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Assessing biomechanics and associated factors in individuals with patellofemoral pain in a clinical setting: A qualitative study based on interviews with expert clinicians

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ABSTRACT

Objectives: To explore the perspectives of ten clinicians from different medical disciplines with experience in managing PFP on how to conduct biomechanical assessments in individuals with PFP in a clinical setting.

Methods: An explorative qualitative design was used to explore the perspectives of ten clinicians with at least five years of experience managing patients with patellofemoral pain. A series of semi-structured interviews were done over Zoom video chat. The participants were from six different medical disciplines (physiotherapy, biokinetics, podiatry, sport science, sports medicine, orthopaedic surgery). Data was analysed thematically.

Results: Four main themes emerged from the data. These were: 1) biomechanical contributing factors that clinicians routinely screen for in patients with PFP; 2) relevant functional activities for biomechanical screening in patients with PFP; 3) conducting gait analysis assessments in a clinical setting; and 4) challenges of biomechanical assessment in patients with PFP. The clinicians expressed conflicting opinions on the usefulness of clinical gait analysis. The clinicians questioned the clinical applicability of some of the biomechanical factors identified as important in the evidence.

Conclusions: It is important for clinicians to include the biomechanical assessment of functional activities linked to pain when managing patients with PFP. However, some of the biomechanical factors identified in the evidence are too difficult to observe without 3D movement analysis equipment and should not be considered clinically relevant. Expert clinical opinion is important to provide contextual information when addressing biomechanics in individuals with PFP.

1. Introduction

Patellofemoral pain (PFP) is a common knee problem, with a high prevalence reported in a young active population [1]. The estimated annual prevalence in the general population is as high as 22.7%, with women, adolescents and athletes demonstrating the highest prevalence [1]. PFP has also been identified as the most common injury in recreational runners [2]. The pathogenesis of PFP is complex and multifactorial and many aspects of it are still poorly understood by both clinicians and researchers [3]. The most common hypothesis for the development of PFP is biomechanical, and involves factors

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associated with increasing the loading of the patellofemoral joint (PFJ). Factors such as patellar maltracking, altered joint kinetics and kinematics and muscle imbalances are thought to contribute to the increased PFJ stress which may consequently lead to pain [4].

Biomechanical contributing factors for PFP have been extensively researched in people with PFP [5]. Kinematic alterations have been observed proximally at the hip joint, locally at the knee joint, and distally at the foot in subjects with PFP [4]. The most common kinematic contributing factors described in the literature are increased hip adduction during running and single-leg squatting (SLS) [6,7]; reduced knee flexion when ascending stairs [8]; and increased rearfoot eversion during walking and running [9,8]. Increased stance phase knee flexion, ankle eversion and stance phase ankle dorsiflexion during running have also been described [6,7].

A systematic review conducted by Leibbrandt and Louw in 2017 [10] aimed to determine the most important gait-related kinematic factors that clinicians should consider addressing in the management of PFP. This was based on the best available evidence from cross-sectional and prospective studies. The authors' found that peak hip internal rotation and increased rearfoot eversion when comparing subjects with PFP to controls were evident in individuals with PFP during walking. The review also reported evidence for risk factors during single-leg squatting, including increased ipsilateral trunk lean, increased knee adduction and increased peak hip adduction in subjects with PFP compared to controls [10]. Unfortunately, most of the evidence observed was based on cross-sectional studies and therefore the link between altered biomechanics and pain observed is not clear. In addition, all of the included studies were conducted in 3D movement laboratories. These procedures are expensive, time consuming and not always available in a clinical setting. It is unclear whether these factors can be identified by clinicians' assessing and managing individuals with PFP using 2D gait analysis methods such as video analysis and clinical gait observation.

Systematic reviews are needed to summarise literature and to provide accurate high quality evidence that guides evidence-based practice. However, there are limitations that clinicians should consider when relying solely on this evidence [11]. The strict criteria used on systematic reviews often results in studies being omitted. Secondly, the findings often focus on very specific populations and other populations are often under-represented, which limits the generalisability of the findings. Most importantly, the clinical applicability and relevance of the findings are frequently unclear [11]. One way to address this is to combine the best available evidence with feedback and valuable insight provided by expert clinicians [12]. Expert clinician opinion from clinicians who are frequently exposed to patients with PFP will add value to the current evidence based on PFP research assistance with the translation of evidence from research into patient management.

Therefore, the primary aim of this qualitative study was to explore the perspectives of ten clinicians from different medical disciplines with experience in managing PFP on how to conduct biomechanical assessments in individuals with PFP in a clinical setting.

Secondary objectives were:

- to determine which biomechanical factors clinicians from different medical disciplines, screened for and how they would assess these;
- to explore how clinicians from different medical disciplines conducted biomechanical assessments and gait analysis on individuals with PFP in a clinical setting;
- to determine the clinical relevance of the current best available evidence on biomechanical contributing factors for PFP based on 3D movement laboratory studies; and
- to identify important additional considerations in the assessment and management of subjects with PFP.

2. Methodology

2.1. Study design

An explorative qualitative design was used to explore the perspectives of ten expert clinicians of different specialities with experience managing patients with PFP using semi-structured interviews. Two focus groups and four individual interviews were conducted online using Zoom. Transcribed interview data was coded in Atlas.ti.8® and analysed using inductive thematic analysis. Ethical approval was obtained from the Health Research Ethics Committee of Stellenbosch University (N19/05/063). The study followed the recommended guidelines of the Standards for reporting Qualitative Research (SRQR) [13].

2.2. Study participants

Purposive sampling was used to identify ten expert clinicians from different disciplines to participate in a series of semi-structured interviews. We aimed to include at least five different disciplines involved in the biomechanical assessment and treatment of patients with PFP, including at least one physiotherapist, one biokineticist, one sport scientist, one podiatrist and one medical doctor. Participants were recruited from Stellenbosch University's ISEM clinic, word of mouth and recommendations from included participants at the end of the interviews. Local and international clinicians who met the inclusion criteria were considered. Participants were required to have at least five years of experience managing patients with PFP and experience in biomechanical movement analysis.

2.3. Procedure

Data was gathered through interviews (focus groups or individual based on the availability of participants). Two focus groups and four individual interviews were conducted between 4 June and 14 July 2020. An interview schedule was determined by two researchers (DL and QL) prior to data collection. The interviews were conducted by the primary researcher (DL), using who led the discussion with open-ended questions. Meetings were arranged on the Zoom video chat application as the data collection occurred during the COVID-19 pandemic when strict social distancing regulations were being enforced. The interviews lasted approximately one hour each. The sessions were audio recorded and the interviewer (DL) also took hand-written notes to aid transcription.

2.4. Data analysis

The audio-recordings from the interviews were transcribed verbatim by independent transcribers. Inductive coding was done using the Atlas.ti.8® software. The coded data was then exported into Microsoft excel and organised into sub-themes or categories. Thematic analysis was used to identify and analyse common themes across the dataset. An inductive approach was used to identify the expert clinical opinions on how to identify biomechanical risk factors for PFP in a clinical setting. The researchers also used investigator triangulation, member checking and peer checking. Transferability was obtained by thick description of procedures for data collection and analysis. For dependability, the data was coded twice by both researchers (DL and QL), checking that codes correlated, and discrepancies were discussed. All participants were assigned a code to protect their anonymity.

3. Results

3.1. Sample description

Two focus groups and four individual interviews were conducted with ten expert clinicians (five males and five females) from six different medical disciplines (three physiotherapists, three biokineticists, one podiatrist, one sport scientist, one orthopaedic surgeon and one sports medicine doctor). Seven of the participants were from South Africa and three were working internationally. The participants had between five and 30 years of experience treating individuals with PFP as well as experience with biomechanical assessment. The average duration of the interviews was 60 minutes. Participant characteristics are described in Table 1.

3.2. Themes and categories identified

Four main themes related to the clinical assessment of biomechanics and associated contributing factors in a PFP population were generated from the data. Within these themes, categories were identified based on open coding. The themes and categories are summarised in Table 2.

3.3. Theme 1: Biomechanical contributing factors

The most identified kinematic factors that the experts screened for were increased hip internal rotation and increased hip adduction during walking, running and single leg squatting. Seven experts identified hip rotation as an important factor and five of the clinicians identified hip adduction as being important, for example:

"a lot of times it is very much related to the hip." *EC5*

Dynamic knee valgus during single leg squatting was identified by four experts, who agreed that this was related to the hip biomechanics such as increased internal rotation found higher up in the kinetic chain, as stated below:

Table 1
Sample description for the included participants.

Expert Clinician ID	Gender (M/F)	Occupation	Setting (City, Country)	Years of experience
EC1	F	Biokineticist	Stellenbosch, South Africa	5
EC2	F	Physiotherapist	Stellenbosch, South Africa	6
EC3	M	Biokineticist	Leuven, Belgium	13
EC4	M	Podiatrist	Century City, Cape town	30
EC5	F	Sports medicine medical doctor	Tygerberg, Cape Town	10
EC6	M	Physiotherapist	Belgrade, Serbia	7
EC7	M	Sport scientist	Stellenbosch, South Africa	5
EC8	M	Orthopaedic surgeon	Stellenbosch, South Africa	23
EC9	F	Physiotherapist	Hung Hom, Hong Kong	12
EC10	F	Biokineticist	Van Riebeekshof, Cape Town	5

Table 2
Themes and categories identified from interview data.

THEMES	CATEGORIES
1) Biomechanical contributing factors that clinicians routinely screen for in patients with PFP	• Trunk forward lean • Hip adduction • Hip internal rotation • Knee flexion/hyperextension • Dynamic knee valgus • Lateral patella glide • Dorsiflexion ROM • Pronation • Cross-over gait
2) Relevant functional activities for biomechanical screening in patients with PFP	• Based on activity level and sports participation. • Single leg squatting • Stair climbing or stepping • Jumping and landing • Double leg squatting • Lunging • Sitting to standing
3) Conducting gait analysis assessments in a clinical setting	• Treadmill versus outdoor • Barefoot versus shod • Use of markers • Cell-phone apps • 2D video and computer software • Visual observation
4) Challenges of biomechanical assessment in patients with PFP	• Defining "normal" gait • Causality risk factors vs contributing factors • Reliability of measurements • The diagnosis of PFP • The variety of contributing factors in different sub groups • Difficulty assessing small movements without 3D technology • Generalisability to real-world situations

"some of the things that I look for is internal rotation of the femur during the movement and a lot of times the internal rotation of the femur will lead to also knee valgus of the knee collapsing in out of the norm." EC1

Increased forward trunk lean (identified by two experts) and contralateral pelvis drop (identified by one expert), were also identified as factors to consider during single leg squatting; however, these were also hypothesised to result from hip biomechanics:

"The trunk follows the hip. So, if there is any excessive hip issue like internal rotation, hip adduction, the trunk will follow that." EC6

Five experts mentioned that they would screen for decreased knee flexion or hyperextension of the knee during walking or running gait and that they could identify it on observation during gait analysis, for example:

"Increased hyper extension of the knee, would you be able to identify that through gait analysis? Yes, definitely we can. We will pick that up on the video as well." EC1

Lateral tracking of the patella during walking gait was identified by two clinicians:

"patella tracking is easy to watch because you can actually see the movement during walking." EC8

Decreased dorsiflexion overall range of movement was commonly identified by four clinicians mentioning it as an important factor to screen for during gait:

"Ankle joint range of motion. If there is any form of dorsiflexion resistance that movement is going to go somewhere. And it can go into the knee." EC4

There was conflicting opinions regarding the relevance of assessing dynamic pronation of the foot during biomechanical screening in patients with PFP. Two clinicians identified it as important; whereas, another two felt that it was not necessarily important:

"Over pronation is described as, if you look at the literature there is literature in either side of the fence. A lot of people blame it for everything, not necessarily." EC4

One clinician mentioned screening for overall movement patterns including over striding and cross-over gait during running analysis in patients with PFP:

"You can eyeball some things like over striding, kinematic things like if you are over striding or if there is as well excessive cross-over while running." EC3

3.4. Theme 2: Relevant functional activities for biomechanical screening in patients with PFP

Most of the participants mentioned that the most appropriate activity depends on the individual's activity level and sports participation, as well as what reproduces symptoms of PFP. Single leg squatting was identified as a useful functional test by seven clinicians and double leg squatting was identified by three clinicians. Getting into and out of a chair was identified as an important activity to assess for patients with PFP, by one expert. Some of the comments were:

"I usually assess those issues in single leg squat. I can assess for an excessive hip adduction during single leg squat." EC2

"I will do squats initially, not as the end point but just to get that initial sense because a squat movement is sort of an enormous amount of what we do during the day is a squat." EC9

Stair climbing or stepping was identified by four clinicians. Jumping and landing was identified by four clinicians and lunging was identified by two clinicians as good functional tests for PFP.

"I will do a step up or a lunge depending if they are in a sporting code or something that mimics like a step up, explosive jumping movement or like a lunging pattern." EC1

3.5. Theme 3: Conducting clinical gait analysis assessments

The clinicians expressed conflicting opinions regarding the use of a treadmill for gait analysis. Two clinicians felt that treadmill running was useful and two thought that it was not appropriate to generalise findings to outdoor gait.

"People do not move on treadmills the same way they move over the ground. So it just does not seem like a good test to me unless they are a gym person and running on treadmills is the thing that they do." EC9

Most of the clinicians recommend doing gait analysis barefoot in order to more accurate assess foot and ankle biomechanics.

"I prefer them doing it barefoot, so you can actually see how their foot is rolling, how they are walking, is there a bit of a foot flap, do they roll inwards before going, before lifting up. So I prefer them doing their walking analysis without any shoes as well as all the other tests." EC10

The use of reflective markers or marking anatomical landmarks on the skin with a permanent marker was recommended by expert EC7:

"you could probably just do this outside with basic markers and a video camera."

"If you can put two markers on the pelvis in a straight line just to check on the video you can draw a line between those two points with a basic video analysis software like Dartswitch and see maybe if there is discrepancies between the legs."

The use of inexpensive and portable technology in the clinic should be used to assess gait in patients with PFP where possible. One expert (EC7) suggested simple cell phone apps and 2D computer software to look at 2D video stills and draw lines:

"So, something that I have found quite interesting is our basic cell phones for example, accelerometers in them and you can access that with several different apps basically or you can even write a basic app and knowledge I guess." EC7

Some used 2D video analysis with frontal plane and lateral views and others just observe or "eyeball" the gait analysis in a corridor or in the clinic:

"I will watch them from those moments they start walking in, from the side, from the front. I will put myself in a place where I can actually monitor their walk-in-gait without them knowing." EC10

3.6. Theme 4: Challenges of biomechanical assessment in a clinical setting when assessing patients with PFP

Eight main categories of challenges were identified from the data. These have been summarised with illustrative quotes in Table 3.

4. Discussion

The main of this study was to explore the perspectives of clinicians with experience in managing PFP with regards to conducting biomechanical assessments in individuals with PFP in a clinical setting. Four main themes emerged from the data; biomechanical contributing factors that clinicians routinely screen for in patients with PFP; relevant functional activities for

Table 3
Challenges of biomechanical assessment identified by the participants.

Challenge identified	Quote
Difficulty defining "normal" gait which makes the interpretation difficult	*"I do not really agree with the concept of normal or correct gait patterns. I do not really agree with the concept of normal or correct ranges and motion either. It just depends on what the person needs to do." EC9*
Difficulty establishing cause and effect between biomechanical variables and pain experienced.	*"What came first, the injury that caused the gait pattern or is it the gait pattern, is it the response to the pain." EC3* *"I think there needs to be a really clear link." EC9*
The risk of causing more harm than good when trying to "correct" biomechanical factors resulting in compensatory movement patterns.	*"So I say someone is quad dominant I do not want to go and make them glute dominant." EC9*
The diagnosis of PFP is still unclear and vague, multi-factorial.	*"Patellofemoral pain syndrome or anterior knee pain in my opinion is not a very good diagnosis. It is not specific; it is almost a cop out diagnosis when you have decided you cannot specifically identify where the pain is coming from." EC8* *"none of us want to be known as the guy to go to when you have a vague anterior knee pain." EC8*
The risk factors vary considerably amongst different sub groups of individuals with PFP.	*"there is a whole other group of people whose biomechanics are fine." EC9*
Clinicians and researchers need to consider the individuals activity or sporting requirements and the effect of fatigue when assessing biomechanics.	*"when people are getting anterior knee pain or any form of patellofemoral pain it is usually only starting when they fatigue. So when you see them fresh in clinic you are not going to see what is really going on." EC4*
Research often not clinically applicable as environment is so controlled and this does not happen in clinical practice.	*"in research we always want to control the environment as much as we can to ensure that we get significant findings and I think that is a challenge for when it comes to clinical practicality. So research significance is not always clinical, clinical practical. So, we need to bridge that gap." EC1*
Two clinicians highlighted the difficulty of measuring certain biomechanical parameters such as hip rotation and pronation in a clinical setting.	*"I think the hip internal and external, anything that goes on like inside the different joints I feel like it is very difficult to examine." EC10* *"It does not matter if you are over pronating. Yes, it can contribute to the PFPS, but it is tough to measure." EC6*

biomechanical screening in patients with PFP; conducting gait analysis assessments in a clinical setting; and challenges of biomechanical assessment in patients with PFP.

4.1. Biomechanical contributing factors

Proximal, distal and local biomechanical deficits have been identified in the research in individuals with PFP [14] and the expert clinicians were in agreement with the need to consider the entire kinetic chain. Individual contributing factors need to be identified, so that interventions can be individually tailored and appropriately delivered. Therefore, clinicians need to know what to screen for during clinical assessments.

Previous research has focused heavily on identifying biomechanical variables that are altered in individuals with PFP compared to asymptomatic controls using 3D movement analysis systems such as the VICON system [15]. There is limited evidence supporting rehabilitation interventions that aim to correct kinematics in individuals with PFP, especially reducing hip adduction and internal rotation in runners with PFP. However, this evidence is conflicting which suggests that there are different sub groups of individuals with PFP [16]. It is therefore important for clinicians to be able to identify these sub groups in a clinical setting even when 3D movement analysis equipment is not available.

Kinematic contributing factors that are identified as important in laboratory-based studies are sometimes difficult to measure accurately in a clinical setting. For example, a previous systematic review [10] identified hip internal rotation and rearfoot eversion as important factors to screen for during gait analysis. However, there was agreement amongst the included expert panel that it is not possible to accurately identify these two factors during gait analysis in a clinical setting. Therefore, screening for these in a clinic when 3D movement analysis software is unavailable, cannot be recommended.

The clinicians emphasised the importance of individualised biomechanical assessments to guide appropriate management strategies that are tailored to the individual. Functional tests should always be guided by the requirements of the individual and factors such as activity levels, sporting codes, activities of daily living and which activities reproduce the individuals knee pain, should be taken into consideration. Abnormal biomechanics can occur in individuals with PFP as a result of factors other than pain. Two studies [17,18] have suggested that kinesiophobia may influence biomechanics more than pain in individuals with PFP when performing single leg squatting and stair descent.

4.2. Functional tests

Identifying functional tasks with the highest sensitivity to detect kinematic differences is important for clinical assessment of patients with PFP as it is hypothesised to improve clinical decision making [19]. The clinicians identified single leg squatting (SLS), double leg squatting, lunging, stair climbing, and jumping as activities that they often assessed in a clinical setting. They also highlighted the need for choosing meaningful activities for the specific patient based on functional and sporting requirements.

The SLS test has been identified as a clinically appropriate functional test and has demonstrated good intra- and inter-rater reliability when used for the visual assessment of movement pattern quality [20]. Participants in the current study agreed that SLS is a useful functional biomechanical screening test for active individuals with PFP. In addition, they felt that they would be able to identify the frontal plane kinematic contributing factors identified in the evidence [10], such as trunk lean, pelvic drop, hip adduction, knee valgus and pronation at the foot. However, it does not need to be used routinely as it may not be relevant for less active individuals with PFP who do not need to be able to perform activities in single leg stance. For these individuals, less demanding activities such as double leg squatting are more appropriate.

Stair climbing, in particular stair descent, is a common aggravating activity for PFP [8]. Stair climbing or stepping activities were identified by four clinicians as being important functional activities for biomechanical screening during clinical assessment. A study by Ferreira et al. [19] has suggested that step down tasks are the most appropriate functional tasks to differentiate kinematics of women with and without PFP. This study investigated 3D kinematics of the trunk, pelvis, hip knee and foot during gait, forward and lateral step down, ascending and descending stairs and single leg hopping. The data was analysed using the Movement Deviation Profile. The findings revealed significant differences between groups for all tasks;, however there was a much larger difference between groups during forward and lateral steeping down compared to the other tasks. Therefore, this might be a good task to choose when assessing biomechanics in females with PFP. It is unclear if the findings would be the same for men with PFP.

4.3. Clinical gait analysis

The interviews yielded conflicting opinions on the usefulness of clinical gait analysis. Some of the experts felt that it is not always indicated especially if walking does not cause pain and running is not an activity requirement for the individual. It is useful for individuals with PFP involved in running sports who are having difficulty with running as a result of the pain. For gait analysis to be appropriate, certain additional considerations were recommended. The choice of environment (treadmill versus outdoor analysis), the use of less expensive technology such as cellphone apps and cameras, the use of simple markers on the feet and pelvis were suggested. However, a recent study (Neal et al., 2020) found that 2D biomechanical measurements using a smart phone app demonstrated poor to moderate reliability for all outcomes. Therefore, more accurate 2D cell phone video approaches are needed before these can be recommended for routine use clinically.

There were conflicting opinions on barefoot versus shod gait analysis. One participant (EC10) suggested that barefoot gait analysis is necessary in order to conduct an appropriate analysis of distal contributing factors at the foot and ankle. Another clinician (EC9) felt that it was important to assess PFP patients in the shoes that they typically wore during the day in order to get a more accurate interpretation of the individuals every day movement patterns.

4.4. Challenges of biomechanical assessment

The interviewees highlighted multiple challenges that they have experienced when conducting biomechanical assessments in a clinical setting. All of the included clinicians acknowledged that biomechanical assessment is important, but that it should only be addressed if there is a clear link between deficits and the pain experienced. Otherwise, the treatment strategy may be unnecessary and there may even be a risk of "over-correcting" and causing secondary injuries (EC9).

The gap between research and practice was highlighted by the clinicians. A major limitation in interpreting evidence from studies using motion capture procedures to collect kinematic data is the significant error resulting from skin and skin-marker movement. The error has been estimated to be as much as 16 mm displacement and 13° rotation for hip rotation [21]. Furthermore, skin-marker measurement cannot account for underlying bone geometry abnormality which means that these methods cannot differentiate actual increased limb rotation from that which is occurring as a consequence of bone torsion.

Therefore, during clinical assessment, both skeletal and dynamic alignment should be considered before formulating a management plan. This is a concern when applying the findings to a PFP population where femoral and tibial rotation have been identified as factors that may increase PFJ stress. Consequently, when kinematic differences between populations are small, the findings should be interpreted with caution [15].

The problem of comparing biomechanics of a PFP to "normal values" in an asymptomatic control group was discussed in the interviews. Group-based analysis can mask variability between athletes and generalise results that might not be applicable to individual patients. Therefore, it is essential that all clinicians working with patients with PFP are aware of their assumptions and limitations when interpreting the results of the research in applied biomechanics and when applying it to individual patients with PFP [22].

4.5. Clinical relevance and future implications

There appears to be a huge gap between research and practice when it comes to biomechanical assessment and resulting treatment approaches in patellofemoral pain. There is a need for mixed-methods research that includes expert clinical opinion in biomechanical research and combining it with the best available evidence when making decisions about patient management. Clinicians have to consider contextual, environmental and patient-specific factors to make the most appropriate treatment decisions and this is not always reflected in quantitative research.

Physiotherapists need to been familiar with biomechanical evidence and know how to conduct biomechanical assessments. Similarly, researchers need to understand the limitations of the evidence and to collaborate with clinicians to find more realistic, cost-effective and clinically meaningful ways to accurately conduct biomechanical assessments in individuals with PFP. There a need for more sensitive measures of biomechanical assessment that are inexpensive and do not need to be done in a laboratory. Future research should focus on more pragmatic methods of movement analysis such as portable systems.

5. Strengths and limitations

To the authors' knowledge this is the first study to obtain expert opinion on biomechanical assessment in patients with PFP. The included participants were from a variety of different medical disciplines which allowed for diverse perspectives to be considered. Multidisciplinary collaboration is important for optimal patient care [23]. All the included clinicians were knowledgeable on the topic of biomechanics and had experience working directly with the population of interest (patients with PFP).

A limitation of this study is that it only focused on biomechanical assessment. There are many possible contributing factors to consider in the management of PFP and therefore addressing biomechanics on its own is not sufficient and should rather be considered one component of a more holistic package of care. In addition, a purpose sampling strategy was used which resulted in the majority of included participants residing in the South Africa. The small sample size may also limit the generalisability of the findings.

In the current study, the Zoom Video Communications program was used for data collection. There are advantages and disadvantages to using Zoom for qualitative research. Advantages include easier accessibility to participants in different locations, participants can leave the meeting at any time, time saving conveniences, secure and password protected data storage, personal safety and cost effectiveness [24]. Possible disadvantages include technical difficulties, missed opportunities for the interviewer to observe and respond to body language and emotional cues, and distractions or lack of privacy [24].

6. Conclusion

Biomechanical assessment and treatment strategies need to be individualised and appropriate for the patients' functional level. This requires a skilled clinician who is familiar with biomechanical evidence, but also understands the limitations of 3D movement analysis. Clinicians should apply the evidence with caution and identify which biomechanical factors are contributing enough to effect change when they are addressed with movement retraining strategies. There is a need for more sensitive measures of biomechanical assessment that are inexpensive and do not need to be done in a lab.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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