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Original Research Article

Clinical Measures of Musculoskeletal Foot and Ankle Assessment: An International Consensus Statement

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ABSTRACT

There is no clear consensus on the methods to assess the status of the foot and ankle within musculoskeletal disease management.
Objectives: To use evidence driven approach to identify a core set of objective musculoskeletal foot and ankle assessment measures to inform a protocol applicable to clinical and research circumstances.
Methods: Nineteen experts from podiatry, rheumatology, physiotherapy, and orthopaedics were included in a Delphi exercise to reach consensus on a core set of clinical foot and ankle musculoskeletal assessment measures. Future research agendas were defined via a face to face expert meeting and strength of recommendation scores were established for each agreed measure.
Results: Following a four round Delphi exercise, ninety-five foot and ankle measures were reduced to a final list of twenty. Future research agendas for validity testing were proposed. Strength of recommendation scores were provided to give an indicated level of recommendation for the use of each measure within clinical and research setting.
Conclusion: The study has provided an expertly derived core set of musculoskeletal foot and ankle assessment measures, applicable for research and clinical use. These are recommended for musculoskeletal screening purposes of the foot and ankle within the clinical and research setting. Using a consensus derived set of measures is a useful step towards a common minimum dataset and improved comparability between studies. Further work is now required to test these measures for validity and reliability in order to define the measures to be included within a foot and ankle assessment tool.

Key words: Foot, Ankle, Assessment**,** Measures**,** Consensus

INTRODUCTION

Population representative meta-analysis has reported a 20% prevalence of foot and ankle pain in adults of middle and old age, with two-thirds reporting moderate or worse disability with daily activities. [1] There is increasing evidence to show that foot problems are highly prevalent in patients who have musculoskeletal conditions. [2-9] Despite this the contribution

of foot and ankle symptoms within musculoskeletal conditions has often been overlooked. This lack of awareness is likely due to the absence of a 'gold standard' for the most appropriate assessment of the lower limb and foot.

Despite advances in musculoskeletal disease management, a large proportion of patients remain significantly impaired by foot complications. [5,10] The emergence of disease led foot and ankle research brings with it the demand for high quality interventional studies to investigate optimal methods of managing foot and ankle pathologies. In the first instance a method for assessing the physical musculoskeletal status of the foot and ankle is required to provide a method for observing baseline characteristics and subsequent change. At present there is no consensus on the ideal method for assessing the musculoskeletal status of the foot and ankle, a reason for which is due to the number of domains that require assessment. Furthermore the limitations highlighted from a previous meta-analysis have shown the requirement for future studies to adopt a standardized method of clinical assessment to explore the contribution of common foot disorders to the development of foot symptoms. [1] The aim of this study was to gain expert consensus on a core set of objective, clinical foot and ankle musculoskeletal assessment measures, applicable for use in both clinical and research settings.

MATERIALS AND METHODS

In order to develop the core set of musculoskeletal foot and ankle measures, a Delphi technique was used. The Delphi technique, a structured process using a series of rounds to obtain consensus, [11,12] has been successfully applied to develop previous statements and guidelines by international task forces such as Osteoarthritis Research Society International (OARSI) and the European League Against Rheumatism (EULAR) to produce consensus recommendations on the diagnosis and management of musculoskeletal diseases. [13-20]

The results of a literature review were presented to the expert group prior to and during a Delphi exercise. We undertook a multistage process consisting of the following steps (Figure 1).

Expert Steering committee

Groups were identified on the basis of foot and ankle expertise and research/clinical experience. Nineteen expert representatives were identified from Podiatry (n=11), Rheumatology (n=4), Orthopaedics (n=1), and Physiotherapy (n=3), from countries including the United Kingdom, Australia and New Zealand. The majority of experts were sourced from Podiatric profession due to the specialism in foot and ankle assessment; however other professions were included to limit bias that may evolve from the education and professional development of specific clinical professions. Expert clinicians/researchers with known and demonstrable experience and expertise in the field of foot and ankle musculoskeletal pathology and management were purposively sampled.

Delphi Exercise

A review was undertaken to determine all clinical foot and ankle musculoskeletal assessments and to demonstrate the evidence available for the reliability and validity each. CINAHL and MEDLINE electronic databases were searched with limitations applied to the searches in terms of language (English), age of paper (published between January 1980 - December 2012) and human participants. Search terms are highlighted in appendix 1. The main concepts of the search terms and synonyms were determined by members of a foot and ankle expert steering group. The

review aimed to capture all current clinical musculoskeletal foot and ankle assessments; therefore all relevant articles were considered irrespective of quality. Data extracted from each article included type of assessment, population and sample characteristics of participants, type/profession and number of assessment examiners, main findings, in particular for assessment reliability and validity. Findings of the review were shared with the expert panel via an interactive web link.

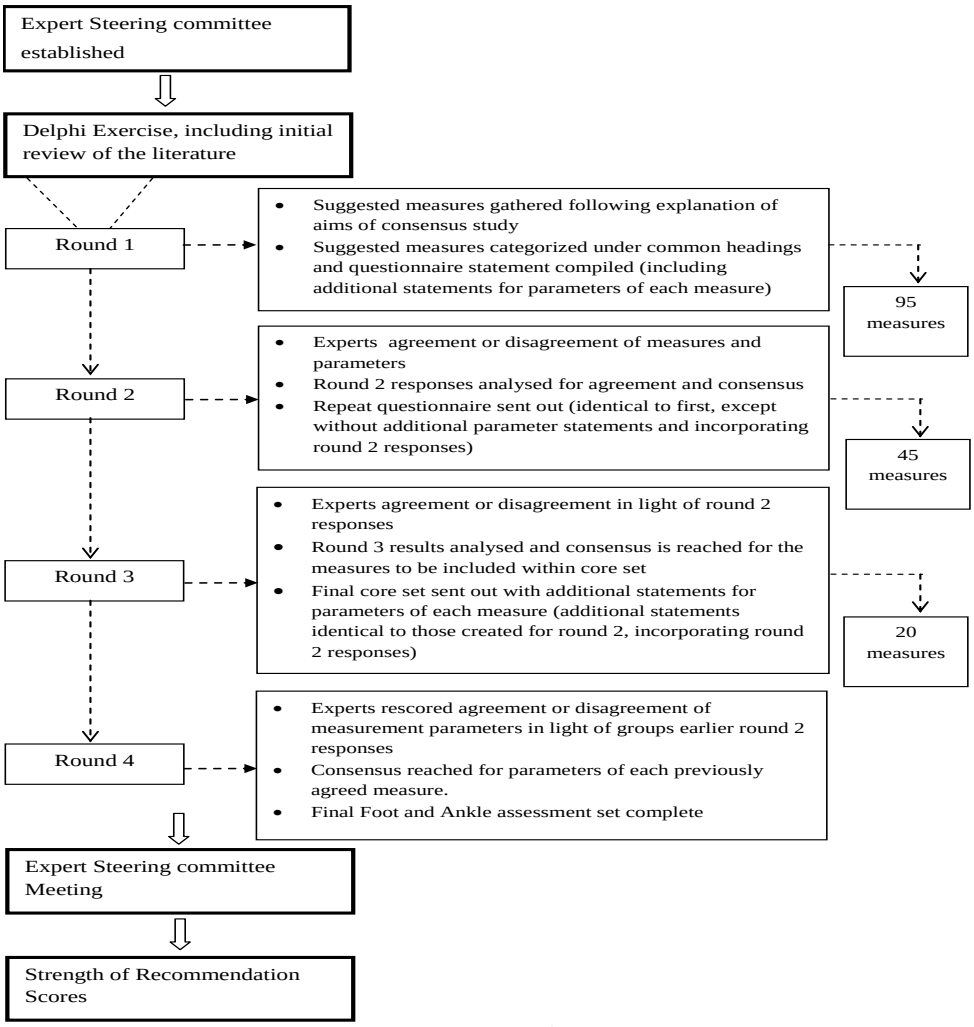

Figure 1. Methods of Study

The expert group then participated in four rounds of a Delphi exercise to reach consensus on which clinical musculoskeletal foot and ankle assessment measures would be recommended for inclusion within a core set. In accordance with previous OARSI Delphi exercises, [8] voting for measures within each round was based on the following: ≥60% votes led to inclusion and ≤20% votes led to exclusion of the measure. Those between these values were discussed and another round of voting followed. The process was repeated until all proposed measures were either included or excluded.

Expert Steering Group Meeting

At the conclusion of the Delphi exercise members of the group were invited to attend a meeting to ascertain future

research agendas beyond consensus of the agreed set of measures.

Strength of Recommendation

Strength of Recommendation (SOR) scoring has been used by initiatives such as EULAR [16,19] and OARSI [13] to develop guidelines for the assessment and management of conditions. SORs are expressed as ordinal scales or as percentages, which represent the average of the committee members' SOR scores for each recommendation, where the lowest value represents the weakest recommendation and the highest represents the strongest. Strength of recommendation values based upon both a clinical and research application, were requested from all experts for each agreed measure. Values were based upon a numerical rating scale from 0-10, where higher values are representative of stronger strength of recommendation and lower values for lesser strength of recommendation.

RESULTS

Delphi Results

Review of current foot and ankle assessments

Following a process of article exclusion, 49 articles were included within the final review (appendix 2).Ten individual categories of foot and ankle assessment measures were identified. Of these only five provided evidence of investigation against outcomes of patient reported pain or function, including arch measures, navicular measures, ankle dorsiflexion, foot posture index and first metatarsal phalangeal joint measures. [21-23] A limited number of measures reported an association with particular functional tests, these include navicular height, ankle flexibility, first metatarsal phalangeal joint range of movement and Foot Posture Index (FPI), [21-23] however only FPI has a reported an association with parameters of dynamic foot function in individuals with pain (patella femoral pain). The review identified no evidence of a comprehensive clinical musculoskeletal foot and ankle assessment protocol. There was considerable variability in the reliability of the measures identified with inter correlation coefficients ranging from 0.00-0.99. [21-59] The review highlighted the need for an agreed set of standardized clinical musculoskeletal foot and ankle assessments to inform a protocol and for further work to justify their use according to clinically relevant outcomes such as pain and function.

Delphi Exercise

Round one consisted of two open ended questions; “Are there any important foot and ankle measures we have failed to identify from the literature review?” and “Which objective measures do you believe are important to be included within a musculoskeletal foot and ankle examination?” Responses were compiled to form a list of ninety five measures. Round two comprised the ninety five measures. Similar measures or terms were merged to avoid repetition and measures that did not meet the inclusion criteria provided in round one were not included. Thirteen measures were accepted, two merged and twenty rejected, based on less than 20% of votes. Forty five measures were left to revote. Following further merging of measures in round three, twenty one measures were accepted. Consensus was reached at this point. Round four was introduced to determine the measurement parameters for each foot and ankle measure. Where voting suggested the use of categorical and/or descriptive reporting for an individual measure these were combined to create a categorical reporting style made up of a choice of common descriptors. During this round, due to decisions made on measurement parameters, two measures of rear foot alignment were merged to create

"rearfoot to leg alignment in relaxed standing". Therefore a total of twenty measures were included within the final set.

The twenty measures identified were categorised according to the relevant the assessment parameters: *observation of:* swollen (tender) joints, skin/nail changes and/or lesions, general foot morphology, hallux valgus, lesser toe deformities: *palpation of:* achilles tendon, proximal plantar fascia insertion: passive *range of motion of:* ankle dorsiflexion with knee extended (non-weight bearing)ankle dorsiflexion with knee flexed (non-weight bearing), metatarsal phalangeal joints, midfoot /midtarsal, 1st metatarsal phalangeal joint, subtalar joint represented as rearfoot inversion/eversion: *muscle tests of:* gastrocnemius /soleus, tibialis posterior: *alignment of:* rearfoot to leg in relaxed stance: *static posture:* Foot Posture Index: *indirect assessment of:* leg length, footwear, gait parameters.

Face to Face Group Meeting

Experts were invited to join a meeting to discuss the core set and develop research agendas. Nine of the expert panel participated in the meeting. Final agreements were made that the core set of assessment measures should eventually be used for screening purposes, within clinical and research situations and at present any form of scoring system is not recommended. The future research agenda beyond strength of recommendation should include validity testing against clinical outcomes such as pain and function.

Strength of Recommendation

Clinical and research strength of recommendation values based on each measure were obtained from the experts present at the meeting (n=9) and the remainder (n=10) via email correspondence. Median values, ranges and standard deviations for clinical and research measures are shown in Figures 2 and 3. Strength of recommendation values were categorised (not recommended, recommended, highly recommended) according to each calculated mean.

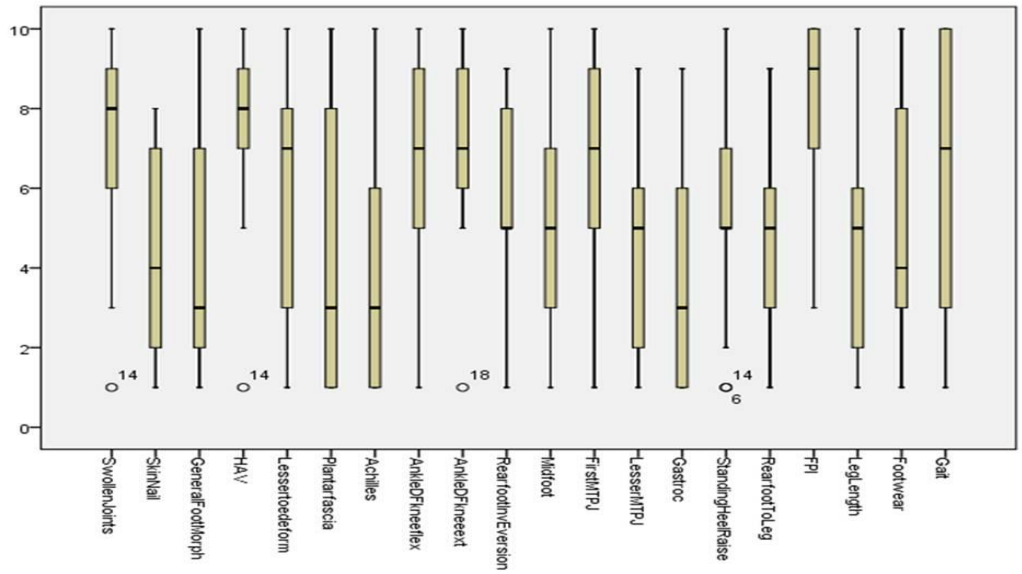

Figure 2. Box plot illustrating median SORs and fences of each measure for clinical circumstance.

° Denotes outlier

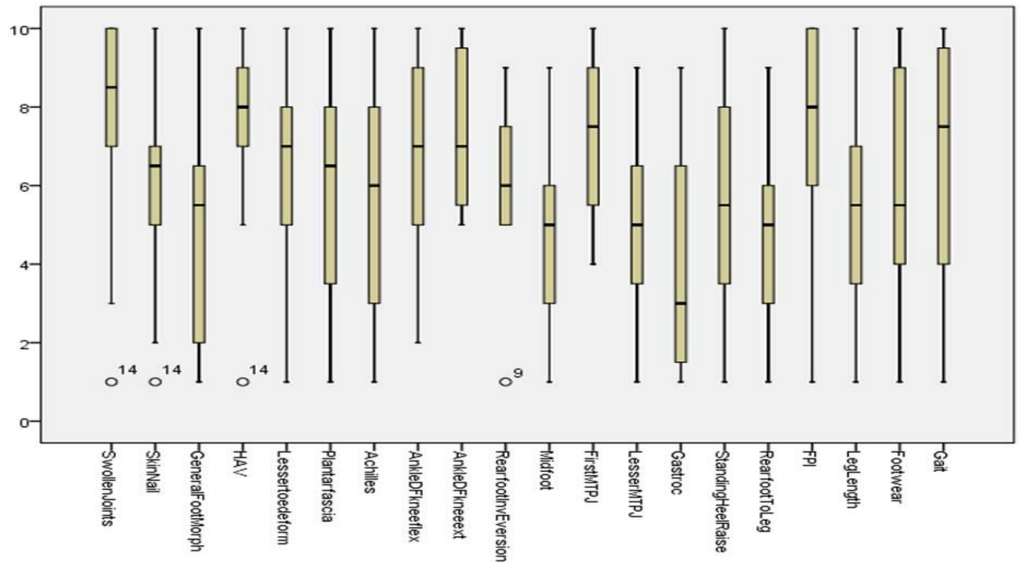

Figure 3. Box plot illustrating median strength of recommendation values and fences of each measure for research circumstance.

° Denotes outlier

DISCUSSION

Through an international consensus exercise we have established a core set of objective foot and ankle assessment measures to inform a standard protocol for future research and clinical evaluation. From this the International Musculoskeletal Foot and Ankle Assessment (IMFAA) have been formed.

The IMFAA is unique as to our knowledge there is no evidence of a current standardized comprehensive musculoskeletal foot and ankle assessment protocol for clinical or research application. Clinical foot and ankle assessment is important to inform the management of lower limb conditions and disease. The absence of agreement for which assessment measures should be used to assess the foot and ankle in clinical practice is a current dilemma for researchers and clinicians. [60] Whilst clinicians routinely use foot and ankle assessment measures, the evidence to support their use is weak. Assessment protocols used within clinical settings are difficult to standardize because they are based on the clinicians subjective experience of what represents a significant clinical finding. This lack of standardization makes any observation of clinical change difficult over time, between patients or between clinicians.

The development of many currently used clinical methods of assessing musculoskeletal foot and ankle status have no reliable objective foundations. Many of which are driven by the historical work of Root et al, [61] which suggests "normal" foot morphology is characterised and referenced to a neutral position of the subtalar joint at midstance phase of gait. This theory is now contested as it has yet to be proven and the accuracy and reliability for measuring subtalar joint neutral has yet to be demonstrated. [62,63]

A variety of methods have since been theorised and developed including, but not limited to, Rose's Valgus Index, [64] Staheli's Plantar Arch Index, [65] Platto' Structural Index, [66] longitudinal arch angle, [67] the arch ratio. [68] These measures are limited in that associations to clinical

outcomes such as foot pain or function have yet to be reported and as such the clinical relevance and minimally important clinical change values have not been established. An association has been shown however between the Foot Posture Index and walking function, [23] medial knee osteoarthritis, [41] some parameters of dynamic foot function in individuals with patella femoral pain [42] and risk of foot and ankle overuse injuries in football. [43] Moreover these individual measures of foot ankle status do not provide clinicians or researchers with a comprehensive multi-dimensional assessment protocol. Instead each focuses upon a specific element of the foot and ankle alone, for example arch anatomy, forefoot structure or foot posture. A standardized comprehensive foot and ankle assessment protocol such as IMFAA that includes a variety of measures, which are not limited to one parameter (i.e. movement, morphology and deformity), has potential to improve screening and the measurement of intervention success/failure.

Standardized assessment protocols have already been identified for osteoarthritis of the knee [69] and hip [70] and for musculoskeletal disorders of the upper limb. [71-73] Consensus statements have been used to develop examination schedules for the diagnosis and classification of musculoskeletal disorders of the upper limb, [71] recommendations for the diagnosis and management of knee, hip and hand osteoarthritis, [13-19] and classification criteria in systemic sclerosis. [20]

The results of the consensus exercise provide the first step in the development of a standardized protocol for clinical musculoskeletal foot and ankle assessment measures, which may be taken forward for validation. As part of the initial validation process strength of recommendation scores were collected to provide a level of recommendation for clinical and research use of each measure based on a 0-10 scale (10 being the strongest recommendation). These findings suggest that observation of swollen/tender joints, HAV presence, ankle dorsiflexion with the knee flexed and extended, first metatarsal phalangeal joint range of movement and FPI are the most highly recommended for use within musculoskeletal assessment of the foot and ankle in both clinical and research circumstances. The range of scores for all measures was consistently wide, and except for the FPI measure, the strength of recommendations scores are generally lower for research than clinical use. This reflects the hesitations in using many current measures for research purposes, particularly those with an absence of quality evidence. This supports the requirement to further test the validity of these measures. The strength of recommendation scores provides a basis of suggestion for the measures to be included within musculoskeletal foot and ankle assessment.

It has been agreed that the IMFAA protocol should be used for screening purposes. It should be viewed as a core set of items that provide the minimal important information to determine musculoskeletal status and can be added upon depending upon clinical circumstance. At present a global scoring system is not recommended due to the lack of similarity between measurement categories, potential ambiguities of summation scoringand limitations of weighting scores based on a number potentially unreliable measures and limited evidence to support others.

The IMFAA provides a standard approach to allow the inclusion of the foot and ankle within clinical research models. A standardized protocol such as the IMFAA will help to overcome the current difficulties we have in comparing foot and ankle status and studies. It has been agreed that all twenty measures require cross sectional and

longitudinal validation and that use of the measures within IMFAA would help to ensure that future investigations involving the foot and ankle are comparable and data sets can be combined across studies. If the IMFAA is introduced to future cohorts it will provide the standardized method required to investigate the role of the foot and ankle and would allow for cross sectional and longitudinal validation.

The IMFAA also has valuable clinical applications. It may be used as a screening tool for the foot and ankle alongside other joint assessments. It will enable clinicians to standardize at least one part of an entire assessment process to monitor changes (progress or deterioration) between visits, following intervention and importantly between clinicians; this will be a valuable formality to ensure best practice where patients are often seen by a variety of clinicians over time. It may also be a potential clinical risk indicator following its validation across particular populations.

Strengths and Potential Limitations

While a range of consensus methods exists, two techniques have a long predominant history, namely the Delphi and the Nominal Group Techniques (NGT). [74] The NGT tends to be limited to a smaller number of experts (usually 9-12), unlike the Delphi where there is no rule to govern the number of participants included. [75] Unlike NGTs, the feature of anonymity within the Delphi allows members to express their opinions privately, potentially reducing the effects of social pressures from dominant characters or the majority within the group. [20] Although compared to the NGT the Delphi technique is time consuming the main benefit, particularly in the current study where worldwide, multi-professional input was vital, is the Delphi does not have geographical limitations, making it ideal for international input.

The identification of experts has been a source of debate in the use of the `Delphi'. [76] Whilst the selection of the expert panel is the vital first stage of the consensus process, it is also raises methodological concerns. Studies have criticised the use of experts, [77] claiming the feature of the `Delphi' to represent valid expert opinion as scientifically overstated. There is also a clear potential for bias in the selection as the exact composition of the panel can affect the results obtained. [76] To limit potential bias with this study more than one inclusion criteria were applied, allowing for a variety of academic and clinical expertise. It also ensured the inclusion of experts from a variety of medical disciplines to reduce potential biases in assessment selections that may have been introduced between professions.

The application of the modified Delphi, which differs to conventional Delphi by introducing a meeting within the process, may also be portrayed as a limitation. It has been stated that having a physical meeting contradicts one of the basic rules of the Delphi procedure, which is avoidance of situations that might allow one or more panel members to dominate the consensus process. [78] The benefits of a meeting however are the face-to-face exchange of information, such as clarification of reasons for disagreements. [79] In the case of the current study a meeting following the conclusion of the Delphi rounds allowed for the proposals of a future research agenda for this area within a structured environment, which ensured clarity and provided an opportunity for expert feedback. This also allowed for expert confirmation in regard to the importance of gathering strength of recommendation scores.

CONCLUSION

Our international consensus statement, using a Delphi technique, has

provided a successful method of gaining expert agreement for a core set of musculoskeletal foot and ankle assessment measures, known as the International Musculoskeletal Foot and Ankle Assessment. Observation of swollen/tender joints, hallux abducto valgus presence, ankle dorsiflexion with the knee flexed and extended, first metatarsal phalangeal joint range of movement and Foot Posture Index are highly recommended for use within musculoskeletal assessment of the foot and ankle for both clinical and research circumstances. It is recommended that the assessment measures be used for screening purposes. Face validity has been acquired and strength of recommendation values provided a level of recommendation for the use of measures. Further work is proposed to validate the IMFAA.

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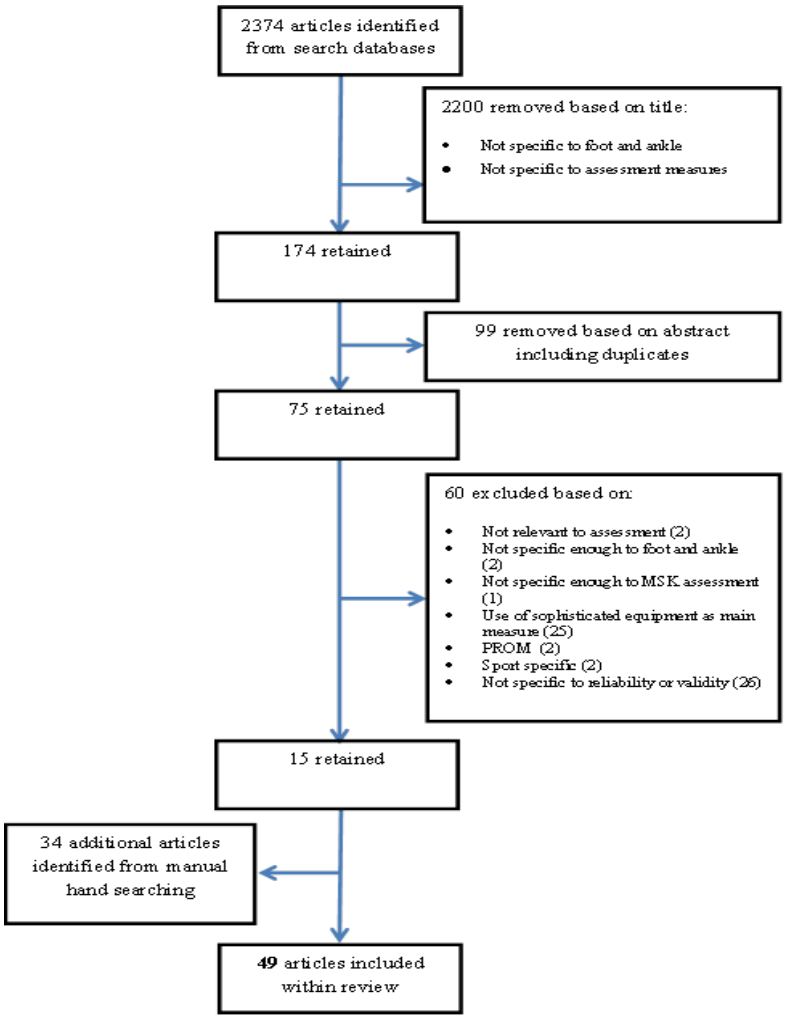
Appendix 1- Search terms

Primary keywords:
Foot Synonyms: feet, (f**t) Associated: Calcaneus, heel, talus , tarsal(s), metatarsal(s), "metatarsal phalangeal (joint)", navicular, hallux, subtalar (joint), rearfoot, "rear foot", hindfoot "hind foot", forefoot
Ankle Synonyms: talocrural (joint)
Assessment Synonyms: measure(ment), exam(ination) Associated: physical, clinical, podiat(ric), ortho(paedic) (examination/assessment/measurement), clinical (examination/assessment/measurement), "foot posture"

Truncated Search terms with Boolean operators
(1) Foot OR feet OR ankle* OR talocrural* OR joint OR calcaneus OR heel OR talus OR tarsals OR navicular OR hallux OR metatarsal* OR metatarsal phalangeal * OR subtalar OR rearfoot OR hindfoot OR forefoot **AND** (1) Assessment* OR measure* OR exam* OR physical OR Clinical OR podiat* OR ortho* OR posture

Appendix 2- Article exclusion process



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