to quantitatively and qualitatively retrieve data regarding the QoL in individuals with SCI in Thailand. The priority was given to quantitative data where qualitative data provided meaning and context to the initial findings (although more qualitative details were present in this study).[21–23] To ensure that the qualitative and quantitative aspects of the study were connected, integrated, investigated, and analyzed with rigor, the following processes were adopted. Data analysis was connected and the data integration occurred at the qualitative data collection through the data interpretation and discussion stage.[22,23] To minimize threats to a study's rigor, as recommended by Refs. 21 and 22, in a study in which results from the quantitative analysis connected to the qualitative data collection and analysis, the subsequent qualitative interviews were performed in volunteers with SCI who participated in the quantitative SF-36v2. Processes of collecting and analyzing the data were shown in Fig. 1.

Participants

Between March and May 2016, volunteers with SCI from different venues such as Sirindhorn National Medical Rehabilitation Institute (SNMRI), Bangpoon Rehabilitation Centre, the Redemptorist Vocational School for People with Disabilities and the Thai SCI Network were invited to enroll in the present study. To increase the number of participants with SCI, the snowball sampling method was used, with the study coordinator contacting individuals with SCI who were referred by hospital staff together with other volunteers with SCI who also joined the present study. Individuals were eligible to take part in the

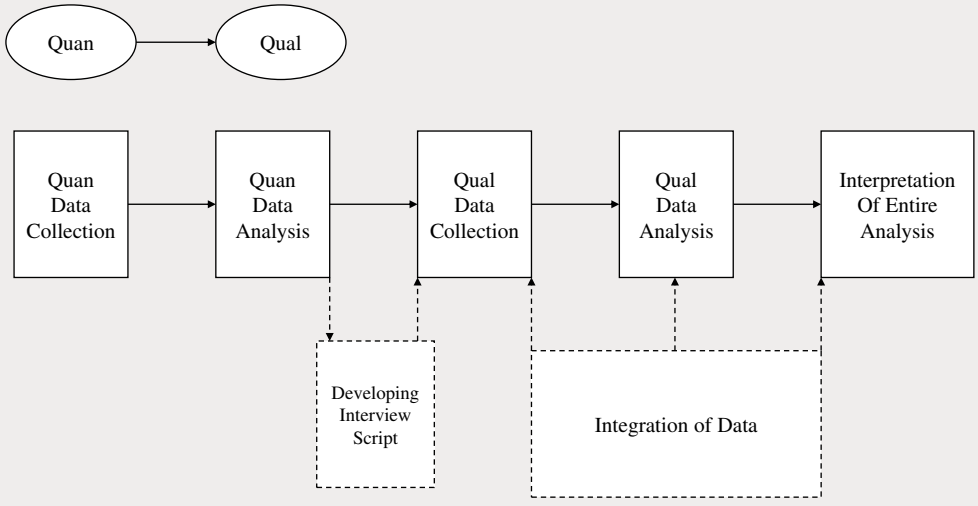


Fig. 1. The mixed-methods sequential explanatory design. Quan = Quantitative; Qual = Qualitative.

research if they (1) were diagnosed as having SCI for more than 12 months (regardless of the cause of injury or the level of completeness), and (2) were able to communicate in Thai. Exclusions were people with a diagnosis of severe cognitive impairment; living in a long-term care facility; or continuing under medical care requiring hospitalization. One hundred and one volunteers with SCI who agreed to participate in the study were contacted by telephone to arrange face-to-face interviews at their convenience using the SF-36v2. All participants with SCI were required to sign the quantitative part of the consent form.

With regard to the qualitative component of the study, of the 101 participants who took part in the SF-36v2 interview, only 11 volunteered to engage in this additional interview (Appendix A). Of these 11 participants, 5 were living in their own accommodation (4 quadriplegias and 1 paraplegia — all employed), and the other 6 were staying at a rehabilitation center or boarding school for the disabled (all were paraplegic patients and unemployed); 8 were male and 3 were female; their ages ranged from 20 to 46; and their average length of time since injury was 8.73 years (between 3 and 26 years). Cause of injury included car accidents, gunshots, falls, and work accidents. They were asked to sign the qualitative part of the consent form before undergoing the semi-structured interview. The study was approved by the SNMRI ethics committee.

Measures and protocol

SF-36v2 questionnaires

The Thai version of the standardized SF-36v2 was used as a standard measure of HRQoL.[9] The SF-36v2 examined various perspectives of health comprising function and dysfunction, distress and well-being, and favorable and unfavorable ratings of each individual's overall health status. The eight subscales were Physical functioning (PF; 10 items), Role functioning-physical (RP; 4 items), Bodily pain (BP; 2 items), General health (GH; 5 items), Vitality (VT; 4 items), Social functioning (SF; 2 items), Role functioning-emotional (RE; 3 items), and Mental health (MH; 5 items).[10] The scores were on a scale of 0–100 with higher scores representing more favorable health status.[9,10] SF-36v2 values of participants from different sociodemographic and disability-related backgrounds were compared.

Semi-structured interviews

For the qualitative part of this study, semi-structured interviews were used to elicit data relating to individuals' perspectives on HRQoL. The prepared questions are shown in Table 1. These questions were modified from the study by Manns and Chad[26] in combination with the results derived from the quantitative part of this research in order to gain more understanding of HRQoL in persons with SCI. Therefore, the data integration occurred at this stage throughout the qualitative analysis (Fig. 1). The semi-structured interview allowed participants to discuss each issue freely based on their own experiences.[27] This participant-focused approach simplifies exclusive and unexpected insights that fall outside a researcher's pre-prescribed hypotheses and questionnaire-driven queries. In addition, the relaxed and loose structure of the interview enables the interviewer to address a

Table 1. Semi-structured interview guide.

(1)	How long have you been living with SCI? (Please describe your functional limitations.)
(2)	How does the SCI affect your life (and QoL)?
(3)	How do you rate your QoL from 0 to 10? (0 means very bad and 10 means excellent) Why do you give yourself those scores?
(4)	What do you think the QoL means? And what things are important to your life (and QoL)?
(5)	How does SCI affect how good your life is (important parts of your life)?
(6)	Does an SCI prevent you from having complete satisfaction in these areas (physical functions, emotional, safe care, relationship with others, occupation, life satisfaction, achievement, social participation and acceptation, traveling and other topics)?
(7)	Since injury, how has your life changed or how is it changing? (How do you manage to cope with those changes?)
(8)	How has the SCI changed your life, the way you think, the goal in your life and perspective toward your surrounding?

wide conceptual framework[28]; for instance, questions were broadly framed around perceived changes in QoL after injury. Open questions — such as "How does the SCI affect your life?" — encourage participants to offer extended responses, therefore providing rich data. In cases where such rich data were not forthcoming, a series of curiosity-driven questions were called to prompt participants to supply further details (e.g., "How did that make you feel?" "Can you tell me more about that?").[27]

Interviews were conducted face-to-face by a trained qualitative researcher (AE), in a place which was convenient for the participant. Face-to-face interviews allow the interviewer to build trust between researcher and participant, thereby encouraging the sharing of feelings and sensitive thoughts. In order to encourage participants to elaborate on their personal experience, it is important to establish a quality relationship.[27] Interviews lasted between 60 and 80 min and were all digitally recorded and transcribed verbatim. Subsequently, the interview data underwent thematic analysis.[28]

Analyses

Quantitative analyses

The data from the SF-36v2 questionnaire were analyzed by comparing the SF-36v2 scores of demographic and diagnosis variables of SCI subgroups. HRQoL data were presented as descriptive data including proportions, means and standard deviation (SD) with higher scores on each aspect indicating better HRQoL. Data analysis was conducted using the Health Outcomes Scoring Software version 4.5. The demographic and diagnostic variables between SCI subgroups were tested; independent *t*-tests were used to compare the mean scores between two levels of demographic and diagnostic variables while one-way ANOVA followed by Bonferroni *post-hoc* test was used to compare the mean scores of those variables with more than two levels. Moreover, two-sample *t*-test for mean and SD was used to compare the scores in eight domains of SF-36 Thai normative data[29] compared with SF-36v2 SCI data. Analyses were conducted using SPSS statistical software. A significance level of 5% ($p \leq 0.05$) was used for all tests. Any notable trends found in this process were then used to construct semi-structured interview questions, the results of which were presented within the qualitative results.

Qualitative analysis

Thematic analysis was used to make a systematic exploration of the transcribed data (Appendix B). This method allows a researcher to generate information based on personal experience into conceptual themes from the interviewed data. We adopted a thematic analysis technique used by Braun and Clark[28] which involves six phases of data analysis: familiarization with the transcribed data, coding all relevant data, generating potential themes from codes, making a thematic map, defining the themes' names and producing a scholarly report. In principle, when new analytical connections and insights surface during the writing stage, previous phases can be altered accordingly.

Results

Quantitative results

Sociodemographic and disability-related background characteristics of the participants are presented in Table 2. The data were compared and presented even the statistically significant different was not reached ($p \leq 0.05$). This was due to the nature of SF-36v2 that the lower scores on each aspect already indicating poorer of HRQoL. Therefore, the exploration of non-statistically significant difference data might lead to more insightful of the HRQoL in persons with SCI when combining its results with the qualitative investigation. The gender difference was clear that no statistically significant difference was found in this demographic but in general comparison, women scored higher than men in seven aspects (Table 2). A comparison of the ages of interviewees revealed that those who were aged 20 years and younger scored the highest with respect to PF, RP, BP (20 years and younger age group scored significantly higher than 20–40 age group, $p = 0.01$), GH and SF while those aged 41 and older scored highest in VT, RE (41 years and older scored significantly higher than 20–40 age group, $p = 0.01$) and MH (Table 2). Age at injury made a difference when assessing QoL, with those who were injured at a younger age ($\leq$ 20 years old) reporting better scores in all eight SF-36v2 domains (with the only significant high score in PF, $p = 0.009$) (Table 2).

Table 2. Comparisons of demographic and diagnostic variables between SCI subgroups.

Groups		N(%)	PF Mean (SD)	RP Mean (SD)	BP Mean (SD)	GH Mean (SD)	VT Mean (SD)	SF Mean (SD)	RE Mean (SD)	MH Mean (D)
Gender	Male	80 (79.21%)	37.38 (21.21)	58.36 (29.59)	55.75 (25.95)	55.70 (21.00)	66.09 (12.61)	74.22 (21.08)	72.81 (27.46)	69.69 (12.92)
	Female	21 (20.79%)	38.33 (25.21)	65.48 (29.62)	66.29 (24.94)	59.81 (19.60)	66.67 (17.49)	82.74 (18.32)	82.54 (21.07)	66.43 (19.57)
	p		0.860	0.329	0.098	0.421	0.865	0.094	0.156	0.385
Age at time of interview	(1) Age $\leq$ 20	7 (6.93%)	42.86 (14.10)	60.71 (30.12)	82.71 (18.54)	71.14 (14.53)	66.96 (9.35)	89.29 (15.19)	81.48 (33.01)	65.00 (15.54)
	(2) Age 20–40	69 (68.32%)	40.65 (22.35)	59.06 (26.31)	53.10 (23.14)	55.13 (20.10)	65.58 (13.24)	74.45 (19.93)	70.65 (25.34)	68.47 (15.20)
	(3) Age $\geq$ 41	25 (24.75%)	27.60 (20.16)	61.75 (38.16)	64.36 (30.32)	56.40 (22.76)	67.75 (16.00)	76.50 (23.47)	86.00 (24.26)	71.60 (15.39)
	p		[1,2] 1.000	[1,2] 1.000	[1,2] 0.010*	[1,2] 0.155	[1,2] 1.000	[1,2] 0.060	[1,2] 0.298	[1,2] 1.000
			[1,3] 0.297	[1,3] 1.000	[1,3] 0.262	[1,3] 0.287	[1,3] 1.000	[1,3] 0.185	[1,3] 1.000	[1,3] 0.944
			[2,3] 0.031*	[2,3] 1.000	[2,3] 0.166	[2,3] 1.000	[2,3] 1.000	[2,3] 1.000	[2,3] 0.010*	[2,3] 1.000
Age at injury	Age $\leq$ 20	39 (38.61%)	44.74 (22.36)	61.86 (26.43)	60.08 (24.54)	58.13 (22.17)	67.47 (10.84)	80.45 (17.40)	79.06 (27.30)	69.10 (13.95)
	Age $>$ 20	62 (61.39%)	33.07 (20.65)	58.57 (31.57)	56.60 (26.95)	55.57 (19.83)	65.42 (15.21)	73.19 (22.27)	72.18 (25.78)	68.95 (16.07)
	p		0.009*	0.589	0.515	0.547	0.467	0.144	0.120	0.962
Time since injury	Time $\leq$ 4 years	26 (25.74%)	31.15 (21.09)	45.19 (32.13)	56.96 (29.32)	58.12 (18.52)	68.03 (16.52)	72.12 (24.83)	68.27 (24.72)	70.19 (14.46)
	Time $>$ 4 years	75 (74.26%)	39.80 (21.97)	64.92 (27.09)	58.28 (24.92)	56.01 (21.48)	65.58 (12.60)	77.33 (19.13)	77.11 (26.82)	68.60 (15.54)
	p		0.084	0.003*	0.825	0.658	0.435	0.451	0.068	0.648
Neurological classification	(1) Quadriplegia ASIA A, B, C	22 (21.78%)	16.36 (13.02)	56.25 (35.88)	56.86 (26.34)	55.27 (20.90)	70.46 (17.16)	75.00 (21.48)	77.65 (27.51)	72.50 (15.02)
	(2) Paraplegia ASIA A, B, C	64 (63.37%)	40.55 (17.87)	63.57 (27.09)	57.81 (26.99)	55.94 (20.51)	63.38 (11.57)	76.76 (20.64)	73.31 (27.10)	67.89 (15.45)
	(3) All level ASIA D, E	15 (14.85%)	56.00 (25.44)	49.17 (28.63)	60.07 (22.27)	61.07 (21.97)	72.08 (13.75)	74.17 (21.37)	77.22 (23.03)	68.67 (14.70)
	p	88.89	[1,2] 0.000*	[1,2] 0.948	[1,2] 1.000	[1,2] 1.000	[1,2] 0.100	[1,2] 1.000	[1,2] 1.000	[1,2] 0.673
			[1,3] 0.000*	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000
			[2,3] 0.012*	[2,3] 0.272	[2,3] 1.000	[2,3] 1.000	[2,3] 0.073	[2,3] 1.000	[2,3] 1.000	[2,3] 1.000

Table 2. (*Continued*)

	Groups	*N*(%)	PF Mean (SD)	RP Mean (SD)	BP Mean (SD)	GH Mean (SD)	VT Mean (SD)	SF Mean (SD)	RE Mean (SD)	MH Mean (D)
Employment	Employed full/part time	27 (26.73%)	33.80 (26.07)	75.75 (29.99)	58.04(26.46)	59.72 (18.28)	69.00 (12.56)	80.50 (20.44)	86.67 (22.57)	68.20 (17.96)
	Unemployed/ retired/student	74 (73.27%)	38.82 (20.49)	54.61 (27.71)	57.91(25.99)	55.51 (21.43)	65.30 (13.97)	74.51 (20.76)	70.94 (26.62)	69.28 (14.32)
	p		0.173	0.009*	0.693	0.529	0.376	0.337	0.003*	0.832
Resident	(1) Home with PA	40 (39.60%)	36.13 (22.74)	66.25 (29.88)	63.53 (25.97)	58.05(20.92)	69.22 (15.59)	80.63 (20.21)	82.08 (22.29)	70.88 (18.81)
	(2) Home without PA	3 (2.97%)	48.33 (22.55)	62.50 (34.80)	34.33 (24.79)	63.00(16.37)	52.08 (13.01)	87.50 (21.65)	66.67 (28.87)	65.00 (5.00)
	(3) Disabled institute with PA	6 (5.94%)	20.00 (7.07)	61.46 (32.93)	64.83 (36.80)	62.67 (9.26)	72.92 (16.62)	66.67 (25.82)	54.17 (39.35)	71.67 (12.91)
	(4) Disabled institute without PA	52 (51.49%)	40.10 (21.79)	54.57 (28.63)	54.21 (23.95)	54.33 (21.73)	63.94 (10.88)	72.84 (20.07)	72.12 (26.55)	67.50 (12.62)
	p		[1,2] 1.000	[1,2] 1.000	[1,2] 0.358	[1,2] 1.000	[1,2] 0.204	[1,2] 1.000	[1,2] 0.262	[1,2] 1.000
			[1,3] 0.557	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000	[1,3] 1.000	[1,3] 0.135	[1,3] 0.014*	[1,3] 1.000
			[1,4] 1.000	[1,4] 0.377	[1,4] 0.521	[1,4] 1.000	[1,4] 0.375	[1,4] 0.069	[1,4] 0.059	[1,4] 1.000
			[2,3] 0.407	[2,3] 1.000	[2,3] 0.571	[2,3] 1.000	[2,3] 0.175	[2,3] 0.279	[2,3] 0.644	[2,3] 1.000
			[2,4] 1.000	[2,4] 1.000	[2,4] 1.000	[2,4] 1.000	[2,4] 0.821	[2,4] 0.226	[2,4] 0.731	[2,4] 1.000
			[3,4] 0.205	[3,4] 1.000	[3,4] 1.000	[3,4] 1.000	[3,4] 0.727	[3,4] 0.491	[3,4] 0.142	[3,4] 1.000

Notes: *The mean scores are significantly different between the levels of demographic and diagnostic variables ($p < 0.05$). [_,_] pair of levels from multiple comparisons.

QoL scores on GH, VT and RE were higher in subgroups with less time since injury (time ≤ four years). However, the significant difference was only found in RP where people with SCI who had the higher number of time since injury show higher score than those who had lesser number of time since injury ($p = 0.003$) (Table 2). With regard to the impact of the type of injury, patients with quadriplegia scored higher on RE and MH while patients with paraplegia scored higher on RP and SF, and the scores in other SF-36v2 domains were highest in patients with ASIA score D or E (statistically significant difference found in PF; $p \leq 0.05$) (Table 2). Higher scores were found in five SF-36v2 domains — RP (statistically significant difference found; $p = 0.009$), BP, GH, VT, SF and RE (statistically significant difference found; $p = 0.003$) — among those who were employed (Table 2) while patients with SCI who lived at home with a personal assistant (PA) showed higher scores in RP and RE (statistically significant difference found that home with PA > disabled institute with PA; $p = 0.014$). Higher scores were not found in those who lived in a rehabilitation center, boarding school or disabled institute without a PA (Table 2).

Table 3 compares the scores of eight SF-36 subscales of Thai normative data[26] and SF-36v2 SCI data from this study, dividing the data by gender. Women with SCI had lower scores on five SF-36v2 subscales: PF (38.33 versus 72.25, $p = 0.0001$); RP (65.48 versus 83.74, $p = 0.022$); BP (66.29 versus 72.42); GH (59.81 versus 63.72); and MH (66.43 versus 71.06). Men with SCI had lower scores on six SF-36v2 subscales: PF (37.38 versus 72.98, $p = 0.0001$); RP (58.36 versus 79.59, $p = 0.0001$); BP (55.75 versus 68.29, $p = 0.0001$); GH (55.70 versus 63.11, $p = 0.0004$); RM (72.81 versus 73.47); and MH (69.69 versus 70.47). Both men and women with SCI had higher scores on VT and SF (women, $p = 0.0001$) while only women with SCI had a higher score on RE (78.32 versus 82.54).

Qualitative results

The themes that arose from the data were overlapping and interdependent (Fig. 2). Among various topics discussed during the interviews, the following were recognized as being the two most salient themes of HRQoL in individuals with SCI: "supporting factors toward QoL" and "driving force post injury". The first theme, "supporting factors toward QoL", had constituent subthemes of "having a paid occupation", "having a PA", "enabling environment", "stigma" and "self-advocacy". The second theme, "driving force post injury", consisted of sub-themes of "self-image", "freedom mobility" and "dignity and life"s goal". The sequential exploration of quantitative data is interlaced through these themes. Some data extraction from the transcribed interview was presented in Appendix C.

Supporting Factors toward QoL: This theme comprises a variety of aspects that alter the QoL of individuals with SCI. Many participants acknowledged that these five sub-themes, "having paid occupation", "having PA", "enabling environment", "stigma" and "self-knowledge", are strongly connected with "what patients with SCI must have to have a good life after injury" and appeared to be the most frequent and potent aspects to arise from the transcripts obtained from the individuals with SCI in this study.

Having Paid Occupation: All persons interviewed reported the importance of having a paid occupation for QoL. Having a job for them meant their financial situation was secure and allowed them an opportunity to be more active.

"*I would like to have some work, or at least have something to do. Like umm … being able to get out, or something like that, so that I can stay in touch with the outside world. Because if I just stay inside doing nothing exciting, life will get too stressful.*" (Interviewee 6: unemployed-male-paraplegia)

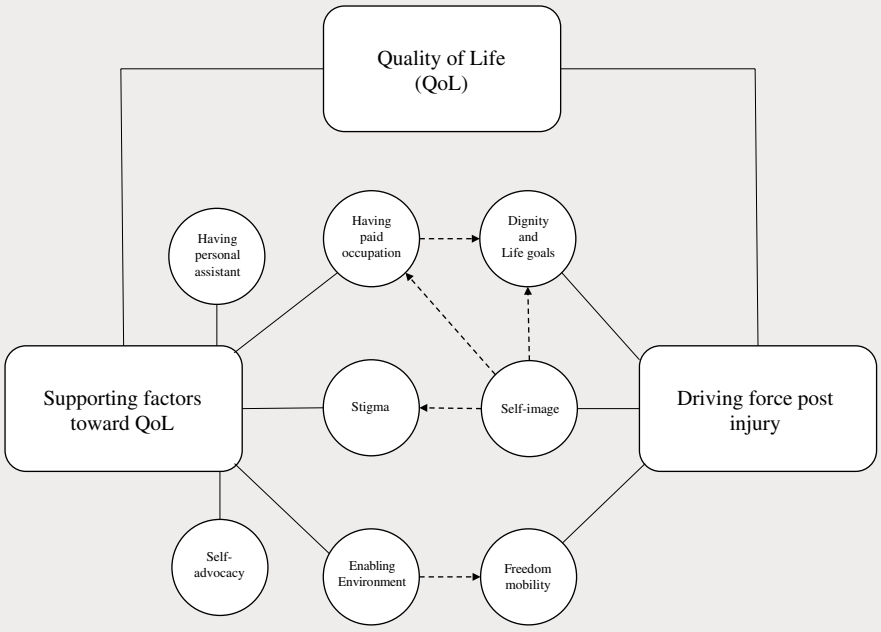
They all assumed that a stable income from a paid job would positively influence their level of independence so that they would be able to be self-reliant when money was needed for health care costs, assistive equipment, and services such as a PA. The respondents wanted to be less dependent on family and government support, and they stated that having a job was desirable not only for the financial stability it offered but also for its attendant self-esteem which they felt also led to a significant reduction in the anxiety suffered by their family members.

Having PA: A PA in this investigation was defined as a person who stayed close to the participant to help them with self-care, work, and activities of daily living in order to ensure that they could live independently and develop self-determination and control over their own lives. A PA could be either someone that the participant hired

Table 3. Mean (SD) scores in eight domains of SF-36 Thai normative data compared with SF-36v2 SCI data.

		Male					Female				
Domains	Lower scores indicate	SF-36 Thai normative $N = 436$	SF-36v2 SCI $N = 80$	t	p	ES	SF-36 Thai normative $N = 721$	SF-36v2 SCI $N = 21$	t	p	ES
Physical functioning	Limitations in physical activities	72.98 (20.84)	37.38 (21.21)	14.01	0.0001*	2.54	72.25 (21.25)	38.33 (25.21)	7.17	0.0001*	4.73
Role physical	Problems with daily activities/work due to physical health	79.59 (28.40)	58.36 (29.59)	6.11	0.0001*	3.48	83.74 (26.11)	65.48 (29.62)	2.29	0.0220*	7.96
Bodily pain	Limiting pain	68.29 (18.84)	55.75 (25.95)	5.13	0.0001*	2.44	72.42 (18.59)	66.29 (24.94)	1.47	0.1410	4.16
General health	Feelings of unsatisfying in health, likely to get worse	63.11 (16.12)	55.70 (21.00)	3.59	0.0004*	2.06	63.72 (17.30)	59.81 (19.60)	1.02	0.3095	3.84
Vitality	Feelings of fatigue	64.06 (13.94)	66.09 (12.61)	1.21	0.2252	1.67	63.17 (13.83)	66.67 (17.49)	1.13	0.2571	3.09
Social functioning	Interference with normal social activities due to physical/emotional problems	70.53 (19.61)	74.22 (21.08)	1.53	0.1269	2.41	65.68 (19.76)	82.74 (18.32)	3.91	0.0001*	4.37
Role emotional	Problems with daily activities/work due to emotional problems	73.47 (33.63)	72.81 (27.46)	0.17	0.8685	3.98	78.32 (32.02)	82.54 (21.07)	0.60	0.5487	7.03
Mental health	Feelings of nervousness and depression	70.47 (14.72)	69.69 (12.92)	0.44	0.6575	1.76	71.06 (14.35)	66.43 (19.57)	1.44	0.1501	3.21

Note: *The mean scores are significantly different between SF-36 Thai normative and SF-36v2 SCI ($p < 0.05$).



Note: Straight line = having connection/relationship between themes and sub-themes; Arrowhead = one having an influence on others.

Fig. 2. Visual representation of the themes and sub-themes of HRQoL in individuals with SCI.

or a family member. A PA had a greater effect on the QoL of persons with quadriplegia than on those with paraplegia. All participants with quadriplegia in this interview hired a live-in PA; for them, a PA was the most important factor in their life after injury.

"*Let's say if my arm was alright, it seems to me that my life would not be problematic, but I cannot help myself, and I have to wait for others to aid me. I need a personal assistant.*" (Interviewee 2: employed-male-quadriplegia)

Participants with paraplegia (most of whom were living in either rehabilitation centers or boarding schools for the disabled), required assistance from family members only when they were at home. This is because their homes were not modified for people with disabilities and some of them said their family requested them not to do anything and kept telling them that if they did want to do something, the family would do it for them.

Enabling Environment: The sub-theme of enabling environment refers to the physical accessibility or inaccessibility of the home, work, public transport or leisure facilities and its consequences for QoL. All participants reported that they could not overcome commuting problems. Lack of accessibility to facilities in Bangkok (and almost everywhere in Thailand), for example, the abundance of inaccessible locations, limited or unsupported transportation and geographical distance were found to be insuperable obstacles. Some participants encountered rejection from their family or landlord when the idea of environmental adjustment was proposed.

"*Right now I'm renting a house, and I asked the house owner for permission to build a new restroom door, but he didn't allow it. The door right now is too small; the wheelchair cannot enter, and that makes me feel uncomfortable, and I don't want to stay there. The problem is that my mom and relatives don't want to move out, and I cannot walk. I can't do anything about it, so I have to live with this hardship.*" (Interviewee 6: unemployed-male-paraplegia)

All participants who were living in rehabilitation centers or boarding schools for the disabled felt that it was more convenient to stay in institutions for people with disability. They could be totally independent there because the environment was adapted to serve people with a movement disorder.

Stigma: The term *stigma* in this context means the attitude that the individuals with SCI think other people have toward them as people with disability. The presence of stigma makes them feel inferior, incompetent and inadequate, and all respondents said that this had a negative influence on their QoL.

"*They still consider people with disability as those who are unable to help themselves, worthless*

individuals who must be taken care of all the time, or even burdens. Yes, burdens on society. Like, why do they come outside? I was once at a walking street at Chiangmai. I saw some pedestrians glancing at me, as if to say, why on earth do you come out, why don't you just stay at home? Something like that." (Interviewee 4: employed-female-quadriplegia)

Self-advocacy: The term *self-advocacy* in this study means knowledge of yourself, knowing what you need and how to get it. It also includes learning about self-determination and making your own decisions in life. Participants stated that self-advocacy was the foundation for taking self-determined actions which gave them the ability to gain self-awareness and understand their own strengths, weaknesses, interests, preferences, and needs. They stated that self-advocacy was the knowledge and skill contributing to a good life after SCI. The participants said that they initially developed their self-advocacy by seeking information about self-care from disabled peers, health care professionals, and social internet networks.

"*My level of disability is severe. I can't help myself. Everyone has bedsores and I am no exception. At first, I didn't realize and had no knowledge of it. They (bedsores) caused me a lot of problems, and it was difficult to recover. I asked for advice from other disabled friends, but would you believe that five people gave me five different pieces of advice? I was wondering what on earth was happening to me?*" (Interviewee 1: employed-female-quadriplegia)

Driving Force Post Injury: Driving force post injury in this context refers to the individuals' motivation based on their personal circumstances and particular vision of how things could be. It emerged after the participants accepted another form of self after their injury. The interviews revealed three motive themes that affected the QoL of persons with SCI in this study: self-image, freedom mobility, and dignity and life goals.

Self-image: The participants stated that their health, disabilities, and financial situations made it difficult to maintain a positive self-image and self-esteem. However, they embraced the fact that self-image and self-esteem are important for their well-being and QoL because feeling good about themselves can positively affect other aspects of life and other people around them. All participants said that they want to be seen as positively capable persons.

"*Let's say I like dressing up. If I only dress up in my house, then what's the point? No one sees me. And it's like when other people talk to me, and they say that I look gorgeous. No one says that I'm fat, not even one. Only gorgeous, right? I can be a beauty in the wheelchair.*" (Interviewee 1: employed-female-quadriplegia)

All employed participants stated that self-image and self-esteem followed after they acquired confidence from being independent. They perceived the positive reactions of other people, and they admitted that they became more open-minded, communicative and outgoing.

Freedom Mobility: All participants referred to the term freedom mobility as the provision of a wheelchair and commuting accessibility. They wanted to boost their independent mobility in order to maintain an active and satisfying lifestyle. They said that mobility and movement were important for QoL because they widened their life experiences, opportunities, and social connections.

"*If I could go out alone, completely without a PA. Wooh, how cool that's gonna be!*" (Interviewee 1: employed-female-quadriplegia)

Dignity and Life Goals: The employed respondents said that after overcoming many adversities, they defined themselves more around their self-worth than around their areas of vulnerability. They also reported that being part of something important helped them feel good about life and have fewer concerns about their daily struggles. All participants set their life's goal as wanting to live and use their best abilities to benefit those who were important to them (their parents) or those who were in need of help (disabled peers).

"*I earn my own living. I don't rely on my parents. Every baht comes from my own labor. By 'labor', I don't mean that I do it all by myself because my fingers are disabled; I could manage to do that with the help of my assistant. The important thing is that I can take care of my mother sometimes. Maybe not everything because mom... Ah, by taking care of her, I mean taking her out for dinner, or buying her what she wants.*" (Interviewee 1: employed-female-quadriplegia)

Discussion

To our knowledge, the present large study is the first one aimed at assessing HRQoL in individuals with SCI in Thailand using mixed-methods

sequential explanatory design. This study evaluated QoL in individuals with SCI living in Bangkok, Thailand, and compared the SF-36v2 scores of SCI sub-groups and with those from SF-36 Thai normative data. This was possible because of the availability of data on participants' characteristics and socio-environmental variables. However, the study was unable to provide some information regarding important aspects to match with the comparison groups. Therefore, comparisons with Thai SCI and other groups must be made with caution. The comparisons provide general perspectives on QoL after SCI.

The qualitative data of this study found QoL themes similar to the previous study[26]; however, it provided some unique details that had not appeared elsewhere because of the different sociocultural structure and psychological perspective of Thais. Also, it provided sufficient supportive in-depth explanations to the quantitative findings.

Integration of the Data

The connection of the data was discussed in this section. Each aspect of the quantitative data was discussed with regard to literature and some qualitative data (themes) were added to provide an in-depth understanding of "how" and "why" they rated their QoL in that way.

The gender difference was found to have an effect on QoL after SCI. In our study, women recorded higher scores than men in every SF-36v2 sub-scale with the exception of MH (no significant difference was found in this domain). The possible explanation for the lower score in MH in women with SCI could be that they tend to suffer from psychiatric ill health more than their male counterparts.[30] However, the higher scores attained by females in the various SF-36v2 subscales are in sharp contrast with the results of other studies which found that women with SCI had more medical, social, and psychological problems than men.[1,31]

With regard to participants' age at interview, this study reported higher scores in RP, BP, GH and SF in younger patients. Overall, the participants in this study were relatively young with mean and median ages of 34.56 and 34 years, respectively. This result is similar to the findings of the study by Arango-Lasprilla *et al.*[32] but lower than in other previous research in which the mean age of participants was greater than 40 years.[1,33–35] Younger age is related to superior levels of energy and activeness, and this may be conducive to more physical activity and adaptability to change.[36]

In this study, younger age at injury had a positive impact on QoL. This is because, in general, those who are younger have a superior capability to cope with injury, especially those whose age at injury is under 35.[37] Another explanation is that younger people are not aware of the likely deterioration in their health as they age, and their body and mindset require less medical and social support.[1]

Regarding the time since injury, this study found better QoL in some domains (GH, VT, and RE) in individuals with shorter duration of disability. This finding is similar to those of the study by Elfstrom *et al.*[38] but different from those of the studies of Krause[39] and Westgren and Levi[1] which reported that QoL improves with longer time since injury. Another study found no difference in QoL associated with time since injury for individuals with paraplegia.[40]

The quantitative findings revealed that women with SCI or those who are younger or having lesser time since injury had higher QoL scores than men, older participants or those with longer time since injury. The qualitative investigation could capture reasons behind these notions that PA have a huge influence on their QoL. As a younger and unmarried member of the family, they were still living with their parent (or with PA hired by their parent). They got all supports and cares from their PA or older family members (especially in women). This is also true for persons with quadriplegia that they have to rely on other people. A PA is essential for attaining QoL in high individuals with SCI. This research found that persons with quadriplegia redefined themselves as "able" and no longer viewed themselves as "disabled" when they were able to use their PA to help them regain control over their everyday life.[41] The relevant theme of "having PA" has not been considered in previous research. The emergence of this theme in the present study may be due to the noteworthy constraints of environmental factors both in the household and in public facilities.

Where "having PA" involved a parent or close family member, overprotectiveness was identified. The closeness of family relationships in Thai culture and the attendant overprotective caring tend to turn individuals with SCI who live with their

family into passive individuals. This is because of a misconception about independent living and physical activity of persons with disability.[42] They believe that a person with SCI should do less activity to reduce the occurrence of accidents and prevent deterioration in their health, and this is probably a result of their ignorance about health promotion for people with disability. However, it also means that they get constant emotional and psychological support from persons around them.

Moreover, the QoL scores were expected to be lower in those with SCI than in the able-bodied persons.[2,12,33–35,43] However, our study yielded an unexpected result that individuals with SCI had higher QoL scores on VT, SF (both men and women), and RM (only in women) than Thai normative data (Table 3). The qualitative investigation of this study suggested that these higher scores in psycho-social variables in Thais with SCI may be accounted for by differences in social roles and family traditions: the strong family relationship and community values which prevail among Thais means that individuals are offered strong emotional support and assistance. The superior Thai family and community relationships can act as a protective factor against depression and other emotional problems.

Employment has been proven to be a factor that influences a better QoL score.[26,44–47] This aspect is strongly related to age and economic and social opportunity. The Thai welfare system and Thai-disabled benefits are relatively low, and it was apparent in the qualitative interviews that unemployed individuals had a poor standard of living. Consequently, the term "having paid occupation" is used to represent the socio-cultural value of work in the Thai cultural context. The qualitative investigation of this study confirmed that employment affords an opportunity for individuals with SCI to gain social, psychological, and tangible values from working which raise their life satisfaction levels above those of the unemployed ones.[48] The Thai Department of Empowerment of Persons with Disability has implemented legislation in the Rehabilitation of Disabled Persons Act that encourages business owners and public agencies to employ persons with disability. Even though this legislation is in force, the rate of people with disability who are employed has not significantly increased. According to the qualitative findings, there are three explanations for this: first, the business sectors may not be aware of the legislation; second, the business sectors might consider the cost of adjusting the workplace to people with disability as too high, and finally, the shortage of finances and transportation for the disabled prevents them from getting to the workplace, resulting in their rejecting job offers.

One essential factor that needs to be addressed are disability benefits and social policies. The reason most Thai persons with SCI desperately try to get a paid occupation is because disability benefits in Thailand are so low that it is impossible to survive financially on them; therefore, further income is essential. This regulation is in contrast with healthcare support in countries in the Scandinavian region where persons with SCI get financial support for housing, workplace, car adaptation, assistive devices, medical care and subsidized medication.[1] In Thailand, different causes of SCI lead to diverse levels of disability compensation. For example, a person with SCI from work-related injuries will receive only workmen's compensation from Social security office[49,50] whereas someone with SCI from a car accident will receive additional support from the Department of Land Transport for assistive devices.[51] This suggests that QoL of Thai individuals with SCI may differ according to the cause of their injury. However, further research is needed to confirm this notion.

Many respondents commented that environmental factors were outside their control and had a significant impact on their participation in physical activity and on their QoL.[52,53] Recognizing this apparently insuperable problem helped us to gain a full appreciation of the situation faced by people with SCI in Thailand. Environmental factors are major predictors of life satisfaction that include, but are not limited to, the natural environment, transportation, support at home, healthcare, and government policies.[53] Several positive developments have been made in urban areas, especially in newly established hospitals, shopping malls, and hotels, which have been adapted to accept the important role of the environment in the lives of people with disability; however, these developments are practically unused by the persons with disability, and the qualitative finding provided several reasons for the same. First, these facilities are based on exclusive and limited areas while most people with disability are living in rural areas or some distance from the city center. Second, poor public awareness of the needs of people with disability and general lack of facilities for the disabled

make those amenities inaccessible for people with disability. Both these reasons reflect the lack of concern of able-bodied people for people with disability and the fact that these positive developments do not cover the area where the majority of persons with the disability live.

As for the residential aspect, scores varied among sub-groups and this made generalization difficult. The majority of individuals with SCI were living in their own home with a PA (39.60%) or in a disabled institute without a PA (51.49%). As people who are eligible to live in a disabled institute must be autonomous wheelchair users, they should have higher scores regarding their severity of injury. The relatively low score presented in this study may have been because of the timing of the survey, which was during the first month of their enrollment into the disabled institute at which point they were just adapting to their new environment. However, the qualitative interview suggested that they were more independent while living in a disabled institute than in their own home because the facilities and environment were well designed for persons with disability. According to the qualitative data, lack of control over environmental factors also includes household adjustment, especially for those who are living in rented houses or apartments, as they cannot add to or readjust the solid construction of the building due to their property rental agreement. This results in an environmental barrier within their own household which tremendously restricts physical activity in their lifestyle.[53–55]

The Standalone Discussion of the Qualitative Data

This section discuss on the themes that have not related, connected or added meaning to the quantitative findings.

One QoL theme that is found in persons with disability but not in able-bodied persons is "stigma".[26] The results of the present study highlight the vulnerability of the population with SCI to emotional disorders which have crossover effects on emotional well-being, relationships and socialization.[26,41,56] It has been suggested that cultural norms, ideas of competence, social worth and individuals' sense of self had an influence on stigma. Furthermore, the disappearance of stigma is also related to how well they adjust to the sudden onset of impairment, and their ability to redefine their values.[8,47,56,57] Additionally, the qualitative investigation in our study revealed that the interviewees had a singular perception that the majority of non-disabled persons held a negative attitude toward people with disability. This may be due to the belief of non-disabled persons that the term "disabled" is synonymous with "incapable of doing things". Further studies should be conducted regarding non-disabled persons' perceptions of persons with disability in Thailand.

The participants used the term self-advocacy to describe their active behaviors and actions in seeking help from other persons as well as promoting their health status. This theme is similar to others found in the previous research, with the "health behaviors" and "physical well-being", that refer to the actions that the persons with SCI do to enhance their health, employment, accommodation, or to be part of recreational activity.[26,38] However, the participants stated that "self-advocacy" came during and after the period of acceptance of their disability. They started to realize which things were essential for their survival and how they could acquire them through the various sources of information and help available. This was aligned with the conceptual framework of self-advocacy involving self-knowledge, knowledge of rights, communication, and being autonomous and competent, all of which are important in the process of internalization and incorporation of health behaviors.[58] The presence of "self-advocacy" could imply that they valued and prioritized active behaviors in exploring different methods of achieving their needs and expectations and adopted these behaviors in their lifestyle.

Moreover, our study revealed that Thai individuals with SCI adore their healthcare professionals. However, just as in other studies, healthcare professionals often focused more on reducing disabilities, minimizing handicaps, instructing mobility techniques and improving activities of daily living without paying attention to the long-term and extensive health needs of their charges.[59–61] Lack of support and recommendation from healthcare staff about life after injury may have a direct and detrimental effect on QoL in persons with SCI. Therefore, it is recommended that healthcare professionals should revise their role to facilitate, help and prepare individuals with disability to adjust their attitude and behavior to adapt to their new circumstances.[55,59–61]

After accepting the new form of self as a person with disability and gaining confidence in being autonomous, many Thai individuals with SCI have developed the motivation to live a better life. The first motive theme is "self-image". The new image of self in this context was defined by the interviewees as the replacement of undesirable historical self-image with an optimistic one of their own creation. Persons with SCI purposively develop their self-image internally and externally to expand their experience, opportunity, and self-esteem because they want to be seen as capable people. This issue has been mentioned by many studies in the field of SCI[8,26,46,53,55–59,62] and has a strong relationship with the most conspicuous theme of "having paid occupation" insofar as SCI individuals try to improve themselves in order to increase their chances of being employed.[46,52,53,58,62,63]

The second motive theme is "freedom mobility". This theme was proposed as an ideal but not as reality. Participants with SCI want to experience control over their own mobility and transportation with minimal or no support. This study found a relationship between this theme and "enabling environment" as it appeared in the previous studies.[36,52–55,59] Certainly, Thai participants with SCI could not achieve "freedom mobility" because environmental factors are not well suited to persons with disability: only the persons with disability who have a reasonable family business background and financial stability can afford to overcome this factor by owning an adaptive mobility car for people with disability.[53]

The last motive theme is "dignity and life's goal". Being confident and wanting to do something meaningful in their life showed that individuals with SCI valued their ability rather than their disability.[64] Having less concern for their vulnerability and daily struggle means that they can meet Thai cultural expectations and achieve desirable feedback from family members and peers. In Thai culture, people value and admire persons who provide care and support for their parents; being able to take care of their parents makes them feel great pride in being Thais.[65–69] Moreover, individuals with SCI put a great value on becoming role models to help and share their attitudes, experience, and knowledge with other people with disability. Being generous to other individuals with disability helps them strengthen their ability and self-worth.[53] Thus, it could be implied that acquiring a sense of being valuable has a positive impact on the QoL of people with SCI.

Limitations

This study had several limitations, and its results should be interpreted with caution. First, these Thai participants with SCI were recruited from an urban area of Bangkok, and therefore, the findings should not be generalized to apply to those living in rural areas where there may be fewer resources for persons with disabilities. Second, the present study used a cross-sectional research model; thus, it was unable to explain changes in QoL over time. Third, sample size calculation could not be performed to estimate the number of participants that reached the significant power level. Consequently, this study may not have included an adequate number of subjects to enable generalization of the results to the whole population with SCI in Bangkok, Thailand. This is due to the lack of epidemiology, prevalence and incidence research carried out in investigating the populations with SCI in Thailand. Finally, the use of SF-36v2 in this study may pose a problem when utilized with persons who use a wheelchair because some SF-36v2 questions refer to walking and climbing stairs. Further research should therefore consider either modifying some questions in the SF-36v2 to increase its sensitivity for use with wheelchair users or using some other data collection instruments.

Conclusion

In conclusion, this study achieved its aim of using subjective and objective measures to explore QoL in Thai persons with SCI. The relatively high scores on SF-36v2 (except in the physical functioning domain) could be explained by the replies in the qualitative investigation about QoL themes of Thai individuals with SCI which were similar to those of other studies but had their own uniqueness in that they specifically describe Thai socio-environmental-cultural aspects. The results of this study may provide a basis for the improvement and implementation of programs for individuals with SCI in order to enhance their QoL.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Author Contributions

AF is the leading researcher. AF and AE contributed to the conception and design of the study. AE contributed to the writing of a research proposal, submitted for ethical consideration, collected both quantitative and qualitative data, extracted and transcribed the data, performed the data analysis, and prepared the manuscript for submission to the journal. JK contributed to the development of the qualitative investigation and analysis. MM is contributed to the recruitment of subjects. All authors revised and approved the final submitted version of the manuscript.

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Appendix A. Characteristics of the SCI Individuals Who Participated in the Semi-Structural Interview

Interviewee number	Sex	Age (year)	Time since injury (year)	Type of injury	Employment	Resident	Cause of injury
1	Female	46	26	Quadriplegia	Employed	Home with PA	Car accident
2	Male	25	5	Quadriplegia	Employed	Home with PA	Gunshot
3	Female	42	16	Quadriplegia	Employed	Home with PA	Car accident
4	Female	45	11	Quadriplegia	Employed	Home with PA	Motorcycle accident
5	Male	25	7	Paraplegia	Employed	Home without PA	Car accident
6	Male	32	5	Paraplegia	Unemployed	Disabled institute without PA	Falling from height (work related)
7	Male	40	3	Paraplegia	Unemployed	Disabled institute without PA	Motorcycle accident
8	Male	20	3	Paraplegia	Unemployed	Disabled institute without PA	Gunshot
9	Male	30	3	Paraplegia	Unemployed	Disabled institute without PA	Car accident
10	Male	26	3	Paraplegia	Unemployed	Disabled institute without PA	Motorcycle accident
11	Male	32	14	Paraplegia	Unemployed	Disabled institute without PA	Motorcycle accident

Appendix B. Description of the Thematic Analysis Process by Braun and Clark[28]

Phase	Description
(1) Familiarization with the transcribed data	Reading and re-reading the transcribed data, taking notes, and making an idea for coding.
(2) Coding all relevant data	Producing the initial codes from the data that appear to be interesting to the analyst.
(3) Generating potential themes from codes	Sorting different codes into potential themes and collecting all the relevant coded data extracts within the identified themes.
(4) Making a thematic map	Reviewing the coded data extracts (level 1), refining the themes that reflect the meanings evident in the data set and creating the thematic map.

(*Continued*)

Phase	Description
(5) Defining the themes	Ongoing analysis to refine the scopes of each theme, and the overall story the analysis tells, creating clear definitions and names for each theme.
(6) Names and producing a scholarly report	Producing the scholarly report of the analysis that contains concise, coherent, logical, non-repetitive and interesting account of the story the data tell within and across the themes.

Appendix C. Data Extraction of the Qualitative Findings Using Thematic Analysis

Extracted transcribed data	Codes	Sub-themes	Themes
"*I must be responsible for myself... I must stand on my own feet in everything. I must sustain myself without any help from others.*" (*Interviewee* 5)	Being financially independence	Having paid occupation	Supporting factors toward QoL
"*I would like to have some work, or at least have something to do... Because if I just stay inside doing nothing exciting, life will get too stressful.*" (*Interviewee* 6)	Having something to do		
"*Because I am in the school, because of knowing that life is for learning and because I get to work after I graduate. But one day, I believe I will get a good job.*" (*Interviewee* 8)	Expectation on future career		
"*I need a job. My life is going to be so great if I could get a job.*" (*Interviewee* 11)	Needing a job		
"*Let's say if my arm was alright, it seems to me that my life would not be problematic, but I cannot help myself, and I have to wait for others to aid me. I need a personal assistant.*" (*Interviewee* 2)	Needing aids from other	Having PA	
"*Because my case is serious and I cannot help myself at all. I must hire a personal assistant.*" (*Interviewee* 3)	Needing aids from other		
"*Well... my mother and my brother told me that I don't have to do that; they will take me there.*" (*Interviewee* 6)	Overprotective parent		
"*I am only able to stay like a useless man. I must wait for others to help me. When I try to go down (the stairs), I feel afraid because the stairway is high... I have to wait for others to do things for me.*" (*Interviewee* 7)	Overprotective parent		
"*In my neighborhood, there aren't any slopes. They might be looked over that I need to use them. Or maybe I am the only disabled person in the village, that's why they don't pay attention to me.*" (*Interviewee* 2)	Outdoor obstacles	Enabling environment	
"*I can't use public transport so I have to take a taxi, sometimes they let me in, sometimes they don't, or let me in then let me out later, or scold me. Some were upset at me as my wheelchair scratched their car.* (*Interviewee* 3)	Transportation obstacles		
"*Right now I'm renting a house, and I asked the house owner for permission to build a new restroom door, but he didn't allow it... I can't do anything about it, so I have to live with this hardship.*" (*Interviewee* 6)	Indoor obstacles		
"*My house has no facilities to assist people with disabilities. They are expensive. My house was just bought but I'm already at the school and everything is ready for people with disabilities.*" (*Interviewee* 11)	Indoor obstacles, preferring school		
"*Not to mention others; even my family members don't accept me.*" (*Interviewee* 1)	Acceptance from others	Stigma	

(*Continued*)

Extracted transcribed data	Codes	Sub-themes	Themes
"*They still consider people with disability as those who are unable to help themselves, worthless individuals who must be taken care of all the time, or even burdens... Like, why do they come outside*" (*Interviewee* 4)	Views from others		
"*Ah, to be honest, it is* 80% *of people who judge the people with disabilities as burdens of society. Ah...* (*people with disabilities*) *always have this and that.* (*Interviewee* 5)	Views from others		
"*There are a lot of kiosks on the sidewalk. When I wheeled through them and ask to pass, they scold at me.*" (*Interviewee* 6)	Actions from others		
"*Bedsore caused me a lot of problems... I asked for advice from other disabled friends, but would you believe that five people gave me five different pieces of advice?* (*Interviewee* 1)	Seeking advice	Self-advocacy	
"*Searching on the Internet by myself, kinda like that. I can't move like healthy people, and need to look after our body... So that I can live my life normally.*" (*Interviewee* 2)	Taking actions for the better		
"*They said moving any parts of my body counts as exercise; therefore I moved my head. I used to be so fat that I fully filled the bed... Turned out I got slimmer.*" (*Interviewee* 4)	Taking actions for the better		
"*Practicing by myself. The doctor never suggests anything.* (*I have to*) *learn by myself.*" (*Interviewee* 8)	Taking actions for the better		
"*Let's say I like dressing up. If I only dress up in my house, then what's the point? No one sees me. And it's like when other people talk to me, and they say that I look gorgeous.*" (*Interviewee* 1)	Feeling good about themselves	Self-image	Driving force post injury
"*My friend who had been studying with me didn't know about my accident (talking on the phone). My voice did sound fine. So I told them, "yup, if I don't tell them I'm disabled, no one knows.*" (*Interviewee* 3)	Feeling good about themselves		
"*After I moved out from my parents house, I feel more confident. I see myself as an independent person. Hanging out with my (disabled) friends makes me feel alive.*" (*Interviewee* 8)	Feeling good about themselves		
"*I started to exercise and build up my muscle. I dress well and be confident. I feel great about myself and that affect the way how others feel about me as well*" (*Interviewee 10*)	Feeling good about themselves		
"*If I could go out alone, completely without a personal assistant. Wooh, how cool that's gonna be!*" (*Interviewee* 1)	Independent mobility	Freedom mobility	
"*I'm already a Bangkokian, so it's not hard traveling around. Especially right now when I already own a car, I can drive to anywhere by myself.*" (*Interviewee* 5)	Commuting accessibility		
"*But when I go out, it's troublesome. Sometimes a fierce dog at the house I have to pass by ran after me, and that's the problem... they bit me, leaving a bad wound.*" (*Interviewee* 7)	Commuting inaccessibility		
"*Every time I decide to go out, I must at least asking for help about* 10 *times on the way to and from my home*" (*Interviewee* 9)	Commuting inaccessibility		
"*The important thing is that I can take care of my mother sometimes. Maybe not everything because of mom... Ah, by taking care of her, I mean taking her out for dinner, or buying her what she wants.*" (*Interviewee* 1)	Taking care of parent	Dignity and life goal	
"*Actually, when I have started working, I did help other disabled people. And I feel so, so great... Maybe, ah, being disabled is good as having a chance to help other disabled.*" (*Interviewee* 4)	Taking care of others		
"*I will go back home and make my parents proud of me. I will be the leader who helps poor and disabled people in my city.*" (*Interviewee* 9)	Taking care of others		
"*I dedicate my life to my beloved son. After I graduate from this school, I will work hard and send him to study in a good place. He is my everything and I will do everything for him. I will not let him down*" (*Interviewee* 10)	Taking care of children		

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Development of a short form of the Hong Kong Chinese orebro musculoskeletal pain screening questionnaire

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Background: The Orebro Musculoskeletal Pain Screening Questionnaire (OMPSQ) is a valid screening tool to identify those musculoskeletal patients at risk of developing chronicity and disability. A Hong Kong Chinese version of the OMPSQ (COMPSQ-HK) was developed with satisfactory construct validity and predictive validity.

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Objective: The aim of this study was to develop a 10-item short form of the COMPSQ-HK (COMPSQ-HK10) and examine its measurement properties.
Methods: The 10 items were identified from the suggestion by the original author of OMPSQ. The data of the 10 items were extracted from the main study to develop the COMPSQ-HK conducted from 2010 to 2013. The internal consistency using Cronbach's alpha, test–retest reliability examining intraclass correlation coefficient ($ICC_{1,1}$), minimum detectable change and 95% limits of agreement, construct validity by correlating COMPSQ-HK10 with pain, disability score, kinesiophobia score and Medical Outcomes Study Short Form 12, and predictive validity investigating receiver operating characteristic (ROC) curve analyses with sick leave > 60 days and return-to-work status at one year were calculated.
Results: A total of 305 back patients and 160 neck patients were recruited with about 30% of patients lost to follow-up at one year. Both the internal consistency (Cronbach's alpha as 0.732 to 0.757) and test–retest reliabilities ($ICC_{1,1}$ as 0.868 for both back and neck patients) were satisfactory. The correlations between COMPSQ-HK10 and COMPSQ-HK for back and neck patients were excellent (Pearson r as 0.919 and 0.896, respectively, $p < 0.001$). The areas under the ROC curves for back and neck patients were similar for COMPSQ-HK10 and COMPSQ-HK, ranging from 0.603 to 0.712. A cut-off score of 54 of COMPSQ-HK10 was recommended in predicting "sick leave of more than 60 days at one year" and "return to work for at least four consecutive weeks at one year".
Conclusion: The COMPSQ-HK10 has comparable measurement properties with the COMPSQ-HK. It is recommended to use the COMPSQ-HK10 for routine screening to identify patients of back and neck pain at risk of developing chronic pain and disability.

Keywords: Musculoskeletal disorders; screening; yellow flags.

Introduction

Musculoskeletal disorders are the second most common cause of disability.[1] Among the 291 conditions studied in the Global Burden of Disease 2010 study, low back pain (LBP) was ranked first in causing global disability and the sixth in terms of overall burden in disability-adjusted life years (DALYs)[2]; whereas neck pain was ranked the 4th in terms of overall disability and the 21st in terms of overall burden in DALYs.[3] In the more recent Global Burden of Disease Study 2015, low back and neck pain was the leading cause of disability globally in terms of years lived with disability in 2015.[4] The management of persistent LBP and neck pain implies substantial burden to the society due to direct and indirect costs, especially for LBP.[5] People with persistent LBP or neck pain are more disabled when they possess certain psychosocial factors, known as "yellow flags". Yellow flags are psychosocial factors that will increase the risk of developing prolonged pain and disability in patients with LBP or neck pain.[6] Early identification of yellow flags is highly recommended in managing patients with LBP[7] and neck pain.[8]

The Orebro Musculoskeletal Pain Screening Questionnaire (OMPSQ) is a widely used screening tool for psychological risk factors for LBP and neck pain.[9] Although the OMPSQ has shown moderate predictive validity in identifying patients with LBP or neck pain at risk of persisting pain and disability,[10] it becomes increasingly difficult for patients to complete the 25-item questionnaire in busy physiotherapy out-patient clinics. If a shorter questionnaire with comparable measurement properties is available, it will be more practical for administration with reduced burden to physiotherapists and patients. A short form of 10-item OMPSQ had been developed from the original OMPSQ based on the factors from a theoretical framework.[11] It includes five concept areas, namely pain experience, self-perceived function, distress, return-to-work expectancy and fear avoidance beliefs. A summary score from 1 to 100 is obtained with higher scores indicating higher estimated risk for cumulated sick leave for 14 days. High correlation and comparable predictive validity of the short and original forms of OMPSQ were reported. The short form had been translated into Brazilian–Portuguese with measurement properties tested.[12]

The aim of this study was to develop a Chinese version of the 10-item short form OMPSQ based on Linton *et al.*'s work[11] and to examine its measurement properties in patients with back and neck pain.

Methods

Setting and design

This study was a part of a prospective observational study conducted in 14 public physiotherapy outpatient centers in Hong Kong. Patients were followed up for one year and the main study aimed to develop a Hong Kong Chinese version of OMPSQ (COMPSQ-HK). The original Hong Kong COMPSQ was cross-culturally adapted and administered. Its development has been reported elsewhere.[13] The Chinese short form was constructed according to the 10 items of OMPSQ identified from Linton *et al.*'s study[10] with five concept areas in pain experience, self-perceived function, distress, return-to-work expectancy and fear avoidance beliefs (see Appendix). The data of the 10-item short form (COMPSQ-HK10) were extracted from the original form of COMPSQ-HK. It was then pilot tested on 30 subjects for field testing.

Participants

Patients were recruited if they were Chinese workers aged 18–65 years old; with acute or subacute non-specific back or neck pain without recognizable or known specific pathology and having onset less than 12 weeks; resulted from injury on duty or having sick leave for more than seven days due to musculoskeletal injury. Those with spinal surgery in the past 12 months; serious spinal pathologies such as fracture, tumor, infection; or other specific conditions such as spondylolisthesis, spinal stenosis, inflammatory disorder, neurological deficits, pregnancy; illiteracy or inability to read Chinese were excluded. Written consent was obtained from each subject and the study was approved by the respective Research Ethics Committees of the seven clusters of the Hospital Authority, Hong Kong.

Procedures

At baseline, data were collected from patients with acute or subacute non-specific back or neck pain on COMPSQ-HK, Chinese Numeric Pain Rating Scale (NPRS),[14] Chinese Roland-Morris Disability Questionnaire (RMDQ-HK),[14] Chinese Northwick Park Neck Pain Questionnaire (NPQ-HK),[15] Chinese Tampa Scale for Kinesiophobia (TSK-HK),[16] Chinese Medical Outcomes Study Short Form 12 (SF-12),[17] together with demographic data such as age, gender, educational level and occupation. The Chinese NPRS is a 0 to 10-point numeric scale to measure pain intensity of patients. The Chinese RMDQ-HK and Chinese NPQ-HK were 24-item and 10-item questionnaires to assess the functional status of patients with back pain and neck pain, respectively. The Chinese TSK-HK was a 11-item scale designed to assess fear of movement/(re)injury. The Chinese SF-12 is a 12-item health-related quality of life summary measure of physical health and mental health. At discharge from physiotherapy treatments, data on NPRS, RMDQ-HK and NPQ-HK were collected again. The Numeric Global Rating of Change Scale (NGRCS)[14] was also used to assess the overall change in condition of patients at discharge. The patients were contacted by phone to assess their cumulative duration of sick leave and return to work status at one year from baseline. Data analyses for patients with back pain and patients with neck pain were separately conducted.

Internal consistency and test–retest reliability

The internal consistency was assessed to compute the Cronbach's alpha. Stable patients with no change in overall condition one week after the first attendance were invited to complete the COMPSQ-HK again to estimate the test–retest reliability of the COMPSQ-HK and COMPSQ-HK10 using the intraclass correlation coefficient with one-way random-effects model ($ICC_{1,1}$). The standard error of measurement (SEM), minimum detectable change in 95% confidence interval ($MDC_{95\%CI}$), and 95% limits of agreement (95% LoA) were computed.

Construct validity

The construct validity of the COMPSQ-HK and COMPSQ-HK10 was tested using correlational analyses of COMPSQ-HK and COMPSQ-HK10 score with scores of NPRS, RMDQ-HK, NPQ-HK, TSK-HK and SF-12 at baseline. With normality assumption of data fulfilled, the Pearson r was calculated.

Predictive validity

The predictive validity of the COMPSQ-HK and COMPSQ-HK10 was also examined with the baseline score as the predictor variable and sick leave duration (more than 60 days of cumulative sick leave) and return-to-work status (return to

part-time or full-time work for at least four consecutive weeks) at one-year follow-up as the outcome variables using receiver operating characteristic (ROC) curve analyses. The ROC curve is a plot of sensitivity (true positive) against "1 minus specificity" (false positive) for various cut-points of the test variable in relation to the outcome.[18] The areas under the curve (AUC) of the ROC curve analyses of COMPSQ-HK and COMPSQ-HK10 were computed and compared. The optimal cut-off scores of the COMPSQ-HK and COMPSQ-HK10 were chosen with the consideration of balanced values of associated sensitivity (Sn), specificity (Sp), positive predictive value (PPV), and negative predictive value (NPV) calculated.[18] The predictive values were computed on a presumed prevalence of 50%.

Data analysis

The ROC curve analyses were conducted using the MedCalc Statistical Software 14 (MedCalc, Ostend, Belgium). All other statistical analyses were conducted using the IBM SPSS Statistics 23.0 (IBM Corp, NY). The level of significance of all statistical tests was set at 0.05.

Results

Baseline data

Twelve males and 18 females participated in the field testing of the COMPSQ-HK10 questionnaire. Their mean age was 47.0 years old (SD 13.6). Twenty-two patients had back pain and eight patients had neck pain. The average time to complete the short form version was 3.2 min (SD = 0.3). Floor and ceiling effects were not observed with COMPSQ-HK10. A total of 465 neck and back pain patients with informed consent were recruited in the original COMPSQ-HK study from November 2010 to July 2013 and the patients were followed up for one year. All the data for the COMPSQ-HK10 were extracted from the COMPSQ-HK. There were 305 patients with back pain and 160 patients with neck pain. The back pain group had a mean age of 42.2 years (SD = 10.0) and half of them were male. The neck pain group had a mean age of 41.6 years (SD = 10.4) and 63% of patients were male. Details of their demographics and baseline data have been reported previously.[13]

For patients with back pain ($n = 305$), the mean COMPSQ-HK and COMPSQ-HK10 was 110.7 (SD = 26.4) and 54.6 (SD = 14.4), respectively. The mean NPRS was 6.1 (SD = 1.9). Pearson correlation coefficient between COMPSQ-HK and COMPSQ-HK10 for back pain patients was 0.919 ($p < 0.001$). For patients with neck pain ($n = 160$), the mean COMPSQ-HK and COMPSQ-HK10 was 109.1 (SD = 25.0) and 55.4 (SD = 13.5), respectively. The mean NPRS was 6.3 (SD = 1.9). Pearson correlation coefficient between COMPSQ-HK and COMPSQ-HK10 for neck pain patients was 0.896 ($p < 0.001$). At one-year follow up, there were 90 patients with back pain (29.5%) and 54 patients with neck pain (33.7%) lost to follow-up despite repeated contacts through various means. *Post-hoc* analysis showed that there was no significant difference in demographics and COMPSQ-HK score between the respondents and non-respondents, except the non-respondents of back pain were about 3.5 years younger.

Internal consistency

The internal consistency of COMPSQ-HK and COMPSQ-HK10 were summarized in Table 1. The Cronbach's alphas of the COMPSQ-HK were 0.843 (95% CI 0.816–0.867) and 0.826 (95% CI 0.784–0.863) for patients with back pain and neck pain, respectively. The Cronbach's alphas of COMPSQ-HK10 were 0.757 (95% CI 0.715–0.796) and 0.732 (95% CI 0.665–0.790) for patients with back pain and neck pain, respectively.

Test–retest reliability

The test–retest reliabilities of the COMPSQ-HK and COMPSQ-HK10 for patients with back pain and neck pain are shown in Table 2. For COMPSQ-HK, the $ICC_{1,1}$ are 0.814 (95% CI 0.627 to 0.913) and 0.922 (95% CI 0.762 to 0.977) in the

Table 1. Internal consistency of COMPSQ-HK and COMPSQ-HK10.

	Cronbach's alpha (95% CI)	
	COMPSQ-HK	COMPSQ-HK10
Back cases ($n = 305$)	0.843 (0.816–0.867)	0.757 (0.715–0.796)
Neck cases ($n = 160$)	0.826 (0.784–0.863)	0.732 (0.665–0.790)

Note: CI — Confidence interval.

Table 2. Comparison of COMPSQ-HK and COMPSQ-HK10 in ICC, SEM, MDC & LoA.

	$ICC_{1,1}$ (95% CI)		SEM		$MDC_{95\%CI}$		95% LoA	
	COMPSQ-HK	COMPSQ-HK10	COMPSQ-HK	COMPSQ-HK10	COMPSQ-HK	COMPSQ-HK10	COMPSQ-HK	COMPSQ-HK10
Back cases ($n = 25$)	0.814 (0.627 to 0.913)	0.868 (0.726 to 0.939)	11.6	5.9	32.1	16.5	−32.4 to 31.8	−16.5 to 16.4
Neck cases ($n = 12$)	0.922 (0.762 to 0.977)	0.868 (0.620 to 0.960)	7.6	5.2	21.1	14.3	−15.4 to 26.7	−10.5 to 16.7

Table 3. Correlations of COMPSQ-HK10 with other variables.

	Pearson r COMPSQ-HK10	
	Back patients	Neck patients
NPRS	0.467	0.525
RMDQ-HK/NPQ-HK	0.523	0.724
TSK-HK	0.472	0.554
SF-12 PCS	−0.437	−0.448
SF-12 MCS	−0.466	−0.339

Notes: All Pearson r with $p < 0.001$; MCS — Mental Component Summary; PCS — Physical Component Summary.

back pain and neck pain patient groups, respectively ($p < 0.001$ in both groups). For COMPSQ-HK10, the $ICC_{1,1}$ are 0.868 (95% CI 0.726 to 0.939) and 0.868 (95% CI 0.620 to 0.960) in the back pain and neck pain patient groups, respectively ($p < 0.001$ in both groups). The 95% LoA of the COMPSQ-HK for patients with back pain and neck pain were −32.4 to 31.8 and −15.4 to 26.7, respectively. The 95% LoA of the COMPSQ-HK10 for patients with back pain and neck pain were −16.5 to 16.4 and −10.5 to 16.7, respectively.

Construct reliability

The correlations of COMPSQ-HK10 scores and other baseline variables are shown in Table 3. Positive correlations were found between COMPSQ-HK10 and NPRS, RMDQ and TSK-HK. Negative correlations were found between COMPSQ-HK10 and SF-12. Correlation coefficients were the highest between COMPSQ-HK10 and RMDQ-HK ($r = 0.523$) for patients with back pain and NPQ-HK ($r = 0.724$) for patients with neck pain.

ROC curve analysis

The results of the ROC curve analyses of patients with back pain or neck pain are shown in Table 4.

Table 4. Results of ROC curve analyses with long sick leave and return to work status at one-year follow-up.

ROC curve analyses							
Patients	AUC (95% CI)	COMPSQ-HK10 optimal cut-off	Sn	Sp	PPV	NPV	Number of patients with affirmed outcome
Outcome: Sick leave more than 60 days at one-year follow-up							
Back ($n = 214$)	0.711 (0.645–0.771)	> 54	68.5%	64.8%	66.0%	67.3%	91 (43.0%)
Neck ($n = 105$)	0.660 (0.561–0.749)	> 54	64.7%	57.4%	60.3%	61.9%	58 (55.2%)
Outcome: Return to part-time or full-time work for at least four consecutive weeks at one-year follow-up							
Back ($n = 215$)	0.712 (0.646–0.771)	≤ 54	57.5%	75.0%	69.7%	63.8%	167 (77.7%)
Neck ($n = 106$)	0.603 (0.503–0.697)	≤ 54	51.3%	64.3%	58.9%	56.9%	78 (73.6%)

In order to predict "sick leave of more than 60 days at one-year", the optimal cut-off score of the COMPSQ-HK10 is > 54 for patients with back pain and neck pain (Table 4). The AUC at this cut-off was 0.711 (95% CI: 0.645 to 0.771), with a sensitivity of 68.5% and a specificity of 64.8% and a positive predictive value of 66.0% and a negative predictive value of 67.3% for back pain, and 0.660 (95% CI: 0.561 to 0.749), with a sensitivity of 64.7% and a specificity of 57.4% for neck pain, and a positive predictive value of 60.3% and a negative predictive value of 61.9%. To predict "return to work (full-time or part-time) for at least four consecutive weeks at one-year", the optimal cut-off score is ≤ 54 for back pain and neck pain (Table 4). The AUC at this cut-off was 0.712 (95% CI: 0.646 to 0.771), with a sensitivity of 57.5% and a specificity of 75.0% and a positive predictive value of 69.7% and a negative predictive value of 63.8% for back pain, and 0.603 (95% CI: 0.503 to 0.697), with a sensitivity of 51.3% and a specificity of 64.3% and a positive predictive value of 58.9% and a negative predictive value of 56.9% for neck pain.

Discussion

A local clinical trial, despite using an informal Chinese version of OMPSQ without adequate cultural adaptation for screening, showed superior effects for targeted interventions for patients with back pain.[19] This study further suggested that a short version of a validated Chinese OMPSQ would be beneficial for routine screening in busy physiotherapy out-patient clinics. The present COMPSQ-HK10 should be practical for routine use as it requires an average of about 3 min for completion. This will certainly help physiotherapists in assessing patient's fear, anxiety and depression in managing musculoskeletal pain disorders.[20,21]

The measurement properties of the COMPSQ-HK10 were comparable to findings of other study.[12] The internal consistencies of the COMPSQ-HK10 for back and neck patients were similar with that of the Brazilian–Portuguese short version (Cronbach's alpha = 0.72). The test–retest reliability of the Brazilian–Portuguese version in terms of ICC was 0.78 whereas that of the COMPSQ-HK10 for back and neck pain was substantial at 0.868. Both the SEM and the 95% LoA of the COMPSQ-HK10 for patients with back pain and neck pain were better than that of the Brazilian–Portuguese version. Different timing in administering the screening tool is likely to affect the test–retest reliability and in particular the predictive validity of the tool. Further studies are required to substantiate the appropriate timing in administering the tool to patients after their onset of musculoskeletal pain disorders.

As shown in Table 3, the construct validity of the COMPSQ-HK10 demonstrated moderate correlations with pain, RMDQ/NPQ, kinesiophobia and SF-12 scores. Despite there was a lower correlation of the COMPSQ-HK10 with RMDQ in the local population ($r = 0.523$) as compared to the correlation of the OMPSQ short form and RMDQ in the Brazilian–Portuguese population ($r = 0.690$), all other figures were comparable.

This study shows fair to moderate predictive validity of the COMPSQ-HK10 in predicting sick leave > 60 days and return to work status at one year. Cut-off days for sick leave was observed to vary from 7 days,[22] 14 days,[12,23] 30 days[24,25] to 6 months[26] in the literature. The choice of > 60 sick leave days as an outcome indicator in this study was much dependent on the local practice that both the waiting time for seeking orthopedic specialist care and the sick leave granted by the attending physician are usually more than 30 days. In the study of Linton *et al.*,[11] the AUC for the OMPSQ short form were 0.70 and 0.81 for the occupational sample and primary care sample, respectively. In the present study, the AUC for the COMPSQ-HK10 in predicting patients with back pain for > 60 days sick leave and RTW status at one year were > 0.7. However, the AUC for the COMPSQ-HK10 in predicting patients with neck pain for > 60 days sick leave and RTW status at one year were slightly less favorable (> 0.6). Similar phenomenon was observed for COMPSQ-HK in predicting long sick leave and RTW status at one year for neck patients. The AUCs for COMPSQ-HK and COMPSQ-HK10 were nearly identical in their predictive validity (Table 5). Linton *et al.*[11] recommended a cut-off of 50 for their OMPSQ short form. In the present study, a cut-off of 54 in the COMPSQ-HK10 for both the back and neck patients was suggested with consideration to optimize the sensitivity and specificity. The selection of optimal cut-off score is largely dependent on the patient characteristics, practice setting and the choice of outcome indicators.[27]

Strong correlations were observed between the COMPSQ-HK and COMPSQ-HK10 for back

Table 5. Comparison of areas under the ROC curve of COMPSQ-HK and COMPSQ-HK10.

	AUC			
Patients	COMPSQ-HK	COMPSQ-HK10	Difference	*P*-value
Outcome: Sick leave more than 60 days at one-year follow-up				
Back	0.708	0.711	0.003	0.828
Neck	0.605	0.660	0.009	0.745
Outcome: Return to part-time or full-time work for at least four consecutive weeks at one-year follow-up				
Back	0.710	0.712	0.002	0.910
Neck	0.586	0.603	0.017	0.591

patients ($r = 0.92$) and neck patients ($r = 0.90$). The test–retest reliability and predictive validity of the COMPSQ-HK10 were highly comparable to those of the COMPSQ-HK.

Limitations

The internal consistency of COMPSQ-HK10 dropped slightly in terms of Cronbach's alpha. Clinicians have to be aware that the short version of OMPSQ has less clinical information and the concept area on coping has been omitted. For a better understanding of the patient's psychosocial condition and discussion of the situation with the patient, the original OMPSQ will be more superior.[11]

About 30% of participants were lost to follow-up at one year and this posed a major limitation to the study. *Post-hoc* analysis was conducted and no significant difference in the demographics and COMPSQ-HK10 scores between the respondents and non-respondents were found, except the non-respondents of back pain were 3.5 years younger. It is believed that the results are still applicable to those patients lost to follow-up. In addition, the use of extracted items from the COMPSQ-HK to develop the COMPSQ-HK10 was likely to have the shared measurement error and contribute to type I error.[28] It is unknown if the results would have differed if only the COMPSQ-HK10 were administered. A study comparing the performance of three SF-36 scales (physical functioning, bodily pain and general health perceptions) administered independently to when they were administered wholly as the full version questionnaire showed no significant difference.[29] Extracting findings of items from those of the full questionnaire is, however, common in the validation of short version of OMPSQ of another language.[12] Finally, the self-reporting of outcomes of their RTW status and sick leave period was another limitation of the study. However, the actual figures could not be verified objectively as these data were not captured systematically in the local scene.

Conclusion

The results of the present study support the predictive validity of the COMPSQ-HK10 with comparable measurement properties to the COMPSQ-HK. Given its limitations, it is recommended to use the COMPSQ-HK10 for routine screening to identify patients of back and neck pain at risk of developing chronic pain and disability. Further study of the COMPSQ-HK10 in other musculoskeletal conditions is warranted.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Author Contributions

All the authors contributed to the conception and design of study, data analysis and interpretation, manuscript drafting, revision and approval for the submission to publication. RKY Lee, JSY Lau, SSF Kwong, EML So, TFY Wong and EWC Lee assisted in the data collection of the study.

Appendix: Short Form of the COMPSQ-HK

Table A.1.

	Item	Concept area	Scoring
1	How long have you had your current pain problem? 你目前疼痛的問題已有了多久?	Pain experience	1–10
2	How would you rate the pain that you have had during the past week? 你如何評估**過去一星期**你痛楚的程度?	Pain experience	0–10
3	Please circle one number that best describes your current ability to participate in each of these activities 請圈出最能形容你現時參與每項活動的能力。 I can do light work for an hour. 我可以做一小時輕巧的工作。	Self-perceived function	0–10, reversed scoring
4	Please circle one number that best describes your current ability to participate in each of these activities 請圈出最能形容你現時參與每項活動的能力。 I can sleep at night. 我晚上睡得著。	Self-perceived function	0–10, reversed scoring
5	How tense or anxious have you felt in the past week? **過去一星期**你覺得緊張或焦慮的程度如何?	Distress	0–10
6	How much have you been bothered by feeling depressed in the past week? **過去一星期**你因感到沮喪而使你有多煩擾?	Distress	0–10
7	In your view, how large is the risk that your current pain may become persistent? 你認為你目前的痛楚持續下去的風險有多大?	Return to work expectancy	0–10
8	In your estimation, what are the chances you will be working your normal duties in six months? 你估計你未來**六個月**內能如常工作的機會有多大?	Return to work expectancy	0–10, reversed scoring
9	An increase in pain is an indication that I should stop what I'm doing until the pain decreases. 痛楚增加就表示我應該停止我正進行的事情，直至痛楚減退。	Fear avoidance beliefs	0–10
10	I should not do my normal work with my present pain. 以我目前的痛楚情況, 我不應作我慣常的活動, 包括工作。	Fear avoidance beliefs	0–10

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Peak torque, rate of torque development and average torque of isometric ankle and elbow contractions show excellent test–retest reliability

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Background: Peak Torque (PT), Rate of Torque Development (RTD) and Average Torque (AT) over a single contraction assess the three components of muscle function during isometric contractions. Surprisingly, AT has never been reported or its reliability confirmed.
Objectives: This study aims to establish protocol reliability for ankle dorsiflexion and elbow extension isometric muscle function (PT, RTD, AT) in healthy participants using the Biodex System 3 Dynamometer.
Methods: Twelve participants (6 male, 6 female, mean age 39.8 ± 16.0 years) performed four maximal isometric contractions on two occasions. Intraclass Correlation Coefficient (ICC), Typical Error (TE) and Coefficient of Variation (CV) for PT, RTD and AT were reported.
Results: The ICC for all strength parameters varied from 0.98–0.92. TE for ankle dorsiflexion PT was 1.38 Nm, RTD 7.43 Nm/s and AT 1.33 Nm, CV varied from $6.26 \pm 6.25\%$ to $11.72 \pm 8.27\%$. For elbow extension, TE was 3.36 Nm for PT, 14.87 Nm/s for RTD and 3.03 Nm for AT, CV varied from $5.97 \pm 4.52\%$ to $18.46 \pm 14.78\%$.
Conclusion: Maximal isometric ankle dorsiflexion and elbow extension PT, RTD and AT can be evaluated with excellent reliability when following the described protocol. This testing procedure, including the application of AT, can be confidently applied in research, exercise or clinical settings.

Keywords: Reliability; strength testing; Biodex system 3; ankle dorsiflexion; elbow extension.

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Introduction

Muscular strength is defined as the production of maximal contractile force against a resistance in a single contraction.[1] To ensure regular functionality of the human body, muscle strength is a paramount requirement. Joint torque produced by muscle strength contributes to normal movement and athletic performance, assists in joint stability and posture control during activities of daily living and plays a vital role in the maintenance of functional independence during the aging process.[2,3]

The measurement of maximal muscular strength (Peak Torque (PT)) is often used to determine physical condition and the effects of training or rehabilitation programs.[4] However, from a functional perspective, the ability to generate torque quickly (Rate of Torque Development (RTD)) and to maintain torque (work/Average Torque (AT) over a single contraction) may be more important than being able to generate high maximal force. Although PT is the universal standard parameter used to measure strength, changes in RTD, Work or AT over a single contraction may represent the most important adaptations occurring from training or rehabilitation.[5,6] A comprehensive muscle function assessment should include all three parameters.[6,7]

First introduced as a device for muscle strength measurement in 1967 by Thistle *et al.*,[8] isokinetic dynamometry is the gold standard for assessing muscular functionality among athletic populations as well as populations engaging in rehabilitation programs.[9]

The application of isokinetic dynamometry for assessing muscular functionality in research and clinical practice requires testing procedures of high reliability, which refers to consistent reproduction of results when tests are performed multiple times under similar conditions.[10] Drouin *et al.*[11] report excellent "mechanical reliability" (Intraclass Correlation Coefficient (ICC) 0.99) for the Biodex System 3 when using force applied by a weight on the dynamometer arm. However, potential for repeatability error increases when applying test protocols with live subjects. Numerous studies have investigated protocol reliability with excellent results (ICC > 0.75), primarily assessing in an isokinetic mode and focusing on knee extension or flexion.[12–15] However, isometric mode is regarded as a safer and more appropriate mode for maximal strength testing, particularly in populations who have restricted range of motion or are unable to comply with isokinetic procedures.[16] Currently, isometric reliability remains underexplored. Studies include PT and RTD only, AT was not yet investigated.[17,18] PT represents the maximum torque produced at a single point of contraction.[19–22] RTD measures explosive muscular strength, which is key during movement performances characterized by reduced contraction times such as sprinting or boxing.[23–25] In the older or clinical population, RTD can be an indicator for the risk of falls.[6] AT over a single isometric contraction can replace the commonly used isokinetic parameter work.[5] Work represents the capability to generate muscle torque throughout the full range of movement[22,26]; this parameter cannot be applied during isometric contractions as there is no movement or distance achieved. In isometric contractions, AT over a single contraction represents the comparable capacity to maintain torque throughout the contraction time interval,[5] which is an important factor when performing activities of daily living. Daily tasks generally do not require maximal strength output, but the uphold of a lower torque over a period of time, e.g., lifting a glass of water to drink, putting the washing on the washing line, etc. The ability to sustain a given level of torque production over time is the most precise indicator of functional muscle rehabilitation. It is possible for tested muscle groups to reach rehabilitation standards for maximal muscle strength without regaining the ability to sustain this standard over time; PT often returns to normal before AT or Work.[7] Considering the importance of this strength parameter for the evaluation of rehabilitation programs and the appropriateness of isometric strength testing regarding safety and limited range of motion for patients, it is surprising that AT over a single contraction was never before reported during strength evaluation or its reliability established. Furthermore, other human joint actions such as ankle dorsiflexion and elbow extension have been investigated less frequently. Ankle dorsiflexion is a vital movement during the gait cycle and balance control[27,28]; likewise, elbow extension represents a movement of everyday function such as reaching.[29] The reliability of both movements has been investigated in an isometric mode in highly homogeneous populations, i.e., older women (mean age 73.3 ± 4.7) or elite swimmers.[17,18] These studies report excellent reliability (ICC 0.86–0.97) for isometric ankle dorsiflexion and elbow extension PT and RTD only.

To date, no study has assessed the test–retest reliability of all three most important parameters for muscle function (PT, RTD, AT) for isometric ankle dorsiflexion and isometric elbow extension using the Biodex System 3.

This study hypothesizes excellent protocol reliability when measuring maximal isometric ankle dorsiflexion and elbow extension strength in healthy non-athletic participants using the Biodex System 3 Isokinetic Dynamometer, with particular focus on the currently unexplored parameter AT over a single contraction. Furthermore, we set out to develop novel recommendations that ensure excellent reliability when assessing isometric PT, RTD and AT using the Biodex System 3 Isokinetic Dynamometer with the Biodex advantage software version 3.45 (Biodex Medical Systems, Inc., Shirley, New York, USA).

Methods

Design

This study followed a cross-sectional study of repeated measures for test–retest reliability. Each participant was familiarized in a separate session prior to the main testing at two time points. The same investigators conducted all tests and performed the verbal cueing in a consistent manner for all sessions and participants.

Participants

Twelve participants (Table 1), 6 male and 6 female (age 39.8 ± 16.0 years) (mean $\pm$ SD), height 1.68 ± 0.09 m, weight 74.1 ± 11.1 Kg) were recruited for this study. Both genders were recruited as previous studies using the Biodex System 3 for isometric strength use the same protocol for both males and females.[30,31]

Subjects were included if they (1) were aged between 18 and 65 years, (2) did not participate in strenuous exercise for 48 h prior to testing and (3) were in good health with no reported musculoskeletal dysfunction or surgical intervention in the tested limb within the last 12 months. Subjects were excluded if they (1) suffered from cardiovascular, respiratory or neurological impairments that would prevent physical strengthening activity or if they (2) were pregnant. The Health Science and Physiology Ethics Committee, Department of Life Science, Institute of Technology Sligo granted ethical approval, all participants provided written informed consent according to the Declaration of Helsinki.

Table 1. Description of participants.

Subject ID	Sex	Age (yrs.)	Height (m)	Weight (Kg)
1	F	23	1.66	68.5
2	M	24	1.77	82.1
3	M	26	1.82	76.5
4	M	25	1.73	53.6
5	F	24	1.57	83.1
6	F	28	1.64	64.4
7	F	52	1.64	78.6
8	F	53	1.57	58.6
9	M	64	1.70	77.8
10	M	51	1.82	92.6
11	M	58	1.64	73.6
12	F	50	1.63	79.5
Mean		39.8	1.68	74.1
SD		16.0	0.09	11.1

Equipment

All tests were conducted on the Biodex System 3 Pro Isokinetic Dynamometer with the Biodex advantage software version 3.45 (Biodex Medical Systems, Inc., Shirley, New York, USA). The standard Biodex ankle unit attachment with limb support and the Biodex Velcro straps were used for ankle dorsiflexion (Fig. 1). The standard shoulder/elbow unit

Fig. 1. Participant positioning for ankle dorsiflexion.

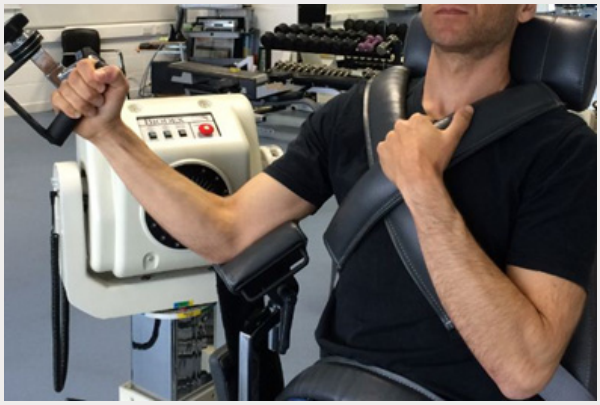

Fig. 2. Participant positioning for elbow extension.

attachment with limb support was used for elbow extension (Fig. 2). Before testing each subject, the system was calibrated according to the procedure in the Biodex System 3 manual.[32]

Participant positioning

Ankle dorsiflexion

Participants were positioned in stocking feet on the adjustable chair with the right leg elevated. The right foot was placed on the ankle unit footplate and the right knee was supported by the standard limb support, both were tightly secured with the Velcro straps provided (Fig. 1). Maximal isometric ankle dorsiflexion strength was assessed at the ankle joint angle of 10° plantarflexion (anatomical reference of 0° was set with the tibia perpendicular to the sole of the foot), 120° knee flexion[33] and 75° hip flexion.[32] The axis of rotation was aligned with the body of talus, fibular malleolus, and through the tibial malleolus. The hip and knee angle were adjusted by changing the distance between the chair and the footplate and by altering the height of the knee support.

Elbow extension

Participants were positioned on the adjustable chair with their right upper arm supported by the standard limb support (Fig. 2). Maximal isometric elbow extension strength was assessed at 85° elbow flexion (angle of most force production),[34] where 0° refers to full elbow extension, the shoulder joint was positioned at 45° shoulder flexion.[29] The axis of rotation was aligned with the center of the trochlea and the capitulum, bisecting the longitudinal axis of the shaft of the humerus. Participants were instructed to hold the handle of the elbow/shoulder attachment with a closed grip. A 5 cm space was consistently kept between the attachment and the anatomical axis of rotation; elbow and wrist joints were aligned with the wrist in neutral position by adjusting the chair, the dynamometer and the length of the arm/shoulder attachment. The shoulder angle was achieved by altering the height of the limb support.

All joint angles were measured with a hand-held goniometer; range of motion measurement followed the Biodex procedure.

Participant positioning, i.e., chair height, dynamometer height, attachment length, etc., was recorded during familiarization to ensure consistent set-up for all testing sessions.

Test-protocol

All testings were performed on the Biodex System 3 Isokinetic Dynamometer in the Health Science & Physiology Laboratory. The protocol was performed at three time points: **Familiarization** (pre-test), **Test 1** (> 48 h post familiarization) and **Test 2** (at least 7 days post-test 1). For all participants, laboratory conditions were consistent and all testings were conducted on the right side only to facilitate data collection.[35]

During all sessions, the lower limb was warmed up first and ankle dorsiflexion was assessed, the upper limb was then warmed up and elbow extension was assessed. The warm-up consisted of 3 min of leg/arm cycling performed at a level of perceived exertion of 10–12 on the Borg scale[36] and 1 set of 5 repetitions of unilateral, submaximal (perceived 50% of MVC), isometric contractions held for 5 s, separated by 5 s of rest.[37] Following the warm-up, maximal isometric strength was assessed using 4 maximal isometric contractions held for 5 s, separated by 45 s of rest.[38] Participants were blinded to the number of repetitions being recorded to avoid "saving energy" for later contractions.

Verbal cues given by the investigator were consistent for all participants during all sessions. For each contraction, participants were instructed to pull their toes towards their shin as "hard and as fast as possible" for ankle dorsiflexion assessment and to push their fist towards the ground as "hard and as fast as possible" for elbow extension assessment. Each participant was asked to give maximal strength each time and not to hold back.

The starting sign given by the investigator was a count down from 3, 2, 1 followed by "go". During the 5 s contractions, the principal investigator would loudly encourage the participant by using the verbal cues "go, go, go, keep going, keep going, keep going and rest".

Data analysis

From each set of four contractions, assessors identified the contraction with (1) the highest PT in Nm, (2) the highest RTD in Nm/s within the first 0.20 s of a single contraction, and (3) the highest AT in Nm of a single contraction. The time of contraction onset was identified manually (gold standard),[39–41] defined as the last trough before a sharp rise. Contractions were excluded if the participant performed an early contraction or counter movement before contraction onset. Counter movement refers to the lengthening of a muscle prior to contraction, resulting in a greater strength output and is indicated by a downward deviation of more than 10% of baseline torque in the resting position.[42]

Statistical analyses

Data were analyzed using the statistical package for social sciences (SPSS) for Windows (Version X, Chicago, IL, USA). Mean PT, RTD and AT were compared using a paired sample *t*-test. The ($ICC_{2,1}$) was used to calculate relative reliability. The first subscript number represents the "model" and the second subscript number signifies the "form". Model 2 was chosen as the appropriate model when each subject is measured by each assessor, and assessors are considered representatives of a larger population of similar assessors. Form 1 represents the use of a single score, in contrast to the use of a mean of multiple assessors' scores.[43] As a statistical measure of absolute reliability, Typical Error (TE) and the Coefficient of Variation (CV) were calculated. These values represent the expected random variability in measurement between two assessment time points.[10]

TE is expressed in the measurement unit it refers to calculated as

$$TE = SD_1/\sqrt{2},$$

where SD_1 is the standard deviation of the differences between the two measurements.[10,19]

CV is expressed as a percentage score. For a sample of individuals, it is recommended to calculate a mean CV from individual CVs.

$$CV = 100 * SD_2/\text{mean},$$

where SD_2 and the mean are calculated from the data of each individual.[44]

Results

For ankle dorsiflexion, 5 out of 96 (5.2%) contractions were excluded, for elbow extension, 21 out of 96 (21.8%) were excluded.

Individual results for each strength parameter for Tests 1 and 2 are given in Table 2. The means,

Table 2. Individual results for PT, RTD and AT for each test.

	Ankle dorsiflexion						Elbow Extension					
	PT (Nm)		RTD (Nm/s)		AT (Nm)		PT (Nm)		RTD (Nm/s)		AT (Nm)	
Subject ID	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
1	22.6	23.6	51.5	62.5	19.28	19.53	23.7	24.1	47.5	21.5	20.29	19.15
2	37.8	43.5	163.5	196.0	35.36	40.48	81.6	94.8	194.0	249.0	66.08	80.96
3	43.9	45.2	214.0	215.0	40.10	41.70	67.7	80.7	234.5	169.5	61.00	61.16
4	21.3	25.4	101.5	122.0	18.59	23.08	29.7	28.6	105.5	94.0	25.60	23.49
5	27.7	26.6	125.0	114.5	22.78	24.04	45.0	41.5	147.0	81.5	36.35	34.55
6	25.9	25.2	118.0	104.5	23.86	22.90	35.9	33.0	148.0	126.0	33.43	29.10
7	21.7	21.7	61.5	89.5	20.18	20.17	31.9	33.4	80.5	97.5	29.11	28.37
8	19.7	14.4	86.0	58.5	18.09	13.52	24.4	25.6	70.5	76.5	21.76	23.94
9	24.3	22.0	100.5	85.0	22.73	18.82	70.2	58.7	193.0	218.5	61.22	52.20
10	44.7	44.3	199.5	214.0	42.38	41.48	65.8	61.4	223.5	214.0	57.74	57.14
11	33.1	36.9	147.0	178.5	29.80	29.50	68.7	72.5	123.5	156.5	60.23	57.66
12	27.5	25.4	116.0	112.0	24.73	22.68	37.0	33.9	74.0	55.5	34.61	30.05

Table 3. Means, standard deviations and reliability measures for PT, RTD and AT.

	PT (Nm)	RTD ($Nm \cdot s^{-1}$)	AT (Nm)
Ankle dorsiflexion			
Test 1 ($n = 12$)	29.18 ± 8.73	123.67 ± 50.14	26.49 ± 8.47
Test 2 ($n = 12$)	29.52 ± 10.25	129.33 ± 56.89	26.49 ± 9.64
T1–T2 Difference (p)	0.72	0.35	1.00
TE	1.38	7.43	1.33
ICC (95% CI)	0.98 (0.91–0.99)	0.96 (0.88–0.99)	0.98 (0.92–0.99)
CV (%)	6.26 ± 6.25	11.72 ± 8.27	6.44 ± 6.69
Elbow extension			
Test 1 ($n = 12$)	48.47 ± 20.83	136.79 ± 63.51	42.29 ± 17.49
Test 2 ($n = 12$)	49.02 ± 23.807	129.99 ± 71.50	41.48 ± 19.54
T1–T2 Difference (p)	0.79	0.53	0.63
TE	3.36	14.87	3.03
ICC (95% CI)	0.98 (0.92–0.99)	0.92 (0.74–0.98)	0.98 (0.92–0.99)
CV (%)	6.05 ± 3.82	18.46 ± 14.78	5.97 ± 4.52

Notes: The highest PT, the highest RTD and the highest AT of the four contractions of each individual in Tests 1 and 2 were used to calculate means, standard deviations and the reliability analyses.

standard deviations and reliability values for PT, RTD and AT are presented in Table 3. There were no significant differences between tests 1 and 2 for all measures for both ankle dorsiflexion and elbow extension ($p > 0.05$).

Reliability analysis

Relative reliability (ICC) was excellent[45] for ankle dorsiflexion (PT 0.98, RTD 0.96, AT 0.98) and for elbow extension (PT 0.98, RTD 0.92, AT 0.98).

TE for ankle dorsiflexion PT was 1.38 Nm, RTD 7.43 Nm/s and AT 1.33 Nm, CV was 6.26% for PT, 11.72% for RTD and 6.44% for AT.

For elbow extension, TE was 3.36 Nm for PT, 14.87 Nm/s for RTD and 3.03 Nm for AT, CV was 6.05% for PT, 18.46% for RTD and 5.97% for AT.

Discussion

According to Fleiss,[45] ICCs in the range of 0.5–0.6 = fair, 0.6–0.7 = good and > 0.75 = excellent test–retest reliability. When measuring PT, RTD and AT for maximal isometric ankle dorsiflexion and elbow extension with the described protocol using the Biodex System 3 Isokinetic Dynamometer, this study established that the test–retest reliability was excellent (ICC 0.92–0.98). Excellent reliability implies high precision of measurement and allows confidence when assessing strength changes following exercise or rehabilitation programs.[10] The combination of all three strength parameters offers a comprehensive analysis of muscle function or recovery.[7]

Relative and absolute reliability established in this study is higher than the previously reported values for ankle dorsiflexion and elbow extension.[17,18,29,37] Previous reliability studies for ankle dorsiflexion and elbow extension have reported PT ICC values ranging from 0.80 to 0.97.[17,18,29,37] Contraction mode may be an influencing factor; joint movement during isokinetic testing appears to result in lower reliability values.[29,37] Furthermore, it is important to record participant positioning to ensure exact replication of protocol.[18] It is not surprising that ICC values are slightly lower due to potential positioning difficulties when assessing individuals who suffered a stroke, particularly, if equipment modification is required.[29]

Reliability (ICC, TE and CV) for RTD in this study is generally lower than for PT and AT. Participants were instructed to contract as hard and fast as possible. Although this is a recommended practice, participant's attention may be more focused on reaching highest peak values, with less emphasis on producing explosive muscular strength.[46] However, RTD ICC values in this study are higher than in the previous similar studies (0.84–0.86).[17] Variability in the methods for obtaining RTD values may be one reason for differing results. In this study, RTD was calculated

using the manual procedure recommended by Biodex System 3 (initial contraction onset to 0.2 s).[32] RTD has previously been reported for other time intervals, e.g., 0–50 ms, 0–50% of PT and 40–80% of PT.[17,47] Considering that RTD is an indicator of initial contraction torque,[23–25] measurements should start at contraction onset. It is worth noting that the Biodex advantage software version 3.45 only allows time intervals of 200 ms when analyzing data using the curser function, or time intervals of 100 ms when using the "log to file" application. This limits the ability to analyze RTD at shorter time intervals.

To our knowledge, this study is the first to include AT over a single isometric contraction. Our findings suggest that the analysis of AT is highly reliable for ankle dorsiflexion (ICC 0.98) and elbow extension (ICC 0.98) and should therefore be implemented in future isometric strength-testing studies. To assess a participant's torque generating capacity in all aspects, it is important to include all three of the aforementioned strength parameters, as one parameter alone does not provide a comprehensive insight into muscular function.

In this study, values for TE and CV are lower than the previously reported ones,[17,37] indicating better test–retest reliability. Differences may be due to the lack of familiarization with the testing equipment and procedure.[17] A lack of a familiarization session may affect scores of the second testing session due to a learning effect.[17] Dynamic modes appear to result in lower absolute reliability,[37] i.e., higher TE and CV values.

Early contractions and counter movements occurred more frequently during elbow extension than ankle dorsiflexion. Observations during testing revealed that more efficient participant positioning could be achieved when performing ankle dorsiflexion compared to elbow extension. During ankle dorsiflexion, all involved joints can be firmly stabilized. In comparison, during elbow extension, the upper arm cannot be firmly strapped to the elbow support due to contraction restriction, potentially resulting in higher technique variability. It may be necessary to address this issue when giving verbal instructions.

Compared to other reliability studies, this study consists of a relatively small sample size ($n = 12$). It is advised to base sample size calculations for reliability studies on the ICC value and width of the confidence interval. The higher the ICC value, and the narrower the width of the confidence interval, the smaller the sample size requirement.[48,49] Based on the lowest ICC value (0.92) and its widest width of confidence interval (0.24) achieved in this study, the sample size of 12 participants is sufficient when calculated as follows[50]:

$$k = \frac{8z^2_{\frac{\alpha}{2}}(1-p)^2(1+(n-1)p)^2}{w^2 n(n-1)},$$

where k = number of subjects rated, n = number of tests, p = ICC value, w = width of 95% confidence interval.

Recommendations for achieving excellent reliability

Assessor observation and comparison with previous studies has led to a number of recommendations resulting in excellent reliability when closely followed:

- Familiarization session should take place prior to test 1.
- Subject positioning should be carefully recorded and reproduced at each testing session.
- Participants should be blinded to the number of repetitions being recorded to avoid "saving energy" for later contractions. Each participant should be instructed to give maximal strength each time and not to hold back.
- To ensure accurate curve analysis, the designed protocol should represent the desired number of repetitions as sets consisting of 1 repetition. For example, in this study, 4 sets of 1 repetition was implemented rather than 1 set of 4 repetitions. When recording numerous repetitions per set, strength curves cannot be viewed individually, this may compromise the accuracy of manual analysis.
- To reduce the number of excluded contractions, how to avoid counter movements should be explained to participants and the importance to wait for "go" before contracting should be emphasized.
- Calculation of the novel parameter AT over a single contraction using the Biodex Software: select a specific contraction in the curve analysis program, click on the "log to file" application and save the data as a text document. The text document can then be opened in a spread sheet and calculations performed as normal.

Limitations

The inclusion criteria regarding age of participants in this study allowed for a wide age range to be recruited. Participation was voluntary and open to all staff and students of the Institute of Technology. This resulted in high age heterogeneity, which differs from other studies. This study, however, did not aim to assess reliability according to age category and there are no obvious reasons why age in a healthy population should affect reliability. Although the relatively small sample size is sufficient for reliability testing, it does not allow for subgroup analysis, i.e., age categories, sex, dominant versus non-dominant side.

Conclusion

This study is the first to establish excellent test–retest reliability for all three strength parameters (PT, RTD and AT) for isometric ankle dorsiflexion and elbow extension for the described protocol using the Biodex System 3 Isokinetic Dynamometer. Furthermore, this study has proven AT to be a reliable strength parameter when testing in an isometric mode. When the aforementioned-recommended procedures are closely followed, this testing protocol can be confidently applied in research, exercise science or clinical populations, in which impairments in ankle dorsiflexion and elbow extension are common.

Conflicts of Interest

All contributors are independent authors and there are no conflicts of interest regarding this paper.

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Author Contributions

Daniel JC Simpson and Monika Ehrensberger contributed to study design, acquisition of data, analysis and interpretation of data, and writing of the manuscript. Study design, acquisition of data and revision of manuscript were carried out by Christopher Nulty. Joanne Regan contributed to study design, interpretation of data, and revision of manuscript. Patrick Broderick contributed to acquisition of data, and revision of manuscript. Dr. Catherine Blake carried out the analysis and interpretation of data and revision of manuscript. Dr. Kenneth Monaghan contributed to study design, interpretation of data and revision of manuscript.

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Physiotherapist–patient communication in entry-level physiotherapy education: A national survey in Nigeria

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Background: Clinical communication impacts on physiotherapy treatment outcome and its competence warrants being assessed during training for physiotherapists given the increasing need to improve patient outcomes.
Objective: This study aimed to investigate the assessment of clinical communication in entry-level physiotherapy programs in Nigeria.
Methods: In a cross-sectional survey, questionnaires were sent by e-mail or hand-delivered to the heads of physiotherapy programs, asking them to consult with faculty members involved in the assessment of clinical communication in undergraduate education.
Results: Six of seven physiotherapy programs responded (an 86% response rate). Assessment of clinical communication and methods of assessing clinical communication by the programs showed wide variation. There was an average of two assessments per year. The objective structured clinical examination with patients (21; 38%) and written communications (report/chart) (13; 23%) were the most commonly used

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assessment methods. Perceived challenges included a lack of facilities, validity, inexperienced examiners, and difficulties in integrating processes and content.
Conclusion: A variety of assessment methods are being used in entry-level physiotherapy programs in Nigeria, which target different components of clinical communication skills acquisition. More effort is needed to improve limited facilities and human resources training to enhance clinical communication assessment in Nigerian physiotherapy programs.

Keywords: Interpersonal skills; patient care communication; clinical competence; physiotherapist–patient communication.

Background

Effective communication is an essential skill that clinicians need in practice to improve the quality and efficiency of care.[1] Therapeutic outcomes in chronic long-term disease management hinge on the quality of a therapeutic alliance.[2–4] The quality of therapeutic alliance, described as the collaborative nature, the affective bond, and the goal and task agreement between patients and clinicians,[5] is partly determined by how clinicians and patients communicate.[6] Hills and Kitchen[7] posited that the safety of the patients, the quality of care they received, as well as the satisfaction they derived from healthcare services is greatly influenced by communication skills of the healthcaregivers.

Most interventions in physiotherapy are of long-term nature. Accordingly, communication skill is central to engaging patients in a therapeutic relationship, and particularly putting the patient at the center of the care as an active participant in decision-making.[8,9] The ability to listen, respond, and convey information clearly, considerately, and sensitively is a prerequisite for a successful practice.[10] A physiotherapist who is not competent in clinical communication may miss important information or may be unable to convey the information to the patient during the course of assessment, thereby leading to a wrong diagnosis and treatment. Therefore, physiotherapists are expected to communicate effectively over every area in their curriculum to provide an effective practice.

For healthcare professionals, communication skills need to be taught and learnt in a clinical context, in either clinical practice or clinically relevant simulations.[11,12] To ensure that graduate physiotherapists are actually competent in communication skills, physiotherapy programs need to provide evidence of skill attainment demonstrated through some forms of assessment. The implication is that during the course of study, students should be assessed on their level of competence. Miller[13] described four models of clinical communication competence ranging from aspects of acquiring theoretical knowledge (described as "knows"), knowledge of how to apply these skills ("know-how"), being able to competently carry out the skills on specific occasions ("show-how"), to the ability to competently carry out the skills on a daily basis ("does"). Evidence suggests that integrative assessment strategies better predict clinical performance than assessment targeting a singular competence test.[14] As part of being able to carry out communication skills in every patient contact, the physiotherapist necessarily needs to ensure that the patients "importantly follow through with recommended home programs." What happens "between" physiotherapy treatments is arguably as important if not more important than the short time that patients spend with the physiotherapist. Thus, the power of communication with the physiotherapist to motivate and encourage the patient to follow through with the "homework" is critical.

There is a growing interest in communication training in the profession of physiotherapy, but research has largely been conducted in high-income countries.[15] Similarly, although there is evidence in physiotherapy supporting the development of effective communication skill as an important aspect of physiotherapy education,[16,17] time constraints within physiotherapy curriculum appear to limit focus to physical rehabilitation thereby neglecting this important aspect of clinical training.[18] Consequently, there is a dearth of literature on clinical communication training in entry-level physiotherapy. A preliminary study of UK physiotherapy institutions delivering qualifying programs identified a need for more experiential teaching and observing the communication

skills with patients.[15] Internationally, there is dearth of research reporting assessment of physiotherapist–patient communication.[8]

Given the increasing globalization of the health professional workforce, clinical communication training of physiotherapists is important irrespective of the country where they are trained. To the investigators' knowledge, there is no literature reporting on the clinical communication assessment methods being used in physiotherapy programs in Africa. This study, being the first of its kind in Nigeria, aimed to benchmark the current clinical communication assessment in entry-level programs in the Nigerian physiotherapy programs. Specifically, this study aimed to explore if and how clinical communication is addressed in Nigerian physiotherapy entry-level programs. We examined the methods used to assess clinical communication and the frequency of assessment within programs.

Methods

Research design

This was a cross-sectional survey of physiotherapist–patient communication assessment in entry-level physiotherapy programs in Nigeria. Heads of physiotherapy programs in Nigeria constituted the sample for this study and a convenient sampling technique was employed in recruiting eligible participants. In reporting the results of this study, broad terminologies of clinical communication are used in some instances, to refer to the construct of physiotherapist–patient communication.

Data collection procedure

A questionnaire originally developed, following extensive literature review, to undertake a national survey of clinical communication assessment in the medical programs in the UK was adopted.[10] To establish the content validity, the items reported by Laidlaw and co-workers[10] were selected, appraised, and further refined, by two Nigerian academics who have an interest and expertise in physiotherapist–patient communication. To do this, the questionnaires were piloted with an experienced group of six physiotherapy educators from three programs (two at each program) involved in clinical communication. Participants reported that the tool was acceptable and easy to use, and provided comments which helped refine the questionnaire. Specifically, the responders suggested that an item relating to challenges and facilitators of clinical communication be included in the questionnaire, and the item relating to what happens to students who failed compulsory communication assessment be made open-ended. Two of the investigators independently evaluated the responses and comments and made suggestions for improving the final tool. Areas of disagreements between the two investigators were resolved by consensus.

At the commencement of data collection, there were eight entry-level physiotherapy programs in Nigeria, however, one new program had yet to admit students. This program was eliminated from the pool of eligible participating programs. Between February 2014 and July 2014, questionnaires were sent to the heads of the seven physiotherapy programs in Nigeria through e-mail or hand-delivered depending on the location and convenience. The heads of the physiotherapy programs were asked to complete the questionnaire for clinical communication assessment after consultation with faculty members involved in clinical communication assessment. Reminders were sent in the form of phone calls and e-mails. The questionnaire asked the programs to list occurrences of clinical communication assessment, recording when the assessment occurred, the types and context of assessment, and in case of practical assessment, who was involved as well as the type of scale used. Open responses were sought in some questions, including what are the greatest challenges and facilitators in the assessment of communication in your physiotherapy program?

Ethical approval

Ethical approval was obtained from the Research Ethics Committee of University of Nigeria Teaching Hospital. Written consent for participation was sought and obtained from the heads of the physiotherapy programs before they were involved in the study.

Presentation of individual reports

Data are presented in the tables of frequency, expressing the assessment method, examiner types, and frequency of assessment. Responses to questions regarding challenges and facilitators in assessing clinical communication were analyzed

thematically,[19] and further synthesized using a narrative synthesis. First, a line-by-line coding of the responses was conducted. This was followed by the organization of these "codes" into related areas to construct "descriptive" themes. These descriptive themes were further development into "analytical" themes. Two of the investigators independently provided the data coding, with themes derived from the data, and consensus was reached on any discrepancies by discussion and reflection. Participants' direct quotes are used in some instances, to illustrate the themes.

Results

The details about the physiotherapy entry-level programs in Nigeria schools and types of clinical assessment among them are presented in Table 1.

Six of the seven eligible physiotherapy programs in Nigeria have comparable entry qualification requirement: credit in ordinary level (high-school level) in English, Mathematics, Biology, Chemistry, and Physics; advanced level pass in English plus two subjects chosen from Biology, Chemistry, and Physics; or a first degree in science/premedical courses.

The duration of study for the six programs is the same: five years for students who entered through the Unified Tertiary Matriculation Examination, and four years for direct-entry students. There were variations in the course offerings of the six programs. Two programs (33%) had a traditional course (emphasis on lectures); one program (17%) had a problem-based course; one program (17%) had an integrated course (similar emphasis on both lectures and didactic teaching); one program (17%) combined both integrated and problem-based learning; while one program (17%) each had a mid-sectional/semester course utilizing varied learning approaches. The mean cohort was 49 (range 30–80). Four (67%) of the six programs had no compulsory communication assessment. For the two programs with compulsory assessments, provisions like re-sits, repeat courses, or carryover of courses to the next class were made available for students who failed the assessment.

Types of clinical assessment used among the physiotherapy programs are shown in Table 2. Seven methods were listed: Actor/simulated patient type of objective structured clinical examination (actor/simulated patient OSCE); objective structured clinical examination with patients [OSCE (patients)]; long case; mini clinical evaluation exercise (mini-CEX); portfolio/reflection; written communication (report/chart); written multiple choice questions (MCQs) or short written answers (SWAs).

Totally 56 clinical communication assessments were reported across the six programs, with a mean of nine assessments per program (range 6–13). The OSCE (patients) and written communication (report/chart) were the most used methods, occurring twice in the programs on average. Three methods — OSCE (patients), written communication (report/chart), and written communication (SWAs/MCQs) — were used by all the programs, and none used a workplace method. On average, the programs assessed clinical communication in five ways.

The stages in progression of the program during which clinical communication is assessed, by whom, and the mark sheet used are shown in Table 3. No assessment was recorded in the first year and only one program (17%) reported conducting clinical communication assessment in the second year. All programs assessed clinical communication during the third, fourth, and fifth years. The highest number of assessments occurred during the final (4.5 times on an average) and penultimate (three times on an average) years. Assessments were completed by physiotherapists and other health communication teachers, while one program reported inclusion of non-health professionals.

Mark sheets used by the programs in grading students in clinical communication assessment varied widely. One program did not provide answer mark sheets used in the assessment. Among the remaining five programs, two (40%) programs made use of a checklist alone; two others (40%) used both a checklist and a global rating, while one (17%) program applied a global rating alone. Respondents were asked if their clinical communication assessment is formative or summative in nature. Five (83%) of the physiotherapy programs responded that the assessments are summative, while one (17%) program included formative assessment in addition.

Four (67%) of the programs responded that they have no compulsory communication assessment for which failure would prevent progression, but communication assessment forms a significant part of their clinical examinations. Two (33%) programs, in addition to having compulsory courses like introduction to clinical, communication skills and ethics, and patient care communication as the

Table 1. Summary of information on types of clinical assessment among the physiotherapy entry-level programs in Nigeria.

Program ID	Course ID	Entry qualification	Course duration	Course type	Cohort size	Any compulsory communication assessment	What happens to students who failed the compulsory communication assessment
01	Entry level	Five-level credit in English, Biology, Chemistry, and Physics. Good first degree in science or premedical courses	Five years for UTME examination; four years for DE	Integrated and problem-based	25	None	Not applicable
02	Entry level	Five-level credit in English, Biology, Chemistry, and Physics. Good first degree in science or premedical courses. "A"-level pass in English, Biology, Chemistry, and Physics	Five years for UTME examination; four years for DE	Integrated	40	None	Not applicable
03	Entry level	Five-level credit in English, Biology, Chemistry, and Physics. Good first degree in science or premedical courses. "A"-level pass in English, Biology, Chemistry, and Physics	Five years for UTME examination; four years for DE	Problem-based	59	No	Not applicable
04	Entry level	Five-level credit in English, Biology, Chemistry, and Physics. Good first degree in science or premedical courses. "A"-level pass in English, Biology, Chemistry, and Physics	Five years for UTME examination; four years for DE	Mid-sectional/ semester	60	Yes	Re-sit
05	Entry level	Five-level credit in English, Biology, Chemistry, and Physics. Good first degree in science or premedical courses. "A"-level pass in English, Biology, Chemistry, and Physics	Five years for UTME examination; four years for DE	Traditional	80	Yes	Repeat course/carryover to next class
06	Entry level	Five-level credit in English, Biology, Chemistry, and Physics. Good first degree in science or premedical courses. "A"-level pass in English, Biology, Chemistry, and Physics	Five years for UTME examination; four years for DE	Traditional	30	No	Not applicable

Notes: UTME = Unified Tertiary Matriculation Examination; DE = direct entry; Course ID: It represents the type studied; reference program studied was entry level.

Table 2. Summary of the number of occurrences and types of clinical assessment among the physiotherapy entry-level programs in Nigeria.

Program ID	OSCE (actor/ simulated patient)	OSCE (real patient)	Long case	Mini-CEX	Workplace	Portfolio	Written communication (report/chart)	Written communication (SWAs/MCQs)	Total
01	2	3	0	0	0	0	2	1	8
02	2	2	1	1	0	0	4	3	13
03	0	1	2	1	0	0	1	1	6
04	1	2	1	0	0	0	2	2	8
05	1	2	1	0	0	2	2	1	9
06	1	4	2	1	0	0	2	2	12
Total	7	14	7	3	0	2	13	10	56

Notes: Program ID represents the different PT programs; numbers are given in the order of how responses were returned. OSCE: Objective Structured Clinical Examination; MCQ: multiple choice questions; SWA: short written answers; Mini-CEX: mini clinical evaluation exercise.

Table 3. Summary of the stages in the progression of Nigeria physiotherapy entry-level program at which clinical communication is assessed.

Program ID	First year of study	Second year of study	Third year of study	Fourth year of study	Fifth year of study	Total	Who assesses communication	Mark sheet used	Summative/ formative
1	0	0	1	3	4	8	• Communication teacher, health professional • Physiotherapist	Checklist	Summative
2	0	2	2	4	5	13	• Communication teacher, health professional • Communication teacher, non-health professional • Actor/simulator • Physiotherapist	Checklist and global	Summative and formative
3	0	0	1	2	3	6	• Communication teacher, health professional • Physiotherapist	Global	Summative
4	0	0	1	3	4	8	• Lecturers	Checklist and global	Summative
5	0	0	1	3	5	9	• Physiotherapist • Communication teachers • Physiotherapist	Checklist	Summative
6	0	0	2	4	6	12	• Communication teachers	—	—

compulsory clinical courses, also reported having integrated assessment in which communication skills are assessed as part of the course and pre-requisite courses. Support for students who failed compulsory communication assessments included examination re-sits after an extended period of revision tutorials, and/or transfer to other program in the university when the student could not cope with rigor.

Respondents were asked to state what the major challenges and facilitators are in implementing clinical communication assessment in their various physiotherapy programs. Qualitative responses regarding challenges and facilitators to the assessment of clinical communication were coded and synthesized thematically. With respect to challenges, five themes emerged: uncertainty relating to validity of the method of assessment; inadequate resources and facilities compared to the student population; inexperienced examiners; difficulty in prioritizing process; and content integration.

One of the respondents stated:

> "Financial and human costs are limiting factors when considering which form of assessment to adopt per time or the tool to use; but again, we are concerned that at some point the tool we have chosen may not have been the best choice to accurately measure students' performance."

Another respondent puts it this way:

> "It's my experience that sometimes the student who is being examined possesses a better communication skill compared to an examiner; and may result in a situation where a good student is undermarked by poorly skilled examiner."

Themes emerging from responses regarding facilitators to assessing clinical communication were identified and included: prior budgetary provisions that considered student cohort, adequate training and retraining of personnel, and attention to validity of methods, content, and processes employed in assessment.

Discussion

This survey provides a snapshot of the status of the assessment of patient communication in the population of eligible entry-level physiotherapy programs in Nigeria. Based on our survey, the duration of physiotherapy entry-level programs was five years for students who entered through the Unified Tertiary Matriculation Examination, and was four years for the ones who gained admission after passing the requisite "A"-level examinations or have obtained a good first degree in applicable science course. The Unified Tertiary Matriculation Examination is a requisite entrance examination for getting into the undergraduate programs of universities, polytechnics, and colleges of education in Nigeria.[20] Through this examination suitably qualified candidates are placed into the available places in these institutions.

Apart from the first year (when no assessment was conducted) and the second year (when only one program reported conducting assessment), Nigerian physiotherapy programs engaged in clinical communication assessment in a fairly uniform frequency — an average of three times a year. There is no benchmark study on the number of assessments in physiotherapy required to adequately assess clinical communication competence. Reports from studies in other health professions varied between 7 (Ref. 21) and 14.[22] It is however difficult to argue against the reliability and generalizability of the number of assessments reported in this study because the modes of assessments also showed wide variability — which is an advantage. Involving a mixture of multiple methods of assessment has been shown to be the most effective approach to evaluating communication and interpersonal competence.[23]

Our findings show that, unlike the physiotherapy programs in the UK which begin clinical communication assessment for students early in their programs,[15] Nigerian physiotherapy programs assess clinical communication mostly beginning from the third year and throughout their curriculum in many ways. The durations of the UK entry-level physiotherapy programs are shorter (three or four years Bachelor of Science and two years pre-registration Master of Science physiotherapy programs)[24] compared to their Nigerian counterparts (five years for the students who gained entrance through the university Unified Tertiary Matriculation Exams and four years for those admitted through direct-entry admission).[25] These shorter program durations of the UK programs perhaps warrant clinical skill education including clinical communication to be started off early in their programs. Whether or not there is any effect of the length of the programs or the time

point at which clinical communication assessments begin during the training on the competence of the graduate has not been investigated.

For the Nigerian entry-level physiotherapy programs, the most frequent forms in which clinical communication assessments were reportedly done were the OSCE (involving patients) and writing communication (report/chart), occurring 14 times and 13 times, respectively. Again these differ with the UK programs which concentrate on theoretical knowledge over practical and experiential learning.[15] The OSCE was initially described by Harden and Gleeson[26] in the 1970s and has since gained popularity. However, the OSCE in its most common form measures only one aspect of clinical communication from Miller's pyramid model of assessment, the "show-how" component.[13] Laidlaw *et al.*[10] report that using this method of assessment alone could miss out testing the other components of skills acquisition. This assertion is supported by several other researchers who independently opined that the OSCE assessment has little correlation with the assessment of knowledge, verbal competence, or written communication, and called for the use of several methods to ensure rounded assessment.[27–29]

It is important to highlight, however, that from this study Nigerian physiotherapy programs were reported to use an average of five methods of assessment, including the written communication (SWAs/MCQs) and written communication (report/chart) assessments. The SWAs and the MCQs could be used to address student responses to patient attitude, while the written communication (report/chart) could be used to either test student knowledge about management strategies or explore students' communication skills through presentation of cases associated with challenging communication issues. The present study did not inquire from our respondents what communication skill was targeted by the use of each specific assessment methods. This needs to be further examined in future studies.

In this study, the OSCE was used mostly during the senior years, with five out of the six programs using only the OSCE (patients) in 75% of assessments in the fifth year. Similar finding was reported among the UK physiotherapy programs.[15] Like these UK physiotherapy programs, knowledge assessment was more common in the early years, through written communication like the MCQs, reports, and charts. Long cases were used throughout the duration of the study. The aspect of understanding how to apply that knowledge ("know-how") through portfolio and performance ("does") seems to be lacking in these programs, as only one program engaged in the portfolio method and no program engaged in the workplace-based method. This is certainly an area needing improvement, as certain outcomes such as attitudes and professionalism, which are difficult to assess by traditional methods, could be accurately evaluated by portfolio assessment.[30] Attributes relating to attitudes and professionalism are increasingly emphasized in the proposal on contemporary and future direction of physiotherapy training and practice.[31]

This study considered the issue of examiners. Assessments were carried out mainly by the physiotherapists with patients sometimes involved as examiners. This finding is encouraging given the experts opinion that evaluation of competence in communication should be based on direct observation by persons who competently perform these skills,[32] and actual participants in an interaction may be better placed to judge the appropriateness of the communication than an impartial observer.[30] Involving patients as evaluators may give accuracy to evaluation of some of the interpersonal skills that create the therapeutic relationship.[33] Although physiotherapists were mostly involved in the assessment, it was not clear if physiotherapy clinicians were part of the assessments or whether only academic physiotherapists were involved. This warrants further investigation.

Several challenges were reported by the respondents in assessing clinical communication, which were grouped under four main themes: validity; difficulty in prioritizing process and content integration; inadequate resources and facilities compared to the student population; and incompetent examiners. Addressing these challenges may promote the effectiveness of assessment and perhaps competence of clinical communication in students. As reported by the respondents, prior budgetary provisions that considered student cohort size may ensure that adequate arrangement are made in time. Generally, funding is a major issue to the Nigerian institutions.[34] All the physiotherapy programs are within the public institutions and solely depend on government funding. Some of the respondents posited that clinical communication generally, and more particularly in physiotherapy clinical education, appears to

compete with other priority funding. Accordingly, resource allocation may be generally skewed towards funding teachings centered on imbibing theoretical knowledge and understanding of disease. Again this calls for review of stakeholders' priority to explore how best generic skill and attributes in area such as physiotherapist–patient communication are included as a priority within current teaching in physiotherapy entry-level training.

Similarly, there is a need for adequate training of those involved in clinical communication teaching and assessment. Generally, there is a dearth of literature regarding adequacy of skills possessed by physiotherapy educators to efficiently conduct clinical communication assessment, and particularly in Africa. Nonetheless, several challenges have been documented,[15] as well as responses from the present study. For instance, respondents in this study typically expressed as a barrier the perceived lack of competence by some examiners; and the possibility of this leading to a situation where a student is underscored. While this may indicate the need for personnel competence training, there was no clear evidence whether or not graduates of these physiotherapy programs are in fact competent in therapist–patient communication based on the current approach. Nonetheless, there is an increasing call for evidence-based clinical education as the foundation for future evidence-based practice of entry-level practitioners.[35] Similarly, there is a growing demand that health professional educators be held accountable to the funds invested in training healthcare professionals.[36] These demands, in addition to the barriers raised by our respondents, highlight the need for future investigation of the clinical communication competence possessed by the entry-level graduates of these programs in order to evaluate if the current approach needs amendment.

Ensuring that entry-level graduates possess the clinical communication skill required for optimum interaction with patients is the responsibility of the clinical educators and the education programs they represent. Whether or not these are in place is a subject of growing research focus. Although challenges were reported by the respondents, it is not apparent whether or not the identified challenges are greater for the specific assessment type. This is so given that our questionnaire did not seek information on the assessment-type specific challenges. Arguably, this information may be important for a tailored intervention. Among others, studies establishing specific assessment-type challenges are needed to inform intervention for improving the training and assessment of physiotherapist–patient communication in entry-level physiotherapy program in Nigeria.

This study provides a base, albeit modest, from which future studies can be developed. Despite its general modesty, there are implications for at least beginning to reflect on optimal physiotherapist–patient communication in physiotherapy professional programs around the world. Specifically, strengthening the physiotherapist–patient communication in entry-level curricula needs to be a priority clinical competency required to be taught and evaluated comparable to other clinical competencies. There are few research works on the medical professionals that have examined the elements of strong positive communication with patients (e.g., trust, respect).

In addition, research is needed from the patient's perspective. Do the patients feel respected, do they feel trusting, do they believe their treatment was well explained, do they believe their "home programs" are well described, do the physiotherapists follow up each visit, are the physiotherapists motivating and encouraged adherence, and do the physiotherapists show alternatives if the patient was unable to follow through with the "home programs?" Finally, given the variability of the findings across Nigerian programs, not only are the studies needed in other countries, but minimum accreditable standards (like other clinical competencies) may be needed to minimize variability.

Conclusion

Assessment of physiotherapist–patient skills in entry-level programs of Nigeria's physiotherapy programs seems adequate to meet the standard for inclusion of clinical communication skill, as prescribed by Norcini *et al.*[37] and Guiton *et al.*[21] Physiotherapy students have their clinical communication assessed on an average of three times a year. The OSCE and written communication were the most common forms of assessment used by programs. It is encouraging that a variety of assessment methods were used, and these methods target different components of clinical communication skills.

Limitations

There are several limitations in this study. First, although the first ever attempt to benchmark therapist–patient communication assessment in physiotherapy program in Africa, data collection relied on heads of departments of the physiotherapy programs instead of all persons involved in the assessment. Although an 85% response rate was achieved, this is still not a comprehensive report of the clinical communication assessment occurring within Nigerian physiotherapy programs, as it relies on a self-report from the heads of the programs. However, it does provide a snapshot of the assessment practices in this area in the majority of programs. Whereas the heads of the programs were requested to consult staffs involved in the assessment prior to completing the questionnaire, the fidelity of this could not be guaranteed as no questions probed regarding the number of assessors each program had or how many were actually consulted. This is another limitation of this study. Furthermore, the nature of the questionnaire did not provide the opportunity for answers to some subtle but important questions. For example, we did not inquire if challenges noted by the respondents were greater for any specific assessment type. Also, emphasis of the present research was on the assessment and not the content and the teaching of patient communication. Given that clinical communication is a singular important competency, its content and teaching in the undergraduate curriculum warrant being assessed. Lastly, in a bid to get optimum response rate, we administered the questionnaire in different ways — e-mail and hand delivery. This might have implications for response rates. These deficiencies should be addressed in future researches.

Conflict of Interest

The authors have no conflict of interest to declare.

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Author Contributions

Ukachukwu Okoroafor Abaraogu: Study conception, design, data collection, and analysis and critical revision of the manuscript. Kaosisochukwu Rachael Aguji: Contributed to the study design, data collection and analysis, and initial drafting of the manuscript. Deborah Onyinyechukwu Duru: Study design, data collection and analysis, and manuscript drafting. Udoka Chris Okafor: Study design, data collection, and critical revision of the manuscript. Antoninus Obinna Ezeukwu: Study design, data analysis, and critical revision of the manuscript. Sylvester Emeka Igwe: Study conception, data analysis, and critical revision of the manuscript. All authors approved the final version of this manuscript.

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