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# Factors and criteria considered by Saudi physical therapists for a safe return to sport after anterior cruciate ligament reconstruction: a mixed model approach

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**Abstract**

**Introduction.** Anterior cruciate ligament (ACL) injury is common among athletes, especially those engaged in high levels of physical activities. The prevalence of re-injury after ACL reconstruction is frequently reported among athletes. This study aims to identify the significant factors considered and criteria used by Saudi physical therapists for safe return to sport (RTS) after anterior cruciate ligament reconstruction (ACLR).

**Methods.** This research examined physical therapists' knowledge and practices related to helping patients safely RTS after ACLR surgery. The study design involved a mixed-method approach, using both online questionnaires and in-person interviews with physical therapists. We developed the questions asked based on items from other research and had them reviewed by experienced physical therapists for accuracy and relevance. A total of 252 physical therapists participated in the study.

**Results.** We found that most specialist therapists suggest that age, psychological support, and patient adherence to rehabilitation are crucial for a safe RTS. They believe RTS should be 6 to 9 months after ACLR. Other factors that could influence the safe RTS are checking the isokinetic muscle strength before RTS and ensuring adequate knee range of motion (ROM).

**Conclusions.** The most crucial factors used by Saudi physical therapists for a safe RTS included the patient's adherence to a suitable rehabilitation program (safe RTS could be 6–9 months after ACLR), the patient's age, and proper psychological support.

**Key words:** anterior cruciate ligament reconstruction, safe return to sport, rehabilitation, physical therapy

## Introduction

An anterior cruciate ligament (ACL) injury is common among athletes, especially those engaged in high levels of physical activities, and it results from situations in which the knee is hyper-extended or twisted forcefully [1]. A patient will feel a painful sensation if the knee is strained or subjected to some load, and this pain hampers the knee's functionality, potentially preventing the individual from performing basic activities. However, surgery can be performed to repair the damaged ligament. Rehabilitation is essential after reconstructive surgery of an injured ACL to help the patient return to an active lifestyle [2].

The long-term impact of a ruptured ACL depends on the severity of the rupture and the treatment administered [3]. Osteoarthritis is one of the significant long-term effects of a ruptured ACL, which affects patients who are subjected to non-surgical treatments for an ACL tear, and the complications of the condition, such as meniscus tear, can occur up to 10 or 15 years after the rupture [4]. Therefore, surgical reconstruction of damaged ligaments is performed on young athletes who still want to participate in competitions. On the other hand, non-surgical treatments can be administered to athletes in the final years of their careers. The problem with this treatment is the likelihood of increasing an individual's chances of developing osteoarthritis [5].

The treatment of a torn ACL focuses on the restoration of joint function and the prevention of long-term complications [6]. Early intervention is crucial for the successful treatment of a torn ACL. Athletes who sustain an ACL injury and intend to return to competition promptly can undergo a criteria-based rehabilitation program. The program usually begins immediately after the surgery. It primarily focuses on reducing inflammation, restoring ROM, and strengthening the quadriceps. The primary goal is to maintain knee extension and achieve knee flexion of 90 degrees [7]. The athlete may occasionally be subject to ROM exercises to gradually place appropriate weight on the knee and increase the quadriceps strength [8, 9]. Preoperative preparation is crucial for optimising outcomes after ACL surgery, as it helps improve muscle strength, range of motion, and overall physical condition before the procedure. Additionally, immediate first aid after an injury, such as the RICE method (Rest, Ice, Compression, Elevation), plays a vital role in reducing swelling and pain, setting a solid foundation for subsequent rehabilitation efforts [10].

Ensuring proper rehabilitation for the injured athlete requires sufficient skill among physical therapists. In addition to cooperation between the athletes and the therapists, understanding the factors considered by the physical therapists and realising the criteria for rehabilitation after ACL reconstruction (ACLR) are essential for a proper and safe return

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to sports (RTS), which means return to practice, training, and competitive games or activities at a level similar to the pre-injury level. In addition, the role of the physical therapist in returning the individual to the previous level of function and activity is fundamental to the operative success and challenge of avoiding re-injury by restoring the functional level of the knee joint. The study aims to investigate the factors necessary for a safe return to activity and adherence to guidelines after ACL reconstruction from the perspective of physical therapists.

## Subjects and methods

This study depends on descriptive analysis and the Mixed Model Approach (concurrent type). Physical therapists from Jeddah City conducted interviews and administered questionnaires to the study participants.

We used an online questionnaire and in-person interviews. We created the questionnaire using Google Forms (Google, LLC) in February 2021. Then, we sent it to physical therapists in Saudi Arabia via email and through social media platforms (Facebook, WhatsApp, Twitter, Instagram, and Telegram) in April 2021. The snowball sampling method was facilitated by encouraging the physical therapists (PTs) to forward the online questionnaire to their colleagues. We modified the interview questions and collected responses from February 2021 to April 2021.

The questionnaire contained three sections. The first section had an informed consent question, the second included 14 questions about demographic details, and the third contained 14 questions about a safe return to sports. The interviews included two sections. The first included four questions about basic demographic information, and the second had 16 questions about a safe return to sports. We utilised questions from previous literature,[1] and nine expert physical therapists reviewed the questionnaire and interview questions. We assessed the content validity and the face validity for the questionnaire and the interview questions through six steps based on the study conducted by Yusoff et al. [11]: preparation of the validation form, preparation of the response process, selection of a panel of raters to conduct response process validation, revision of the items for clarity and comprehension, scoring for each item based on the clarity and comprehension rating scale, and finally calculating the face validity index (FVI). We obtained acceptable reliability for the content and face validity for both the questionnaire and the interviews based on the opinions of the nine experts mentioned previously.

We calculated the minimum sample size required to achieve a power of 0.8 using the G*power software (latest ver. 3.1.9.7; Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). We chose a logistic regression test with an odds ratio of 1.5 and a significance level of 0.05 for a priori power calculation. As a result, the minimum sample was indicated to be 208 respondents.

We invited 336 physical therapists to participate in the questionnaire for this study, and five of them declined to participate. We excluded physical therapists (male and female) with less than one year of experience in ACL rehabilitation and those who declined to participate in the questionnaire. The final sample size of the questionnaire was 234 participants (Figure 1, Table 1). For the interviews, we conducted 28 interviews with physical therapists, and subsequently excluded 10 of them. The sample size of the interviews was therefore 18 participants (Figure 2). As a result, the total sample size was 252 ($n$ = 252) male and female physical therapists with 5 to 20 years of experience in sports physiotherapy, as recognised by the Saudi Ministry of Health.

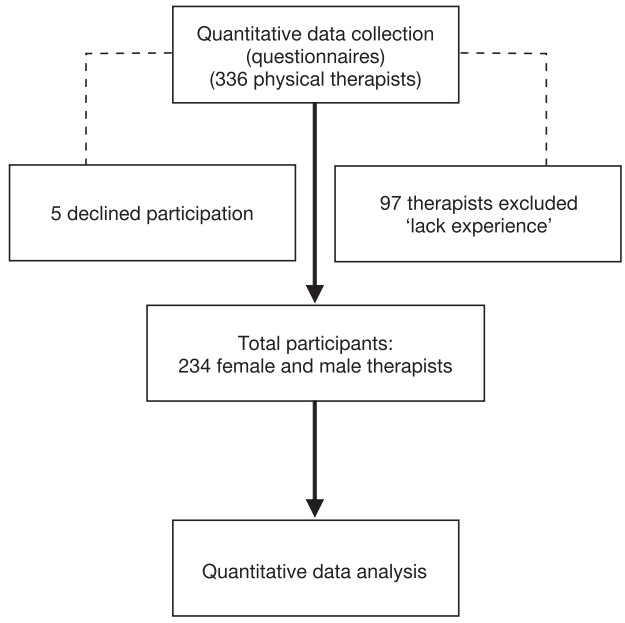


Figure 1. Quantitative data collection

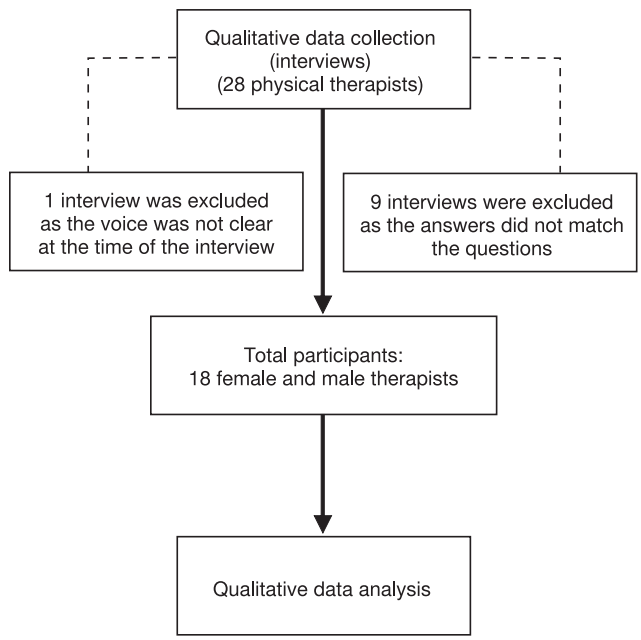


Figure 2. Qualitative data collection

We coded and analysed the qualitative data using a thematic approach in the Excel program. The data analysis was conducted by two researchers with different scientific backgrounds to enhance the reliability of the findings. For quantitative data, we coded and analysed it using IBM's Statistical Package for Social Sciences software (SPSS), version 21, IBM, United States. Continuous demographic data were analysed using means and standard deviations, but in the case of categorical, data percentages and frequencies were used to describe the sample age, sex, years of experience, educational qualifications, employment status, workplace regions, etc. We used binary multivariate logistic regression tests to determine the predictors of factors affecting strict adherence to protocol by the physical therapists. We reported the odds ratio (OR) and 95% confidence interval (CI) to explain the magnitude of the relationship between the predictor variables and the dependent variable. We used an $\alpha$ level of 0.05 or less for all the statistical analyses to determine the statistically significant predictors.

## Results

### Outputs of the questionnaire

Table 2 shows that most physical therapists recommended an ideal time for a safe return to sport is 6–9 months after ACLR. Furthermore, the majority of therapists believed that age could determine a safe RTS after ACLR. Psychological support after ACLR is essential for a safe RTS. In addition, most therapists believed that patients' adherence to rehabilitation impacted a safe RTS. However, the results suggest RTS following ACLR can cause injury, and there were no barriers in management for a safe RTS.

The binary logistic regression analysis showed that physiotherapists who had treated more than 20 cases were nearly twice as likely to follow the protocols strictly as those who had treated fewer than 20 (Table 3).

Table 1. Socio-demographic variables of the physical therapists in Saudi Arabia

| Variable | | *n* (%) |
|---|---|---|
| Sex | male | 206 (88.00) |
| | female | 28 (12.00) |
| Age (years) | 20–30 | 112 (47.90) |
| | 31–40 | 102 (43.60) |
| | 41–50 | 16 (06.80) |
| | 51–60 | 2 (00.90) |
| | over 60 | 2 (00.90) |
| Specialty | musculoskeletal | 101 (43.20) |
| | non-musculoskeletal | 133 (56.80) |
| Region | central | 48 (20.50) |
| | eastern | 21 (09.90) |
| | western | 105 (44.90) |
| | northern | 10 (04.30) |
| | southern | 50 (21.40) |
| Qualifications | bachelor | 174 (74.40) |
| | master | 60 (25.60) |
| Employment | government | 145 (62.00) |
| | non-government | 89 (38.00) |
| ACL patients treated | < 20 patients | 132 (56.40) |
| | > 20 patients | 102 (43.60) |

ACL – anterior cruciate ligament

### Outputs of the interview

#### *Making decisions regarding patients' safe return to sport after ACLR*

Regarding the specific tests used by the respondents to decide whether the return to sport would be safe, the analysis indicated that isokinetic muscle strength was the most commonly used test in this respect. Moreover, the participants indicated that other tests could also be used along with the isokinetic muscle strength. For example: ROM, hop testing, endurance testing, balance, zig-zag test, pelvic muscle strength, Motor Tests, Stability tests, no pain, psychological readiness, tensiomyography, $VO_2$max, DIER test for the spine, speed, agility, and balance tests.

#### *Milestone approach vs. time frame-based goals approach for rehabilitation progression*

Concerning the milestone approach vs. the time frame-based goals approach for rehabilitation progression, six participants intended to use both approaches for rehabilitation progression. However, six participants used the milestone approach only, and five participants used the time frame approach only. One of the participants indicated that the milestone approach could be used only for athletes. In addition, several milestones were used to prevent recurrence, including change of direction, knee stability, speed reaction of the muscles, muscle power, full ROM, and full recruitment of muscle activation. Many of the participants mentioned ROM. The focus was also on knee muscle strength as an ideal milestone.

Table 2. Factors influencing safe RTS after ACL according to questionnaire of therapists in Saudi Arabia. Regression analysis

| Variable (%) | | Factors | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | T-SRTS (months) | | | AI-SRTS | | PS-SRTS | | PAR-SRTS | | RTS-ACLR | | | NBM-SRTS | |
| | | > 6 | 6–9 | 9 < | yes | no | yes | no | yes | no | yes | no | not sure | yes | no |
| Qualification | BDH | 27.00 | 48.90 | 24.01 | 88.50 | 11.50 | 97.10 | 02.90 | 94.80 | 05.20 | 33.30 | 27.00 | 39.70 | 44.8 | 55.2 |
| | MDH | 36.60 | 38.30 | 25.01 | 86.70 | 13.30 | 96.70 | 03.30 | 95.00 | 05.00 | 35.00 | 41.70 | 23.30 | 45.00 | 55.00 |
| Years of experience | < 10 years ET | 27.00 | 47.70 | 25.30 | 91.40 | 08.60 | 96.00 | 04.00 | 96.60 | 03.40 | 31.00 | 29.30 | 39.70 | 44.30 | 55.70 |
| | > 10 years ET | 36.70 | 41.60 | 21.70 | 78.30 | 21.70 | 100.00 | 00.00 | 90.00 | 10.00 | 41.70 | 35.00 | 23.30 | 46.70 | 53.30 |
| Employment | Gov T | 31.80 | 46.80 | 21.40 | 87.60 | 12.40 | 98.60 | 01.40 | 92.40 | 07.60 | 35.90 | 29.00 | 35.10 | 44.8 | 55.2 |
| | Non-Gov T | 25.80 | 44.90 | 29.2 | 88.80 | 11.20 | 94.40 | 05.60 | 98.90 | 01.10 | 30.30 | 33.70 | 36.00 | 44.90 | 55.10 |
| Musculoskeletal experience | MSP | 15.90 | 46.40 | 37.70 | 90.10 | 09.90 | 98.00 | 02.00 | 98.00 | 02.00 | 39.60 | 33.70 | 26.70 | 47.50 | 52.50 |
| | Non-MSP | 39.90 | 45.80 | 14.30 | 86.50 | 13.50 | 96.20 | 03.80 | 92.50 | 07.50 | 29.00 | 28.60 | 42.2 | 42.90 | 57.10 |

BDH – bachelor's degree holders, MDH – master's degree holders, ET – expertise as therapists, Gov T – governmental therapists, Non-Gov T – non-governmental therapists, MSP – musculoskeletal physiotherapists, Non-MS – non-musculoskeletal physiotherapists, T-SRTS – time for safe RTS, AI-SRTS – age influences safe RTS, PS-SRTS – psychological support is important for safe RTS, PAR-SRTS – patient's adherence to rehabilitation affects safe RTS, RTS-ACLR – RTS after ACLR (anterior cruciate ligament reconstruction) leads to injury, NBM-SRTS – no barriers in management for safe RTS, RTS – return to sport

Table 3. Logistic regression to find the factors that influence the strict adherence of protocol by physical therapists

| Variable | | 95%CI for β | | β | *p*-value |
|---|---|---|---|---|---|
| | | lower limit | upper limit | | |
| Sex | male | 0.80 | 4.52 | 1.91 | 0.14 |
| | female | reference* | | | |
| Qualification | postgraduate | 0.54 | 2.31 | 1.11 | 0.76 |
| | undergraduate | reference* | | | |
| Employment | government | 0.65 | 2.33 | 1.23 | 0.52 |
| | non-government | reference* | | | |
| Experience | > 10 years | 0.54 | 2.31 | 1.12 | 0.76 |
| | < 10 years | reference* | | | |
| Specialty | musculoskeletal | 0.85 | 3.13 | 1.63 | 0.14 |
| | non-musculoskeletal | reference* | | | |
| No. of ACLRs Treated | > 20 patients | 1.01 | 3.61 | 1.87 | 0.04** |
| | < 20 patients | reference* | | | |
| Awareness of ACL Protocol | yes | 0.69 | 5.50 | 1.96 | 0.20 |
| | no | reference* | | | |

ACLR – anterior cruciate ligament reconstruction, ACL – anterior cruciate ligament; * 0.5–4.5, ** significant

### *Ideal time frame to be achieved for safe return to sports*

Eight participants indicated their preference for a rehabilitation progression lasting 6–9 months, whereas four participants suggested 9–12 months. Notably, one participant expressed that the ideal duration could be more than a year. Regarding the effect of age on a safe RTS, the results indicated that seven specialists interviewed believe that age can influence a safe RTS, while two participants believed that age has no impact.

### *Awareness of guidelines or test batteries for safe return to sports after ACLR*

Concerning the awareness of the guidelines, fifteen specialists were aware of the guidelines or test batteries for a safe RTS, while only three respondents were unaware of such guidelines. The analysis revealed that six specialists used the Australian guidelines. However, five respondents used their own protocol. In addition, two respondents used the American guidelines.

All respondents believed that adherence to rehabilitation could affect a safe RTS after ACLR, and they also believed in the role of outcome measures in a safe RTS. The results revealed that thirteen respondents did not use knee function measures, while three used different measures.

### *Criteria for measuring knee muscle strength and neuromuscular status*

Concerning the criteria for measuring knee muscle strength and neuromuscular status, the isokinetic muscle strength criteria were the most used in this respect, as nine participants used them. Four participants used the Manual Muscle Test (MMT). However, two participants preferred to use other measures besides isokinetics and MMT. Moreover, one participant preferred to use tensiomyography besides isokinetics to measure muscle strength, and another participant preferred to use Progressive Resistance Exercise (PRE) with MMT. On the other hand, one of the respondents believed that muscle strength is not an indicator of a safe RTS and that the focus should be on muscle control instead. However, another respondent did not believe in isokinetics and preferred functional knee alignment. The analysis indicated that all participants used various performance-based outcome tools, for example, the zig-zag, horizontal, and vertical jump tests. In addition to cardiovascular fitness, motion analysis and functional exercises, such as squats, lunges, and jack jumps were also used. None of the participants used the KT-1000 arthrometer measurements to check the anterior knee laxity. However, one participant believed that the stress radiograph was better than the KT-1000 in examining knee laxity.

### *Possibility of re injury after returning to sport*

Regarding the possibility of re-injury after returning to sport, the results indicated that 15 specialists believed that RTS after ACLR could lead to injury. On the other hand, one of the specialists suggested that it would not lead to any injury, and two of them were unsure. The responses provided by the participants indicated that the level and type of injury could vary from one case to another.

### *Role of psychological counselling/support in safe return to sport*

Notably, all the interviewed specialists believed in the significant role of psychological support for a safe RTS.

## Discussion

The current study used two research tools: a questionnaire ($n$ = 234) and in-person interviews ($n$ = 18). Our results showed that 56.4% of Saudi physical therapists believed that returning to sports after ACLR would take 6–9 months. Dur-

ing the period of rehabilitation, it is important to consider the critical factors affecting a safe RTS and preventing re-injury among patients with ACLR [12, 13]. Physiotherapists usually recommend at least six months of rehabilitation with high patient adherence to rehabilitation sessions for a safe RTS [14, 15]. However, survey studies by Dingenen et al. [16], Greenberg et al. [17], and Korakakis et al. [12] showed that 65% of Flemish, 50% of American, and 70% of Greek physiotherapists, respectively, advised less than nine months of rehabilitation among ACLR patients to RTS. On the other hand, the period of 9–12 months is ideal for RTS after ACLR, as recommended by 54% of Australian physiotherapists [18], and 63% of New Zealand physiotherapists [19].

One of the critical risk factors among patients with ACLR is the evidence of re-injury. The current study reported that 40.7% of the participants believed that RTS following ACLR causes injury. In this regard, the return to strenuous knee sports (pre-injury Tegner Activity Scale score of 6 or greater) less than nine months after ACL reconstruction was shown to significantly increase the risk of sustaining a second ACL injury [20]. This increased risk, which is approximately seven times higher, can be attributed to the incomplete healing of the ACL reconstruction [21].

Also, Meredith et al. [22] showed that a decreased re-injury rate was associated with achieving the pre-injury level of activity, as defined by the same type, frequency, intensity, and performance quality. Therefore, a physiotherapist's incorrect estimation of knee strength may lead to insufficient rehabilitation to promote functional improvement and the application of rehabilitation exercises that are unsuitable for the patients, or a premature return to pre-injury activities [3, 20]. In addition, Van Melick et al. [23] suggested that patient adherence to rehabilitation exercises and the type of rehabilitation applied play a crucial role in the rate of re-injury among subjects with ACLR. Consequently, nine months of rehabilitation or more after surgery would reduce the re-injury rate after ACL reconstruction [14]. Also, patients typically achieve increased knee strength, greater limb symmetry, and improved functional capacity after at least six months of rehabilitation before RTS [15, 17, 24]. These latter factors (knee strength, greater limb symmetry, and improved functional ability) confirmed their relationship with a safe RTS [25, 26].

Our result, in agreement with several previous studies, reported the importance of physiological function evaluation in patients with ACLR in deciding on a safe RTS [12, 21, 27, 28] due to different factors such as the age of the patient [29] and the patient's adherence to the rehabilitation, which may vary across the individuals [30]. Regarding the relationship between the age of the patients and a safe RTS, our survey showed that 87.6% of Saudi physical therapists believed that age determined a safe RTS. These findings agree with those of Kaeding et al. [13], who reported that patients younger than 20 years old had a high rate of a safe RTS. Meanwhile, Grindem et al. [14] found no clear relationship between age and re-injury rates among patients who underwent ACLR.

The results of the current study showed that the specialists had different perceptions on deciding on patients' safe return to sports after ACLR; A third of the participants used both approaches for rehabilitation progression (milestone and time frame-based goals approaches), a third of the participants tended to use the milestone approach, while the other third of the participants used the timeframe-based goals approach. In this respect, the milestone approach is reported to be more beneficial for rehabilitation and is preferred by physiotherapists who are aware of the published ACLR guidelines compared to those using the timeframe-based goals approach [22, 25].

In agreement with our findings, psychological support and patients' adherence to rehabilitation were crucial factors affecting a safe RTS after ACLR [19, 31, 32]. While, Korakakis et al. [12] added that psychological support, adherence to rehabilitation, and ROM were considered factors in RTS. Furthermore, Aquino et al. [33] recorded that physiological function and range of motion were mainly used to suggest a return to sports.

Our results reported that the experienced physiotherapists surveyed were adhering to protocols and guidelines very strictly. These findings were similar to those of Buckthorpe et al. [34], who reported that experienced therapists in ACLR rehabilitation followed protocols more, especially at the RTS stage.

Our outcomes were compatible with several studies regarding the importance of assessing knee muscle strength and neuromuscular status, including Welling et al. [35] and Wright et al. [36]. Similar to our findings, Mille et al. [37] reported the importance of maintaining cardiovascular fitness as well as overall conditioning, such as squats, lunges, and jumping jacks, in athletes to ensure a safe return to sports. Our results showed that KT-1000 arthrometer measurements were poorly used to check the anterior knee laxity and function measures. In this regard, Isberg et al. [27] found that only one physiotherapist used KT-1000 arthrometer measurements to examine the anterior knee laxity. However, to check the knee function measurements, the physiotherapist used radio-stereometric analysis (RSA) instead, as they focused on restoring strength and motion to the affected knee during the rehabilitation period.

## Limitations

One limitation of the research is that while there are existing studies on the topic conducted in other countries worldwide, there is a lack of similar studies conducted in Saudi Arabia, where the research was carried out. This absence of local studies may limit the generalisability of the findings to the specific socio-cultural and environmental context of the country of study.

## Conclusions

Physical therapists in Saudi Arabia suggest several critical factors for a safe return to sports after ACLR. First, regular rehabilitation for a minimum of six months to ensure an optimal recovery. The age of the patients is also critical, as younger individuals tend to have a safer healing process, as well as proper psychological support and patient adherence to a suitable rehabilitation program. This will lead to a safer recovery and a lower likelihood of re-injury, according to the findings of this study.

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## Ethical approval

The research related to human use complied with all the relevant national regulations and institutional policies, followed the tenets of the Declaration of Helsinki, and was approved by the Research Ethical Committee in Jeddah Health Affairs (Institutional Review Board IRB, approval No.: #A01063). The informed consent for the interviews received approval from Jeddah's Health Affairs Research Ethical Committee. For the interviews, an official letter was sent from the Faculty of Medical Rehabilitation Sciences/Department of Physio-

therapy to the Ministry of Health hospitals in Jeddah to gain approval for conducting interviews with physical therapists working there. For the physical therapists working in the university hospital, private clinics, and sports clubs, the communication with them was friendly to conduct the interviews. The physical therapists voluntarily participated in the study while working in hospitals, clinics, rehabilitation centers, or home healthcare.

## Informed consent

Informed consent was obtained from all individuals included in this study.

## Disclosure statement

No author has any financial interest or received any financial benefit from this research.

## Conflict of interest

The authors state no conflict of interest.

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