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PATELLAR TENDINOPATHY: AN INTERNATIONAL E-DELPHI PERSPECTIVE

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ABSTRACT

Patellar tendinopathy is a chronic pathology of the anterior knee related to overloading of the patellar tendon. The purpose of the study was the formulation of a rehabilitation framework for patellar tendinopathy based on data from South African and international experts in the medical field. An e-Delphi survey was conducted with a mixed methods study design to obtain the opinions of eight experts. The e-Delphi survey consisted of three rounds, where the first two rounds focused on collecting opinions from the experts as a basis for the development of a rehabilitation framework that were evaluated in the third and final round. Consensus was reached regarding load tolerance, addressing individual athletes' needs, response to load progression principle, rest from activity, lower limb flexibility, hip and core strengthening, proprioception training, sport-specific skills training, return to sport assessment and functional ability of the athletes. Partial consensus was gained regarding isometric training, eccentric exercise, cardiovascular training and adapting rehabilitation for out and in season. Patella strapping was important during rehabilitation, as well as the expectations from the trainer and/or coach influencing rehabilitation. This research revealed a unique and collated perspective of internationally recognised experts regarding a patellar tendinopathy rehabilitation framework.

Keywords: Patellar tendinopathy; e-Delphi survey; Rehabilitation framework.

INTRODUCTION

Patellar tendinopathy is a chronic pathology of the anterior knee (Saithna *et al*., 2012) related to overloading (Malliaras *et al*., 2015) and frequently associated with sports that involve jumping. It can affect athletes in a variety of sporting codes. It is characterised by pain and functional impairment, and may even be a career-ending pathology in some cases (Saithna *et al*., 2012). These issues highlight the necessity for the continuous in-depth investigation of this complex pathology. An extensive body of literature is available on the pathology and management of patellar tendinopathy in the clinical set-up, with limited information on experts' combined opinions or related frameworks for patellar tendinopathy, despite their comprehensive knowledge on the topic. This identified the need for a research study suggesting a framework for the treatment of patellar tendinopathy through the collation of the opinions of experts. An e-Delphi survey was constructed to incorporate the opinions of international experts for the formulation of a patellar tendinopathy rehabilitation framework.

PURPOSE OF RESEARCH

Taking into consideration the diverse and evolving role that conservative rehabilitation plays in the management of patellar tendinopathy (Reinking, 2016), the main aim of the research was to use an e-Delphi survey as a unique approach to formulate a rehabilitation framework for patellar tendinopathy. This was accomplished through the collection of qualitative opinions, supplemented with some quantitative elements, from eight experts representing South African and international views.

METHODOLOGY

Ethical considerations

Ethical clearance was obtained from the Ethics Committee of the Faculty of Health Sciences (ECUFS 181/2015) of the University of the Free State, South Africa. Written informed consent was also obtained from all Delphi panel members before commencement of data collection.

Research design

A mixed methods research design was used applying primarily a qualitative research approach for the e-Delphi survey, supplemented with some quantitative elements. This is seen as a promising methodology to explore critical issues when the investigation outcomes require isolated opinions from experts on an explicit subject (Habibi *et al*., 2014). In this study, it equipped the researchers with information relevant to patellar tendinopathy rehabilitation as the basis for the formulation of a patellar tendinopathy rehabilitation framework, as presented in this article.

Selection of experts

The selection of experts for this e-Delphi survey was based on a recently published systematic review on patellar tendinopathy (Morgan *et al.*, 2016) that was used as a screening tool to identify individuals to serve on the e-Delphi panel. The literature states that prudent selection of an appropriate panel of experts forms the cornerstone of an e-Delphi survey, as this maximises the quality of the responses obtained, lessens potential bias and assists in the credibility of the results (Nworie, 2011). It has been suggested that a panel of experts selected for an e-Delphi survey should consist of individuals from heterogeneous educational backgrounds, selected due to their high educational qualifications (Donohoe *et al*., 2012), special expertise (Nworie, 2011) and extensive knowledge of the subject matter (Donohoe *et al*., 2012).

The international experts (n=5) were authors of previous publications on the topic (Morgan *et al*., 2016) and the South African experts (n=3) were selected from different South African universities having publications in the field of sport and sport science. The credentials of the experts correlated strongly with the literature. An adequate number of experts is five to ten participants (Habibi *et al*., 2014), although a larger panel size would decrease group errors and reinforce decision quality (Giannarou & Zervas, 2014). Demographic details of the panel members are summarised in Table 1.

***Table 1*. DEMOGRAPHIC DETAILS OF E-DELPHI PARTICIPANTS**

Variable	Distribution of participants (n=8)
Gender	Male (n=4) Female (n=4)
Nationality	Australia (n=1) Brazil (n=1) Korea (n=1) South Africa (n=3) The Netherlands (n=1) United States of America (n=1)
Profession	Physiotherapist (n=5) Medical doctor (n=3)
Field of expertise	Patellar tendinopathy (n=6) Sport (n=2)

e-Delphi process

The e-Delphi methodology is an interactive and iterative process that can continue for several rounds (Donohoe *et al*., 2012). Its foundation is based on anonymity and the free expression of the opinions of participants by allowing reconsideration and refined opinions through controlled feedback (Giannarou & Zervas, 2014). It is frequently used in the health sciences environment (Donohoe *et al*., 2012).

In this study, the e-Delphi survey consisted of three rounds. The first two rounds focused on collecting opinions from the experts on the rehabilitation of patellar tendinopathy as a basis for the development of a rehabilitation framework. These experts then evaluated this in the third and final round.

Data collection

The primary focus of the e-Delphi survey was to collect the opinions of the selected panel on the rehabilitation of patellar tendinopathy by means of a semi-structured online questionnaire. Items included in the questionnaire for round one of the survey were based on the data collected in the prior systematic review (Morgan *et al*., 2016). SurveyMonkey™ software (2017) was used and the identified panel of experts were invited via email. The email included an information letter regarding the study, ethical information, the e-Delphi survey itself, and information on how to use the electronic software for the completion of the questionnaire. Attrition bias was limited in subsequent rounds by only including experts who responded to the invitation in the first round of the e-Delphi survey. This reply was regarded as an agreement of consent to participate for the full duration of the survey (Slade *et al*., 2014).

The questionnaires were only available online, having a set deadline (two to three weeks) with a reminder email sent weekly. The completion of the questionnaires took approximately 40 minutes, with the option to complete the questionnaires over consecutive sessions. The option

to save the data was available and the experts could review their answers before final submission.

The questionnaires for Round One and Two consisted of a three-point Likert scale (agree/partially agree/disagree) and served as the quantitative component. This was followed by an open-ended question at the end of each section being the qualitative component whereby additional comments or suggestions could be provided. The questionnaire included four sections, namely (1) establishing the components of a patellar tendinopathy rehabilitation programme; (2) establishing the suggested basis of decision-making on components of a patellar tendinopathy rehabilitation programme; (3) inclusion of components in the patellar tendinopathy rehabilitation based on a time-based approach; and (4) inclusion of components in the patellar tendinopathy rehabilitation based on a pain-based approach.

The results of Round One were used for the development of the questionnaire for Round Two. Round Two questionnaires had the same structure and main sections as the previous questionnaire. Questions on which consensus had been reached were indicated as such in the questionnaire. If consensus was not reached, the question was included in the following round for further consideration. In some cases, slight adaptations were made, such as combining questions or making questions more specific, based on the feedback received from the e-Delphi panel.

After completion of these two rounds of the e-Delphi survey, the results were used to compile a draft framework for the rehabilitation of patellar tendinopathy. This draft framework indicated consensus, partial agreement or disagreement percentages (quantitative elements) on components included in the framework. Round Three provided the e-Delphi panel with a final opportunity to review the draft framework and to provide feedback. This feedback was qualitative in nature and incorporated in the development of the final framework presented in this article.

Validity of the e-Delphi survey

The validity of the e-Delphi survey intrinsically relied on the panel of experts who were carefully selected after an in-depth systematic review (Morgan *et al.*, 2016). This review disclosed the eligibility of members to be included on the panel of experts having suitable competence and knowledge of the research subject. Flexibility also enhanced the validity of the captured data through the substantial time between rounds which the experts could use in considering the questions.

Analysis of data

The responses from the experts on the questionnaires used in Round One and Round Two were quantitatively analysed in SurveyMonkey™ and descriptive statistics were calculated. Group consensus for each question was defined as a total cumulative agreement of 80% and more, and was considered indicative of overall agreement. Feedback on the draft patellar tendinopathy rehabilitation framework was analysed qualitatively and included in the final patellar tendinopathy rehabilitation framework presented in this article.

RESULTS

Eight experts contributed to the first two rounds (n=8), of which six (n=6) experts participated in Round Three of the e-Delphi survey. The response rate was 100% (n=8) for the first and second rounds, and 75% (n=6) for the third round.

In the third and final round, the experts who responded to the patellar tendinopathy draft framework were in support of this framework, but made some additional comments. The panel indicated that currently there is no specific model for patellar tendinopathy rehabilitation, which rather relies on an individual assessment with regular re-evaluation.

They also suggested that plyometric (high impact loading of the patellar tendon from a stable base) and sport-specific skills (required to prepare the athletes for return to sport after a long period of downtime) (Rudavsky & Cook, 2014) be combined during the rehabilitation intervention to avoid work overloading of the patellar tendon in terms of frequency, intensity and duration. Furthermore, they specified that return to play will take time during patellar tendinopathy rehabilitation.

***Table 2*. E-DELPHI FIRST ROUND RESULTS (n=8)**

Aspect	Agree	Partially agree	Disagree
Consensus reached			
Rest from activity in 1st - 2nd weeks	87%	13%	0%
Lower limb flexibility/stretching	87%	13%	0%
Hip strengthening	87%	13%	0%
Core strengthening	87%	13%	0%
Proprioceptive training	87%	13%	0%
Sport-specific skills training	87%	13%	0%
Return to sport assessment	100%	0%	0%
Consensus NOT reached			
Eccentric exercises (EE)	50%	50%	0%
Cardiovascular training 1st-2nd week	75%	25%	0%
Time-based rehabilitation approach*	0%	0%	0%
Pain-based rehabilitation approach*	0%	0%	0%

* No consensus

Table 3. **E-DELPHI SECOND ROUND RESULTS (n=8)**

Aspect	Agree	Partially agree	Disagree
Consensus reached			
Load tolerance principle	87%	13%	0%
Individual needs addressed during rehabilitation programme	87%	13%	0%
Progression of rehabilitation programme according to response to load	87%	13%	0%
Consensus NOT reached			
Isometric training (qualitative results*	0%	0%	0%
Eccentric exercises (EE)	63%	12%	25%
Patella strapping important during rehabilitation and return-to-sport	50%	37%	13%
Expectations from trainer and/or coach influence rehabilitation	62%	38%	0%
Time-based rehabilitation approach*	0%	0%	0%
Pain-based rehabilitation approach*	0%	0%	0%

* No consensus

DISCUSSION

The results quantified three central aspects, namely functional abilities, individualised rehabilitation and load tolerance, to form the foundation of the rehabilitation framework. Specifically, load tolerance, is the single most important aspect of the framework and was a principal conclusive result. Load tolerance can be achieved by establishing the load via loading specific to the individual's functionality. The experts were of the opinion that although acceptable, all rehabilitation activities are arguably not necessary and may be viewed as secondary, as long as the athlete can tolerate the load on the tendon, but it might assist in a speedier return to sport, reduce re-occurrence and improve overall function. The load tolerance principle implies that pain on the provocation test must return to baseline within 24 hours after activity or rehabilitation, which indicates that the patellar tendon has tolerated the load. The results of this e-Delphi were comparable with literature that also focussed on load tolerance on the tendon, musculoskeletal unit and the kinetic chain during rehabilitation (Malliaras *et al*., 2015).

The entire expert panel stated that functional activities are particularly highly valued (100%) and can be beneficial if used in combination with the important approach of load tolerance. This was supported by literature that functional muscle strength (Murtaugh & Ihm, 2013) and abilities are impaired in athletes with patellar tendinopathy and need to be addressed in rehabilitation (Pećina *et al*., 2010).

The individual athlete's needs must be addressed in the rehabilitation programme, which was a prominent aspect emphasised in the e-Delphi survey and therefore included in the patellar tendinopathy framework. These results correlated with Rudavsky and Cook (2014) who stated that individually, an athlete's needs can be achieved through a comprehensive evaluation by the sports rehabilitation personnel to identify areas of special needs and shortcomings in the biomechanical chain. The formulation of an individualised rehabilitation programme must take special consideration in that elite athletes require more intense rehabilitation than amateur athletes for successful return to sport and avoiding a relapse of the pathology due to the amplified training demands and level of participation (Rudavsky & Cook, 2014).

The results revealed explicit consensus on a variety of components that should form part of the rehabilitation framework. When the components were investigated in isolation, it confirmed a robust consensus amongst the e-Delphi experts that athletes should rest from any activity that aggravates pain during the first and second weeks of rehabilitation, although they may continue with functional activities. This finding confirmed that rest from activity and monitoring of pain are important (Malliaras *et al*., 2015), since it may have a positive effect on reducing the progression of patellar tendinopathy by unloading the patellar tendon (Reinking, 2016). This rest period can also be spent valuably in educating the athlete about patellar tendinopathy and planning of the treatment intervention (Kulig *et al*., 2015).

Lower limb flexibility as a component of patellar tendinopathy rehabilitation was also a point of consensus among the experts. This related to literature specifying that flexibility insufficiencies in the lower limb have the capacity to support a larger overload on the knee extensor mechanism, with the possibility of developing patellar tendinopathy (Scattone Silva *et al.*, 2016). The extensor mechanism of the knee consists of the tibial tuberosity, four quadriceps muscles, patella and the patellar tendon, and is involved almost in any functional movement of the lower limbs. Injuries to this apparatus of the knee is commonly observed by medical personnel and can be devastating to daily life or sport participation of the athlete (Haddad & Raja, 2013). The focus area of flexibility during patellar tendinopathy rehabilitation must be the knee and ankle (Scattone Silva *et al.*, 2016).

It is always a necessity to address strength deficits in athletes with patellar tendinopathy (Kulig *et al*., 2015). There was a strong predisposition (87%) towards hip strengthening as a component of the rehabilitation programme. This result was in agreement with previous findings that patellar tendinopathy is associated with weak hip extensor muscles and poor lumbopelvic control, and has the probability to modify the load distribution on the lower limb kinetic chain (Stasinopoulos, 2016). Rehabilitation interventions aiming to improve hip extensor muscle strength in patellar tendinopathy is a valued asset (Scattone Silva *et al*., 2016).

Further consensus was reached regarding core strengthening. This finding was exceptional in this patellar tendinopathy e-Delphi survey as minimal previous evidence in the literature identified weak core muscle strength as a statistically significant predisposing factor for patellar tendinopathy. However, Powers (2010) identified that weak core muscle strength has an adverse effect on knee movement. Literature proposes interventions that focus on strengthening the trunk and abdominal muscles as an effective feature in managing or preventing overuse pathologies affecting the knees (Lebec *et al*., 2014) and enhancing sport performance (Cuğ *et al*., 2012).

Impaired proprioception in athletes with patellar tendinopathy leads to a decreased ability to detect passive motion in the injured leg when compared to the non-injured leg (Groot *et al*., 2016). It is furthermore associated with a reduced awareness of force signals required for weight judgement (Torres *et al*., 2017). This literature supported the consensus of the experts in this study about proprioception re-training as part as the rehabilitation programme, which assists in improving articular position sense function, flexibility and balance of the knee (Park *et al*., 2014). Once functional strength, kinetic chain shortfalls and movement patterns have been restored, sport-specific training can commence (Rudavsky & Cook, 2014). Sport-specific skill training develops the athlete's expertise needed for participating in a specific sport (Davies *et al*., 2015) and consensus was reached on the inclusion of sport-specific skills as a component in the rehabilitation programme for patellar tendinopathy. This supports the literature describing that sport-specific skills can begin when slow progression load is tolerated and it is possible to duplicate the demands of the sport in terms of volume and intensity (Malliaras *et al*., 2015). One particular recommendation from the e-Delphi survey Round Three was that plyometric and sport-specific skills should be combined to avoid overloading the tendon, with constant monitoring of the duration and frequency of the activities.

For a successful return to sport, a comprehensive rehabilitation programme addressing all the identified deficits in the assessment is necessary (Rudavsky & Cook, 2014). It correlates with the results of this e-Delphi survey where consensus was reached that return to sport assessment should form part of the rehabilitation programme to ensure that all deficits have been addressed. Rehabilitation personnel should discuss the specific goals for the athlete's return to sport (Dragoo *et al*., 2014) and load progression to avoid overloading of the patellar tendon. In the absence of such an approach, the athlete will be susceptible to active tendinopathy upon resumption of sport participation (Scott *et al*., 2013). Being patient until fully recovered is a key aspect for successful return to sport in patellar tendinopathy (Rudavsky & Cook, 2014).

The experts (87%) also agreed that the load on the patella tendon must first be tolerated before any progression of the rehabilitation programme can take place, and this includes all exercises and activities related to sport. The e-Delphi participants also made it clear that the athlete could have good function and strength in the lower limbs although the patella tendon might still not be comfortable with the load, which would result in signs and symptoms of pain and discomfort. This was another original and important result in this e-Delphi survey that once again highlighted the prominence of the load tolerance principle, indicated by the experts to be the core aspect of the rehabilitation framework. Furthermore, progression relies strongly on load tolerance as a pivotal point of consensus in the e-Delphi survey. Malliaras *et al*. (2015) suggested that progression of the rehabilitation programme must be based on pain, strength and function, with advancement mainly based on pain monitoring. This differs from the e-Delphi

finding of the load tolerance principle. The experts already specified in Round One of the survey that reduction of pain via rest from activity is a secondary objective of rehabilitation, with the emphasis being primarily on load tolerance rather than on pain.

Loading of the patella tendon, however, must not commence in isolation because a variety of specific impairments might also be present and need to be addressed in the kinetic chain (Malliaras *et al*., 2015). That is why all the secondary identified components in the e-Delphi survey play an equally vital role and must not be overlooked as they all add to the rehabilitation process. Closer investigation into other possible components for the rehabilitation framework based on partial consensus from the e-Delphi survey revealed that although no consensus was reached on isometric training, some of the e-Delphi experts were still of the opinion that isometric exercises should be high on the hierarchy of the holistic treatment programme, as expressed in their open-ended comments. Because patellar tendinopathy in athletes is difficult to manage, the inclination to use isometric exercises can be important initially in the clinical setting, as it is safe and not likely to cause any further injury (Rhyu *et al*., 2015). Isometric exercise reduces pain in the patellar tendon almost immediately, and this prevents muscle atrophy until isotonic exercise can commence (Rio *et al.*, 2015).

With regard to eccentric exercises (EE), partial consensus was obtained among participants. EE still plays a respected part in patellar tendinopathy rehabilitation, being one of the most comprehensively discussed modalities for the treatment of patellar tendinopathy over the years. Díaz (2016) recently added that the main focus during EE training should be to load the patella tendon. The mechanism of EE is to encourage the creation of tendon collagen fibres, enable its remodelling with a pain reduction of 60% to 90% and general satisfaction in athletes (Díaz, 2016). The fact that EE was not an aspect of total consensus among the experts was an interesting finding in this e-Delphi survey, because EE has always been regarded as the cornerstone of patellar tendinopathy rehabilitation (Scattone Silva *et al*., 2015). This result might have been influenced by the expert's clinical reasoning from previous experience in patellar tendinopathy rehabilitation, to move away from the traditional treatment modalities in the search for novel approaches to manage this challenging pathology. The two components of isometric training and EE could be incorporated in the rehabilitation since these are clinically designated to reduce pain in patellar tendinopathy (Van Ark *et al*., 2015).

Cardiovascular training must also be included in the rehabilitation programme during the first and second weeks. Literature specifies that cardiovascular ability can be maintained by decreasing the load on the lower limbs by using cross-training activities such as cycling, swimming or pool running instead of over-ground running and jumping (Reinking, 2016). Another aspect of agreement among the experts was that patella tendon strapping plays a part during the rehabilitation and return to sport in patellar tendinopathy. This type of treatment modality has been described in the literature dating back many years (Schwartz *et al*., 2015). It is supported by De Vries *et al.* (2015) that a patella strap or sports tape decreases pain in the short-term, although it is not more effective than placebo taping. Nevertheless, the long-term effects remain inconclusive (De Vries *et al*., 2015) with the working mechanism being to alter the angle between the patella and the patellar tendon (Schwartz *et al*., 2015).

Lastly, partial agreement was reached in the e-Delphi survey with regard to the influence of the expectations of the trainer and/or coach on the rehabilitation of patellar tendinopathy. This might be due to the experts being from different professions, their roles in rehabilitation and the level of participation of the athlete with whom they engage as contributing factors, as previously described by Kulig *et al*. (2015). One aspect that can be useful in addressing this matter is to involve and inform the trainer and/or coach about the short- and long-term goals and time frame of the rehabilitation programme to ensure realistic expectations. Another aspect is to enhance the knowledge of the trainer and/or coach about patellar tendinopathy pathology (Scott *et al*. 2013), unloading and reloading of the patella tendon and prevention strategies, extrinsic factors, load management and realistic rehabilitation goals and time frames (Kulig *et al*., 2015). Based on the results from this survey and the integration of these results with existing literature, a framework for the rehabilitation of patellar tendinopathy was developed and is presented in Figure 1.

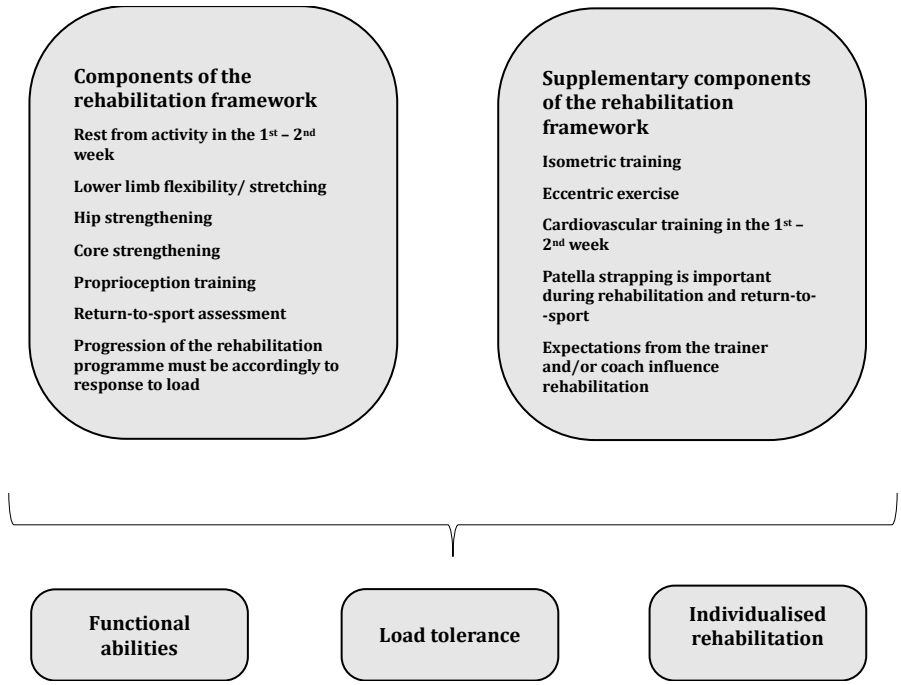

Figure 1. PATELLAR TENDINOPATHY REHABILITATION FRAMEWORK

This e-Delphi survey thus makes a unique contribution by means of a patellar tendinopathy rehabilitation framework compiled from the opinions of international experts in the field of sport, rehabilitation and more specifically patellar tendinopathy. The research is further enhanced through the use of a robust theoretical framework for the e-Delphi methodology (Habibi *et al*., 2014).

The experts included in this e-Delphi survey are influential researchers who have contributed to the development of knowledge on the topic. This is advantageous, as the data captured were of superior quality because of the knowledge and experience of the experts in patellar tendinopathy through their continuing academic investigation in the subject. Definite tendencies were apparent through the research process, probably because five out of the eight experts specialise and are constantly involved in patellar tendinopathy research. Nevertheless, it is important to note that the opinions of these experts regarding the patellar tendinopathy rehabilitation framework presented here, might not have been unconditionally true or necessarily the best guidelines, but rather a framework that this group of experts considered appropriate for patellar tendinopathy rehabilitation.

The experts described this e-Delphi survey as "innovative, interesting and extremely relevant" to patellar tendinopathy research and confirmed that the outcome of this research by means of the patellar tendinopathy rehabilitation framework is an excellent treatment summary. They warned, however, that the framework should be considered as a guideline rather than a "recipe", since there is no one specific protocol for patellar tendinopathy rehabilitation.

ADVANTAGES, CHALLENGES, STRENGTHS AND LIMITATIONS OF THE E-DELPHI SURVEY

The electronic collection of data was an effective medium between the experts and the researchers due to geographical separation. It enabled cost-effective data collection (Donohoe *et al*., 2012), anonymity and the distribution of information from previous rounds (Slade *et al*., 2014). The e-Delphi survey provided an opportunity to create an environment to identify trends in the formulation of the patellar tendinopathy rehabilitation framework. The number of experts in the panel was deemed adequate with a low withdrawal rate leading to rich and diverse data collection in the survey. This might also be because experts related well to the subject as it was directly linked to their field of interest and research.

A challenging feature of the e-Delphi survey was to obtain consensus on a topic, such as patellar tendinopathy rehabilitation. Unfortunately, two experts dropped out in Round Three, but six did complete the e-Delphi survey in its entirety. The success of retaining the majority of the panel was accomplished by constant communication via email.

A limitation of this e-Delphi survey was that some experts initially declined the invitation due to other work-related responsibilities. A second constraint of the patellar tendinopathy rehabilitation framework was the diversity of viewpoints of the experts regarding patellar tendinopathy.

CONCLUSION AND PRACTICAL IMPLICATIONS

This research is of important value as it presented a unique and collated perspective of internationally recognised experts regarding a patellar tendinopathy rehabilitation framework. The outcomes of this research suggest that load tolerance, functional assessment and an individualised rehabilitation programme will be vital to successful patellar tendinopathy

rehabilitation intervention. Load tolerance is deemed most critical and forms the foundation of the patellar tendinopathy framework.

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