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### Title

Current Management Strategies in Osgood Schlatter: A cross-sectional mixed method study

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## Abstract

### Background

Osgood Schlatter (OS) is the most common knee condition in adolescent athletes aged 9-16. Without evidence to guide clinical practice it is unclear how OS is managed. The aim of this study is to investigate how international healthcare professionals (General Practitioners, Physiotherapists, Rheumatologists, Sports and Exercise Medicine Doctors and Orthopaedic Surgeons) diagnose and manage OS.

### Methods

This mixed-method study used a convergent parallel design. A quantitative questionnaire and semi-structured interview covered prognosis, diagnosis, treatment, and return to play of adolescents with OS. For quantitative data those who reported likely/very likely considered 'for' and unlikely/very unlikely 'against' (for specific diagnostic/management strategy). Qualitative data analysis used a phenomenological approach.

### Results

Two hundred and fifty-one healthcare professionals completed the questionnaire. The most common diagnostic criterion was pain at the tibial tuberosity (97% for). The most common treatments were patient education (99%) and exercise therapy (92%). Other treatments options were more heterogeneous, e.g. pain medication (31% for, and 34% against). Managing training load (97%), pain intensity (87%) and psychological factors (86%) were considered the most important factors influencing the return to activities. Several themes emerged from the interviews (on N=20) including imaging, pain management, family, psychosocial factors influencing prognosis.

### Conclusion

Diagnosis criteria of OS was relatively well agreed upon, whereas triangulation of qualitative and quantitative data showed heterogeneity of treatments. Psychosocial factors including family were highlighted as critical in the management of OS.

Keywords: Adolescents, Apophysitis, Musculoskeletal Pain, Osgood Schlatter, Osteochondrosis.

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## 1. Introduction

Knee pain is the most common musculoskeletal pain complaint in adolescents <sup>1</sup>. Osgood Schlatter (OS) is the most frequent type of knee pain in adolescents and affects approximately 10% of adolescents, and as much as 20% of the active adolescents in some sports <sup>2</sup>. Osgood Schlatter occurs frequently in both boys and girls but are reported to be more prevalent in boys<sup>3</sup>. As OS is related to maturation of the tibial tuberosity, it is commonly asserted that OS is self-limiting and will resolve within 12-18 months or ultimately resolve with growth <sup>4</sup>. However, OS-related complaints can persist into adulthood and affect sport participation <sup>5-7</sup>. Development of Osgood Schlatter is related to growth and is also thought to be the result of repetitive high forces being transferred from the quadriceps muscle to the insertion of the patellar tendon on the active growth plate of the tibial tuberosity. Over time, this can result in pain during contractions of the quadriceps during activities which load the knee such as jumping and running <sup>8,9</sup>. Imaging findings may show cartilage swelling, partial avulsion of the secondary ossification centre of the tibial tuberosity and patellar tendon changes <sup>10,11</sup>. Narrative reviews recommend stretching of the quadriceps muscle, reduction of aggravating activities and passive modalities such as a patella strap to alleviate pain and in some cases surgical intervention <sup>12,13</sup>. However, a recent systematic review identified only one randomised control trial including adolescents with OS, indicating a lack of evidence for treatment of adolescents with OS <sup>14</sup>. This lack of high-quality evidence, and therefore limited knowledge on how to most effectively manage OS could potentially lead to ineffective or potentially harmful care in patients with OS. Investigating health-care practitioners (HCP) current use and rationales behind their management strategies could guide future high-quality research in order to improve care in patients with OS. Therefore, this study's aims are to investigate the current management strategies of OS across different health-care practitioners and to compare differences strategies between HCP with a special interest in OS. Data was stored securely according to approval of Aalborg University, Denmark.

## 2. Materials and Methods

### 2.1 Study Design

This study was a cross-sectional study of healthcare professionals, using a mixed methods convergent parallel design <sup>15,16</sup>. The quantitative part consisted of a survey, while the qualitative part consisted of a semi-structured interview. This study was reported according to the

Strengthening the Reporting of Observational studies in Epidemiology (STROBE) statement, and the Good Reporting of Mixed Methods Study guideline for reporting<sup>17,18</sup>. Findings from qualitative and quantitative components were triangulated by the convergent parallel mixed method<sup>15</sup>. Questionnaire based studies are exempt from full research ethics committee approval according to Danish Law. Participation was entirely voluntarily.

## **2.2 Participants and Recruitment**

This study included participants who had a background as either Physiotherapists, General Practitioners, Rheumatologists, Sports Medicine Doctors or Orthopaedic Surgeons. Participants were recruited using a multi-modal recruitment strategy<sup>19</sup>. This method was chosen to recruit a representative sample of international Physiotherapists, General Practitioners, Rheumatologists, Sports Medicine Doctors and Orthopaedic Surgeons from different settings and countries.

Participants were first recruited by chartered societies from several countries (UK, DK, SWE, NO and NE) by requesting societies to forward the survey to their members. Participants were also recruited through a public invitational post online via Social Media (Twitter and Facebook), emails with invitations to participation through professional networks and by word of mouth at conferences. No formal sample size calculation was undertaken, but it was estimated that 20 participants from each profession would take part in survey and 300 in total. For the interview, it was expected participants would participate until data saturation was achieved. Respondents from the survey were asked if they would consider being part of an in-depth interview on OSD.

Participants who agreed to participate in the interview were randomly selected by a random number generator ([www.random.org](http://www.random.org)) to be invited to participate. At least four representatives from each profession were required. Data collection began in July 2018 and ended in November 2018.

## **2.3 Procedures**

### **2.3.1 Survey**

The survey consisted of a 64-item questionnaire including items on participant background of informants, prognosis, diagnosis, treatment strategies, return to activities (RTA) and current evidence. Participants were also given the opportunity to select 'other' if they wanted to add any additional comments or strategies that were not available'. Each item was created using previous literature or based on feedback from experts. The questionnaire was pilot tested by 1-2 experts

from each profession, to determine relevance and comprehensibility of the items. After changes based on feedback were from the piloting were integrated and evaluated, data collection commenced. Responses were captured securely using REDcap™.

### **2.3.1 Interview**

An interview guide was developed, consisting of 20 questions structured around the following domains; background, diagnostics, treatment, expected outcomes, return to play and evidence. Interviews were conducted in English or in a native language if possible (e.g. Danish). The interview was first pilot tested with 8 participants (minimum 1-2 from each profession) to improve language, understanding and relevance. Interviews were conducted using Skype recorded with consent from the participant. Interviews were transcribed anonymously.

## **2.4 Data Analysis**

### **2.4.1 Statistical analysis**

All data was analysed in SPSS (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Results are presented using descriptive statistics. The likelihood of using diagnostic test, active or passive approach, most common intervention, most important factor to influence return to activities and prognosis were compared across professions using the Chi-squared test. This were determined by merging the two response categories ‘very likely’ or ‘likely’ into for each item. These were also compared between those with and without a special interest in OS using the Chi-Square test. The level of significance was  $p < 0.05$ . A Bonferroni adjustment was used for multiple comparisons and Z-scores were computed for post-hoc analysis with  $Z > 2$  indicating statistical significance.

### **2.4.2 Thematic Analysis**

This study used condemnation through inspiration of Amedeo Giorgi<sup>20</sup>, based on a phenomenological approach. First, each interview was listened to in a naïve way and subsequently listening again to identify possible themes. Themes emerged on the basis of statements that was considered important for the respondents. One researcher conducted, transcribed and analysed the interviews. The identified themes and transcriptions were then cross-checked by at least one author (SH or MSR) for agreement. Quotes from the interviews will be used to illustrate findings and support reasoning.

### 2. 4. 3 Triangulation

Quantitative and qualitative data was integrated and triangulated in the final part of the analysis. Themes were compared to the cross-sectional domains to highlight convergence or divergence or complementarity between the two data sets. Both datasets were used to explain findings in the other dataset and vice versa. Equal weighting was applied to data originated from the qualitative and quantitative data collection.

## 3. Results

### *Sample*

Two-hundred and seventy-two participants responded to the questionnaire. Seventeen did not fulfil the inclusion criteria and were excluded. Ultimately, the study sample consisted of 255 respondents which included 159 Physiotherapists, 35 General Practitioners, 13 Rheumatologists, 23 Sports and Exercise Medicine Doctors and 27 Orthopaedic Surgeons. Eighty-three of the participants reported a special interest in OS. Thirty-five countries were represented, with United Kingdom (UK) being the most common (88 respondents) followed by Denmark (N= 42), Australia (N=27), United States (N=18) and Ireland/Canada (both N=11). Participants were primarily represented from private practice (32%), primary care (28%), or sports (21%) (See table 1 for full participants characteristics). The interview included twenty participants from 11 different countries as follows; 6 Physiotherapists, 3 General Practitioners, 3 Rheumatologists, 4 Sports Medicine Doctors and 4 Orthopaedic Surgeons (See table 2 for full participants characteristics). See Figure 1 for an overview of treatment strategies used in this study.

**INSERT TABLE 1: Participants Characteristics: Survey**

**INSERT TABLE 2: Participants Characteristics: Interview**

### *Diagnostic criteria*

The most common criteria were pain at the tibial tuberosity reported by the patient (97% for), followed by pain on palpation over the tibial tuberosity (93% for). Imaging was the least likely diagnostic criteria (38% for). Pain localised over the tibial tuberosity was significantly different between those with and without a special interest ( $\chi^2 = 8.808$   $p = 0.032$ ). Participants with a special interest were more likely to answer neither for nor against ( $Z = 2.10$ ). There were no significant differences between professions ( $p > 0.05$ ).

The qualitative data indicated all respondents considered the clinical examination as the main pillar of the diagnosis. However, the interviews provided insight in scenarios where imaging could be useful (although not for diagnosis);

*“Imaging will more likely say it is an OS or patella tendinopathy, but I don’t think it is that important to know, so the cost don’t benefit the treatment.” (Ben)*

*“I don’t think it is recommended (red. imaging) – but sometimes when the parents are very oppressive with me or the child and they need to be reassured – because the diagnosis in France are normality of x-ray and ultrasound, so I only do it if I have a doubt.” (Quinn)*

### **Triangulation**

There was a convergent validation regarding the use of a thorough clinical examination to diagnose OS. The qualitative data highlighted that rather than being used to make the diagnosis, imaging is used to rule-out other severe pathologies, such as fractures and bony tumours.

### **Treatment options**

Seventy-five percent of the participants favoured an active approach compared to the 25% who preferred to wait-and-see. For those selecting active approaches, 68% expected 1-5 sessions with the patient, 23% expected 6-10 sessions and 9% expected more than 10 sessions. The two most frequently used approaches were patient education (99%) and exercise (92%) (Figure 1). Thirty-three out of 51 who selected ‘other’, stated in free text that they used load management consisting of reducing or altering load. Significant differences between professions were found for complete rest ( $\chi^2 = 33.723$   $p = 0.006$ ) heat ( $\chi^2 = 23.558$   $p = 0.023$ ) and surgery ( $\chi^2 = 31.818$   $p = 0.011$ ). Rheumatologists ( $Z = 3.5$ ), orthopaedic surgeons ( $Z = 3.3$ ) and physiotherapists ( $Z = -2.5$ ) were more likely use complete rest as a strategy. Orthopaedic surgeons ( $Z = -2.4$ ) were more unlikely and physiotherapists were more likely to use heat as a strategy ( $Z = -2.8$ ). Orthopaedic surgeons ( $Z = 2.0$ ) were more likely to use invasive interventions such as surgery and rheumatologists ( $Z = 4.3$ ) were more likely to be against surgery as a treatment strategy. The qualitative data supports different treatment modalities being used. Respondents tried to modify activity/ reduce sports-specific load (N=15). Pain management emerged as first line of care (N=13), and many discussed either mild-analgesic or non-steroid anti-inflammatory drugs.

Surgery was considered for very severe or unresolved cases (N=5). The qualitative data showed rationales behind certain management strategies,

*“Here the patients will be treated with shockwave, and it works wonder, I have a success rate that around 97-98%, which you must not say - so people say it can't be possible - he has overlooked something, but I do not - I have only had two occasions for the last 10 years where it has not worked.”* – Derek

### **Triangulation**

The quantitative data showed a great heterogeneity of different treatments which also was shown in the qualitative data where management was a mix of multiple treatments strategies. Patient education was the most common strategy and often involved information about disease in order to be reassured about its prognosis, but also to guide both the child and its family in proper load management. Others implied that the additional use of exercise would increase the capacity of the tissue and improve motor control. The use of both mild and potent pain medication was used in order to alleviate pain, often in the earlier stage of the injury. Both also more non-invasive methods such as cryotherapy and shockwave were being used to decrease pain and to get the participant to return to prior activities.

### ***INSERT FIGURE 1: Treatment Strategies***

### ***Psychosocial Factors***

Eighty-six percent of the respondents thought that psychological factors were important for RTA and ninety-five percent of the respondents thought that social factors were important for RTA. There was a significant difference between professions in social factors ( $\chi^2 = 38.646$   $p = 0.001$ ) and psychological factors ( $\chi^2 = 44.012$   $p < 0.001$ ). Orthopaedic surgeons were more likely to answer very unlikely ( $Z = 3.0$ ) and physiotherapists were also more likely to respond very likely ( $Z = 3.9$ ). The qualitative data also highlighted the mental components in rehabilitation.

*“It is almost here where you can win it all, the mental component – it is here you would convince the athlete that everything will return to normal”* – Martin

### **Triangulation**

The qualitative data supported the quantitative that psychological and social factors were



important. The qualitative data also underpinned if not addressed, these considerations could potentially lead to a poorer outcomes and long-term consequences.

### ***Return to Activities***

The majority of respondents expected patients with OS to be back doing their pre-injury activities within 6 months (61%). Error in training load were considered the most important factor influencing RTA (97%) with pain intensity (87%) and psychological factors (86%) being the second and third most important factors for RTA. Significant difference between professions were found for considering the importance of tissue damage ( $\chi^2 = 48.292$   $p = 0.001$ , load management ( $\chi^2 = 40.662$   $p = 0.001$ ) and pain at rest ( $\chi^2 = 31.502$   $p = 0.012$ ). Physiotherapists were more likely to state that load management was important in determining RTA ( $Z = 3.7$ ). Orthopaedic surgeons were more likely to state that load management was very unimportant. Physiotherapists were most likely to say that tissue damage were very unimportant ( $Z = 4.9$ ) and rheumatologists were more likely to state that tissue damage were very important ( $Z = 3.3$ ). Lastly, orthopaedic surgeons ( $Z = 3.0$ ) were more likely to be against the importance of pain at rest in RTA. The qualitative data indicated some respondents experienced that some patients would not be expected to be back playing their sports again and would be asked to give up on their sport.

*“I think the pain improves, but not necessarily their function. 1-2 of the adolescents per year have to fully give-up their sport, because they don't respond to treatments.”* (Eric)

And,

*“ I also see someone there for some reason experience chronic discomfort in the area. There are a few who cannot return, but then there are some who give up along the way”* (Jacob).

### **Triangulation**

Overall it seems like participants from both data sets expect that patients with OS would be back in less than 6 months. The qualitative data underpins than in rarer cases some may not be able to return to activities. Emerging from the qualitative data it seems like chronic pain could have detrimental effects on their kids' eagerness to return.

### ***Family related factors***

Family was identified as a theme in the qualitative data. Reassurance and proper education of the family were stated as key components of successful management. The majority of the respondents stated that the parents could be both a barrier and a facilitator for the rehabilitation of the child's injury.

*“It is one of the pitfalls, if the parents or the coach are not well-informed...I often experience parents who are very different, some of them have things that they, themselves, have not fulfilled and try to push it over on their children and they are the worst parents”*

– Derek

*“The parents often live their lives through their children and therefore they push the child, the parent's life collapse if their child can't play. But also, some of the parents are afraid that the child will like to sit and play videogames and then they will never get him back to sport in that age”* – Helmuth

#### **Future Research**

Fifty-six percent of the respondents thought that there was sufficient evidence for the diagnosis of OS, 26% thought that there was sufficient evidence for the injury mechanism, 23% for the treatment and 20% for the long-term consequences of OS. Twenty-two percent answered that there was not sufficient evidence for any of the above and 16% didn't know. The interview highlighted the theme that future research should revolve around the effectiveness and improvement of the current management strategies of OS, including pain management and exercise. Peter summarizes the importance of continuing research;

*“Usually the children come to me, unrecognized. The doctor, the paediatrician even from the orthopaedic surgeon. This is really sad. We should increase awareness of the disease and to educate the physicians more.”* (Peter)

#### **4. Discussion**

This study is the first to investigate diagnostic and management strategies of OS across a sample of different specialities. The HCPs included in this study considered the clinical examination the cornerstone for diagnosing OS and appeared confident to make the diagnosis on the basis of this without the use of imaging. There was a much larger heterogeneity in what treatment strategies were being used, with differences between surveyed respondents. Psychosocial factors such as

social exclusion, the mental struggle of being injured and pain intensity can be difficult to manage and may strongly impact prognosis, patients' ability to comply and return to activities.

#### **4. 1. Current management compared to evidence and recommendations from narrative reviews**

It is often unclear how clinicians decide on the best treatment option in the absence of research and guidelines, which is one of the reasons why qualitative data was included in the current study. There are currently no widely agreed guidelines on the management of OS and only one RCT study informing some aspects of treatment <sup>21</sup>. This may translate into the variation of OS treatment which was observed in the current study. Similar heterogeneity is seen in patellofemoral pain, another common knee pain complaint. Despite patellofemoral pain has a strong evidence base with level one evidence supporting exercise as treatment, heterogeneity exists in the management of this condition by UK physiotherapists <sup>21</sup>. If we look at how the data from the current study compare to recommendations from narrative reviews, we found that cryotherapy was often used (53% were 'for') which was supported by the qualitative data where clinicians emphasised pain management as a core strategy. Cryotherapy is also supported from the narrative reviews together with stretching <sup>4,11</sup>. In addition to that, we found that the majority were for stretching (52%) in line with recommendations from narrative reviews <sup>4,11</sup>. Several narrative reviews, suggest the use of rest which is not supported by the majority of the respondents in this study (78.9% against complete rest) <sup>4,11</sup>. On the contrary, education is not mentioned in the reviews as a treatment strategy together with ordinary exercise which is often used as treatment in both of our data sets and in PFP <sup>23,24</sup>.

#### **4. 2. Merging of data**

The merging of quantitative and qualitative data gave insight into the clinical reasoning behind the management. The qualitative data revealed the rationale behind load management and exercise were inspired by the research in tendinopathy, where gradual loading is considered the cornerstone of managing this pain condition <sup>25-27</sup>. The qualitative data also revealed psychosocial variables were considered to be very important and can have severe consequences when

neglected. This is interesting as research on this subject has been overlooked, and to the authors' knowledge there are no OS-specific studies examine the role of these factors. Psychological and sociological factors such as social exclusion, lack of support and emotions have previously been shown to linked to a higher risk of injury or recurrence of a previous injury <sup>28-30</sup>. Also, emerging from this study performative parenting or parents who inappropriately push their children back into sports before complete readiness is an interesting topic in the light of the activity-related nature of OS. It is suggested that parents can induce additional stress to the adolescent which can negatively affect the adolescent's health <sup>31-32</sup>. It is plausible that early RTA and increased levels of emotional stress can lead to recurring symptoms and progressively worsening of the disease, although future research should investigate the role of performative parenting in the management of OS.

#### **4. 3. Research implications**

Only 23% of respondents stated that there was currently sufficient evidence on treatment, which highlights the need for future studies. Psychosocial factors were considered important, which underpins the need for research to explore this and investigate if interventions targeting psychosocial barriers in OS patients improve the likelihood of returning to prior activities. There is a need for more research in this area, to determine how best to balance these factors and stakeholders in the management of OS.

#### **5. Strengths and limitations**

This study recruited participants across different profession to ensure that we captured a variety of the different management strategies from the most relevant HCP involved in the management of OS. A significant strength is the use of mixed methods which allowed us to understand both the "what" and the "why" allowing us the understand the rationales behind certain strategies. Injection therapy were not provided as an answer in the questionnaire, which may influence the interpretation of the use of injection therapy in the management of OS. The data collection period was, because of pragmatic reasons, limited to 4 months and participants were mainly recruited from social media which may reduce generalisability of the sample. In this explorative nature of this study, is it uncertain how responder bias affected the findings from this study and combined with the aforementioned limitations cautions should be taken when generalising and interpret the findings from this study.

## **6. Conclusion**

This study revealed that the diagnosis of OS is made primarily upon clinical exam by the HCPs included, and that imaging is rarely used except in cases of ruling out other serious pathology.

There appears to be greater heterogeneity in the management strategies with many different interventions being utilised in clinical practice. The majority of HCPs in the current study believed adolescents with OS would be back playing sport pain free within 6-months, however they highlighted psychosocial aspects as potential barriers. Based on the responses from the participants, it is evident that there is a great need for further studies, investigating the different management strategies being used in this study, with the purpose of guiding clinical practice.

## **7. Perspectives**

Osgood Schlatter is a common condition in sports medicine <sup>2</sup>, and there is a lack of management strategies which have been evaluated in research <sup>14</sup>. The current study indicates that there may be heterogeneity in treatment of this, some of which varies across professions. These findings align with narrative reviews that indicate several treatment strategies for the management of OS <sup>4,11</sup>.

Interestingly the mixed method approach revealed that some clinicians see OS closely related to patellar tendinopathy and draw on research from that domain in their treatment <sup>27</sup>. Long-term functional deficits have been documented in OS <sup>6</sup>. The data revealed the potential importance of addressing psychological and social factors which may facilitate or impede recovery (e.g. desire to splay sport / be with friends or oppressive parents may be a barrier to adhering to advice on sporting activity).

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Tables

**Table 1:**

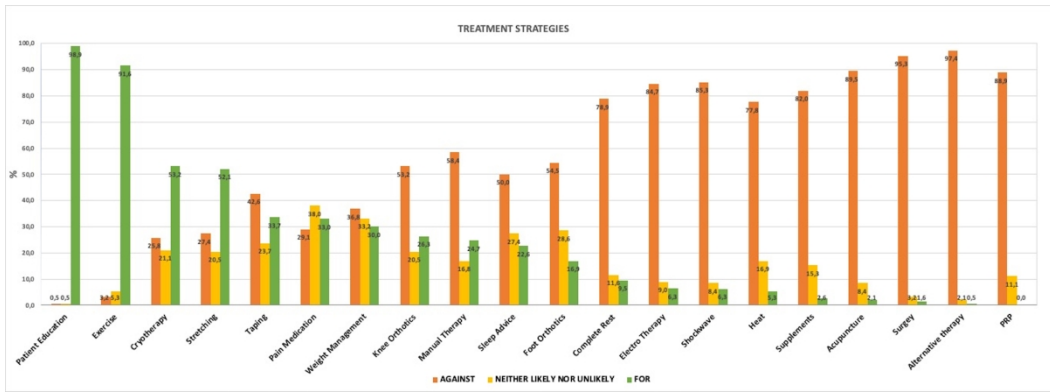
<b>Country (n)</b>	UK (88); Denmark (42); Australia (27); USA (18); Ireland (11); Canada (11); Other (58)
<b>Profession (n)</b>	Orthopaedic Surgeon (26); Rheumatology (13); Sports Medicine (23); General Practitioner (34); Physiotherapist (158)
<b>Experience (n)</b>	0-5 Years (38); 5-10 Years= (61); 10-15 Years (73); 15-20 Years (57); 20+ Years= (27)
<b>Cases per week (n)</b>	0-5 Cases per week (214); 5-10 Cases per week (38); 10-15 Cases per week (4); 15+ Cases per week (0)
<b>Setting (n)</b>	Primary Care (72); Secondary Care (34); Tertiary Care (11); Private Practice (83); Academia (1); Sports (52); Other (4)
<b>Special Interest (n)</b>	Yes (83); No (174)

*Table 1 – Participants Characteristics: Survey*

**Table 2:**

<b>Country (n)</b>	Denmark (7); The Netherlands (1); UK (2); US (2); Canada (1); Macedonia (2); Belgium (1); Malta (1); Ireland (1); Germany (1); France (1)
<b>Profession (n)</b>	Orthopaedic Surgeon (4); Rheumatology (3); Sports Medicine (4); General Practitioner (3); Physiotherapist (6)
<b>Experience (n)</b>	0-5 Years (1); 5-10 Years (3); 10-15 Years (3); 15-20 Years (9); 20+ Years (4)
<b>Cases per week (n)</b>	0-5 Cases per week (14); 5-10 Cases per week (5); 10-15 Cases per week (1); 15+ Cases per week (0)
<b>Setting (n)</b>	Primary Care (3); Secondary Care (1); Tertiary Care (2); Private Practice (9); Academia (0); Sports (5); Other (0)
<b>Special Interest (n)</b>	Yes (9); No (11)

*Table 2 – Participants Characteristics: Interview*



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