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The one-week prevalence of overuse-related shoulder pain and activity limitation in competitive tennis players living in Toronto: a feasibility study

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Objective: *We aimed to determine the feasibility of conducting a cross-sectional study to estimate the one-week prevalence of overuse-related shoulder pain and activity limitation in competitive tennis players.*

Methods: *Eligible for the study were competitive adult tennis players who reside in Toronto. Using a convenience sample, the Oslo Sports Trauma Research Centre Overuse Shoulder Injury Questionnaire (OSIQ) was administered online to provide preliminary estimates of the prevalence of shoulder pain and activity limitation, injury severity and pain intensity. Feasibility outcomes included evaluating participation rate and missing data in the questionnaire.*

La prévalence sur une semaine des douleurs à l'épaule et des limitations d'activité liées à la surutilisation chez les joueurs de tennis de compétition vivant à Toronto : une étude de faisabilité

Objectif : *nous avons cherché à déterminer la faisabilité de mener une étude transversale pour estimer la prévalence sur une semaine de la douleur à l'épaule et de la limitation d'activité liée à la surutilisation chez les joueurs de tennis de compétition.*

Méthodologie : *les joueurs de tennis adultes compétitifs qui résident à Toronto sont admissibles pour l'étude. À l'aide d'un simple échantillon, l'Overuse Shoulder Injury Questionnaire, OSIQ (questionnaire sur les blessures à l'épaule), du Centre de recherche sur les traumatismes sportifs d'Oslo a été mis en ligne pour obtenir des estimations préliminaires de la prévalence de la douleur à l'épaule et de la limitation des activités, de la gravité des blessures et de l'intensité de la douleur. Les critères de faisabilité comprenaient l'évaluation du taux de participation et des données manquantes dans le questionnaire.*

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Results: *Forty-three tennis players were included in the questionnaire (68.3% participation rate, 100% completion rate). There was no missing data. The one-week proportion of those with shoulder pain and activity limitation was 41.9% with a mean injury severity of 33/100. Mean pain intensity was 1.9/10.*

Conclusion: *Our study demonstrates that it is feasible to conduct a cross-sectional study to measure the one-week prevalence of shoulder pain and activity limitation in tennis players.*

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KEY WORDS: tennis, shoulder, injury, feasibility, shoulder pain, chiropractic

Résultats : *quarante-trois joueurs de tennis ont été inclus dans le questionnaire (taux de participation de 68,3 %, taux d'achèvement de 100 %). Il n'y avait pas de données manquantes. La proportion sur une semaine de personnes souffrant de douleur à l'épaule et de limitation d'activité était de 41,9 % avec une gravité moyenne des blessures de 33/100. L'intensité moyenne de la douleur était de 1,9/10.*

Conclusion : *notre étude démontre qu'il est possible de mener une étude transversale pour mesurer la prévalence sur une semaine de la douleur à l'épaule et de la limitation d'activité chez les joueurs de tennis.*

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MOTS CLÉS : tennis, épaule, blessure, faisabilité, douleur à l'épaule, chiropratique

Introduction

Tennis is a demanding aerobic and anaerobic sport with repeated overhead motions placing significant loads through the dominant shoulder.[1–3] The shoulder is one of the most common body parts affected when it comes to injuries in tennis.[4,5] Despite injury, many players continue playing through pain rather than adjusting their training schedules or taking time off.[6,7] This often results in an increase in injury severity.[8]

Previous epidemiological studies have reported that the prevalence of shoulder pain in overhead athletes ranges from 21.4% to 41.6%.[9] The prevalence of shoulder pain in recreational adult tennis players in one particular study in the United States was 10.0%.[10] Unfortunately, the pain rating score for the shoulder specifically was not described in the study nor were the impacts of shoulder pain on tennis performance. To our knowledge, shoulder pain in adult competitive tennis players in Canada has not yet been reported. Shoulder pain is a contributing factor in injury reports with the prevalence of shoulder injury in tennis ranging from 1.5% to 27.2%.[5,11–17] Previous studies reporting shoulder injury in tennis used inconsistent criteria to define injury severity and used time loss (complete inability to train or compete) to define injury.[5,11–17] Using "time loss" to define injury likely resulted in an underreporting of injuries as players often do not take time off for injuries.[7] We currently lack information on the prevalence of shoulder injuries in Canadian tennis players.

The definition of injury from the 2009 Consensus Statement on standardized injury and documentation and reporting in tennis encompasses injury irrespective of time loss and captures a broad spectrum of injuries.[18] The statement recommends to measure injury severity as "the number of days that have elapsed from the date of onset of the medical condition to the date of the player's return to full participation in tennis training and availability for match play".[18] The consensus definition of injury severity is problematic because a player that has not yet returned to full participation in tennis training cannot be accurately classified. Bahr *et al*.[19] in 2009 and Clarsen *et al*.[7] in 2013 addressed this limitation and outlined the importance of severity measures being based on pain, function and the consequences of injury on athletes' participation and sporting performance rather than on the duration of time loss. The Oslo Sports Trauma Research Centre Overuse Shoulder Injury Questionnaire (OSIQ) addresses these issues by classifying injury severity according to pain, function and the consequence of injury on an athlete's participation and sporting performance.[7]

The aim of our study was to determine whether it is feasible to conduct a cross-sectional study to estimate the one-week period prevalence of overuse-related shoulder

pain and activity limitation in competitive tennis players living in Toronto. Our study evaluated the recruitment rate and secondarily described the burden of shoulder pain and activity limitation in a convenience sample of the Toronto tennis population to determine if the OSIQ is feasible to implement in this sample of Toronto tennis players as this has not been studied. Establishing the feasibility of questionnaire administration sets the stage for future larger scale prevalence studies to take place in the Canadian tennis population. Knowledge on the topic is the first step in helping to inform tennis players to adjust their training schedules and to seek early treatment to avoid an increase in the injury severity. Based on estimates from previous studies, we hypothesize that the one-week prevalence of shoulder pain and activity limitation is 12% in the Toronto competitive tennis population.[7]

Methods

This study was performed following the 1964 Declaration of Helsinki principles and was approved by the Canadian Memorial Chiropractic College Research Ethics Board (REB) on March 17, 2020 (REB approval number 2002B03). Informed consent to participate and consent to publish was obtained from all participants.

Study design and source population

A cross-sectional survey feasibility study was conducted in March of 2020. The study sample included competitive adult tennis players at an intermediate level or higher who reside in Toronto and play competitive tennis for the Boulevard Club, the Granite Club, the Toronto Lawn, or the Toronto Mayfair Pro League. All competitive tennis players from the tennis clubs/league at the Boulevard Club, the Granite Club, the Toronto Lawn, and the Toronto Mayfair Pro League were eligible (approximately 15 players per club team). Recruitment initially took place through an email template that was provided to the tennis directors of the Boulevard, Granite, and Lawn tennis clubs as well as the Mayfair Pro League to be distributed to the tennis member email list with the link to the questionnaire on SurveyMonkey (Momentive Inc, San Mateo, 1999). Due to the COVID-19 pandemic, this method of recruitment could not be carried out as the tennis clubs felt it was an inappropriate time to send out a research invitation email and therefore convenience sampling was conducted instead. Our recruitment strategy only included tennis players that the primary investigator knew, including those recruited from the public league website network where names and email addresses were listed. Although we had planned a recruitment strategy that included a representative sample, the COVID-19 pandemic interfered with our recruitment strategy. Known members of the respective tennis clubs as well as non-members on the club league teams were recruited through social media or direct recruitment. If the individual agreed to participate, they were sent the questionnaire via email. Participation was voluntary.

Study Sample:

To be included, players had to be 18 years of age or older with a history of competing in an intercounty league, Pro League, or tournament in the last year. Players were excluded if they were younger than 18 years old and or had a current shoulder injury due to a known acute mechanism or pathological cause (i.e., fracture, dislocation, infection, frozen shoulder, systemic disease, or neoplasm) as the goal was to capture repetitive gradual onset mechanism shoulder problems related to tennis rather than acute sudden onset shoulder problems. Inclusion and exclusion criteria were applied after participants completed the questionnaire. The criteria were applied based off the responses to questions regarding age, the presence of a fracture, dislocation, infection, frozen shoulder, systemic disease, or neoplasm/tumor diagnosis in the dominant shoulder and if the participant had competed in an intercounty league, Pro League or a tournament in the last year. The shoulder was defined as the articulation of the glenohumeral joint as well as the articulations of the acromio-clavicular, sterno-clavicular and scapulothoracic joints.[20]

Questionnaire

An online survey using the SurveyMonkey application was created to collect the data for this study. Demographic questions were made to capture the following: gender, hand dominance, forehand technique preference (double or single handed), backhand technique preference (double or single handed), age, height, weight, and competition level (intercounty, pro league, or tournament). The OSIQ questionnaire (see Appendix 1) was formatted into SurveyMonkey, where the primary feasibility outcomes of participation rate and missing data were collected. The questionnaire evaluates injury severity as well as the

one-week prevalence of shoulder activity limitation and pain. This questionnaire is a reliable and valid tool used to measure physical function and pain in sport. It was originally developed in Oslo, Norway on junior and senior athletes from five different sports including cross-country skiing, floorball, handball, road cycling and volleyball.[7] The questionnaire consists of four questions. The level of participation, extent of reduction in training volume, extent of affected performance and level of pain are subjectively quantified. The OSIQ is a validated, pilot tested questionnaire with established face validity and internal consistency with a Cronbach's α score of 0.91.[7]

Pain intensity scoring was added to the questionnaire and was measured using the 11-point Numeric Pain Rating Scale (NPRS). The scale consists of numerical values 0-10, 0 indicating no pain and 10 indicating the worst pain imaginable. The NPRS is a validated outcome measure for shoulder pain with a test-retest reliability of 0.74, a Pearson correlation coefficient score of 0.26.[21]

Statistical analysis

For categorical variables (gender, hand dominance, double-handed or single-handed backhand) counts and percentage were calculated. For continuous variables (age, height, weight) the mean and the standard deviation (SD) with a 95% confidence interval (CI) were computed. All outcomes were calculated in percentage. The completion rate was calculated by dividing the number of respondents that fully completed the questionnaire by the total number of submitted questionnaires both complete and partially complete. The participation rate of those that met the inclusion criteria was calculated by dividing the number of respondents that met inclusion criteria by the total number of respondents that the questionnaire was sent to. Overall participation rate was calculated by dividing the number of participants who consented to participate (i.e. clicked "yes" to participate in the survey) by the number of respondents that the questionnaire was sent to. Missing data was calculated for each of the four OSIQ questions with the numerator representing the number of missing responses and the denominator representing the number of respondents overall. The prevalence could not be calculated due to an inadequate denominator; instead, the proportion of those with shoulder pain and activity limitation was recorded by dividing the number of players that reported a shoulder problem in question 1 by the total number of players that completed the questionnaire. Of those that reported a shoulder problem in question 1, the same method was applied to questions 2-4 of the OSIQ to determine the percentage of shoulder problems that resulted in reduced training volume, an effect of performance and pain as well as the extent of the limitations/pain.

Injury severity was calculated using the allocated numerical values (0 to 25) for each of the answers to the four questions in the OSIQ. The values were summed in order to calculate a severity score from 0 to 100 for each shoulder problem. The response values were allocated such that 0 represented no problems and 25 represented the maximum level for each question. Questions 1 and 4 were scored 0-8-17-25, and questions 2 and 3 were scored 0-6-13-19-25.[7]

The mean pain intensity score from the NPRS was calculated by multiplying the number rating of pain intensity by the number of responses for that rating, taking the sum and dividing it by the total number of responses.

Results

Sixty-three participants were invited and fifty-six completed the questionnaire. Thirteen participants were excluded as they did not meet the inclusion/exclusion criteria. Of those, nine were excluded as they had not competed in an intercounty league, Pro League, or tournament in the last year and four were excluded as they had been diagnosed with a shoulder dislocation on the symptomatic side. Forty-three players were included in the study. Forty-three complete surveys were recorded. There were no incomplete surveys present. Participation rate of those who met inclusion criteria was 68.3%, overall participation rate was 88.9%, and completion rate was 100%.

In our sample of tennis players, participants completed the questionnaire in an average of three minutes with no missing data present. Participants 18-30 years of age represented 69.8% of the study participants followed by 23.3% between the ages of 31-40, 4.6% between 51-60 and 2.3% between 61-70. Participant characteristics revealed that 62.8% of the tennis players were males while right-handed players represented 90.7% of the sample. All participants had a single handed forehand while 83.7% had a double handed backhand and 16.3% had a single-handed backhand. The mean height, and weight were 1.8m (SD: 0.10, CI: 1.75, 1.82) and 74.6kg (SD:13.61, CI: 70.42, 78.80), respectively.

The one-week proportion of shoulder activity limitation and pain was 41.9% (CI: 27.1%, 56.6%). Of those with a shoulder problem, reduction in training volume, effect on performance and extent of pain were recorded (figure 1 & 2). Participants with minor reductions in training volume were reported at 61.1% (CI: 46.5%, 75.7%) while 27.8% (CI: 14.4%, 41.2%) had a moderate to major reduction in training volume or could not train at all. A minor effect on performance was reported by 50.0% (CI: 35.1%, 64.9%) of players while 27.8% (CI: 14.4%, 41.2%) reported a moderate to major effect on performance or an inability to perform. Mild pain was reported by 72.2% (CI: 58.8%, 85.6%) of players and moderate to severe pain was recorded in 11.1% (CI: -1.7%, 20.5%). Overall, 77.8% (CI: 65.4%, 90.2%) reported any reduction in training volume, 77.8% (CI: 65.4%, 90.2%) noted an effect on performance and 83.3% (CI: 72.2%, 94.5%) had shoulder pain. Mean injury severity was 33/100 (SD: 11.35, CI: 29.60, 36.39). A higher value indicates greater severity. Mean pain intensity on the NPRS was 1.9/10.

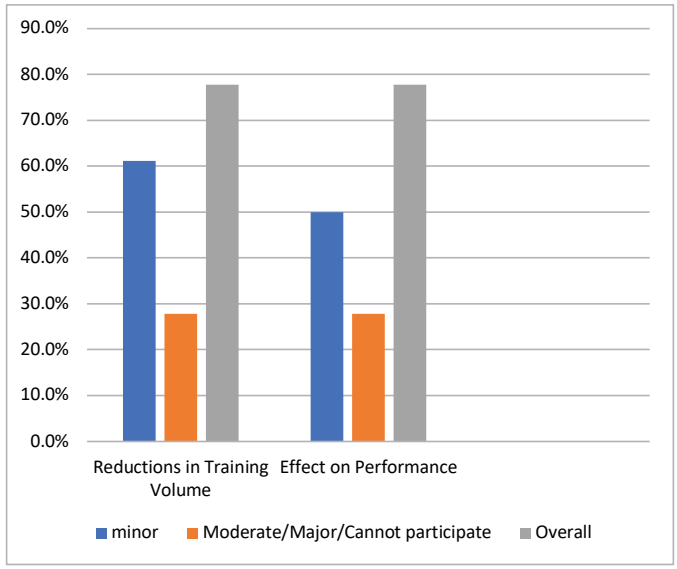

Figure 1.
Individuals reporting a shoulder problem: Extent of shoulder activity limitations

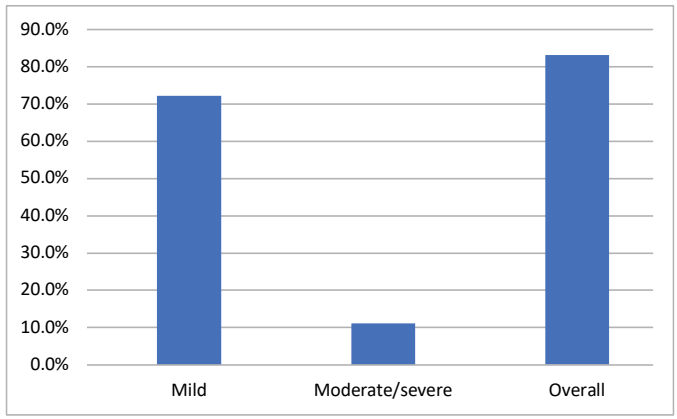

Figure 2.
Individuals reporting a shoulder problem: Degree of pain

Discussion

This study aimed to determine the feasibility of conducting a cross-sectional survey to evaluate the one-week period prevalence of shoulder pain and activity limitation in competitive tennis players living in Toronto. The results suggest that the questionnaire implementation in the Toronto tennis population is feasible and that our recruitment and data collection methodologies are acceptable to administer to tennis players. Therefore, complete data can be collected for the questionnaire in a very reasonable amount of time. Moreover, the participation rate was exceptionally high, suggesting that the participants were interested in the study. Although we had planned a recruitment strategy that included a representative sample, the COVID-19 pandemic interfered with our recruitment strategy. Consequently, our recruitment strategy only included tennis players that the primary investigator knew personally. Therefore, our pre-existing relationship with the included tennis players is a significant confounder to the participation rate, and our results cannot be easily generalized. We did not use an a priori defined sampling frame; therefore, we could not determine who was eligible for the survey before inviting players to participate. Consequently, we applied the inclusion/exclusion criteria after we received the completed questionnaire. Forty-three surveys met inclusion criteria and were included in the study (43/56 = 68.3% participation rate). There were no incomplete surveys recorded resulting in a completion rate of 100% (43/43).

The one-week proportion of shoulder pain and activity

limitation in competitive tennis players was 41.9%. Such a high proportion may support the notion that more shoulder problems can be captured when the injury definition does not require time-loss. Athletes often play through pain in both training and competition and therefore shoulder activity limitation and the degree of pain should be included in questionnaires evaluating injury prevalence and severity. This is in accordance with the International Olympic Committee consensus statement on the methods for recording and reporting epidemiological data on injury and illness in sport 2020.[22]

Among players with moderate to severe reductions in training volume or performance 75% reported mild pain. This finding suggests that minor pain may affect each player's game differently as some players may compensate more effectively. It was interesting to note that nearly 44% of players were still training and competing despite moderate reductions in training volume or performance. Such a finding may be explained by the fact than many tennis players may not be aware of the increased injury severity that can result if adequate modifications to training and competition are not in place.[8]

Sixteen-point seven percent of players with a shoulder problem reported no pain. This emphasizes the importance of not restricting injury prevalence studies to reports of pain as athletes may describe shoulder problems in alternate ways (i.e. discomfort, instability, etc.). Such an approach would capture more shoulder problems that exist in tennis participation.[7]

The feasibility study conducted addresses an important gap in the literature by investigating the prevalence of shoulder pain and activity limitation in tennis irrespective of time loss. Our findings are in line with previous studies that have reported acceptable feasibility of the OSIQ in cross-country skiing, floorball, handball, road cycling and volleyball.[7] The results of our study need further research and cannot be generalized; our study is the first in a series of investigations to better understand the effects shoulder problems may have on training/competition, performance and injury severity.

Post-study modifications to the questionnaire

Based on the feasibility study results, we will modify the questionnaire to include more clarity when asking participants to describe pain intensity. The Numeric Pain Rating Scale (NPRS) measuring pain intensity was inconsistent due to a lack of clarity in the question as those initially indicating no pain in the OSIQ, reported pain greater than 0/10 on the NPRS. We failed to specify that the pain intensity was referring to the current pain experienced in the shoulder. Future pilot investigations including the NPRS for pain intensity should clearly instruct participants to rate their shoulder pain intensity in relation to the current shoulder problem they have described in the previous questions.

Strengths

The OSIQ is standardized and uses valid and reliable tools to measure the prevalence of shoulder pain and activity limitation. Our study was feasible likely due to the brevity of the questionnaire with only 15 questions and an average time to completion of three minutes. Participant familiarity with the investigator as well as the common topic of interest being tennis, likely influenced many tennis players to participate in the questionnaire resulting in a moderately high participation rate of 68.3%.

Limitations

Our recruitment strategy only included tennis players that the primary investigator knew. Although we had planned a recruitment strategy that included a representative sample, the COVID-19 pandemic interfered with our recruitment strategy. Therefore, an unbiased prevalence could not be reported, and our results cannot be generalized. Additionally, we did not use a priori defined sampling frame therefore, we could not determine who was eligible for the survey before inviting players to participate. The purpose was to describe whether it was feasible to conduct a cross-sectional study and obtain a preliminary estimate of the prevalence of shoulder pain and activity limitation in competitive tennis players. Non-responder eligibility could not be reported as data on non-responders was not available. Had Covid-19 not restricted the designated tennis clubs to take part in the study, non-responder data would have been available and non-responder eligibility would have been described. Secondly, the NPRS could not be reported due to ambiguous results however the questionnaire will be modified to ensure clarity in the question for future investigations. The current study did not describe competition level, and therefore rating systems such as the National Tennis Rating Program (NTRP) should be implemented in future studies. The NTRP is

a rating system that was developed to identify and categorize the general characteristics of tennis players in 13 different levels of tennis ability. Currently, NTRP ratings are generated by the United States Tennis Association (USTA), which is committed to providing players with the most accurate rating information. Lastly, since the completion of this study, the creators of the OSIQ have modified question 2, and it now asks about the extent to which athletes have modified their training or competition rather than the extent to which an athlete has reduced their training volume. This change may reflect a greater number of ways in which an athlete can modify sports participation (i.e. reduced intensity, type of training) likely capturing an even larger array of shoulder problems.[23] The updated modification should be tested in a follow up pilot investigation.

Clinical implications

Understanding the prevalence of shoulder pain and activity limitation is necessary to develop future injury prevention strategies and implement early treatment interventions.

Conclusion

It is feasible to conduct a cross-sectional study on the one-week period prevalence of shoulder activity limitation and pain in competitive tennis players living in Toronto. Findings from the feasibility study suggest that the participation rate is adequate while a high proportion of tennis players with shoulder pain and activity limitation were identified. This feasibility study has addressed the changes necessary to improve the clarity of the questionnaire. We recommend future investigations to explore the prevalence of shoulder pain and activity limitation in competitive tennis players.

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Appendix 1.
Questionnaire

1. GENERAL INFORMATION

1. In the last year have you competed in an inter-county league, Pro League or a tournament?
   - ☐ Yes
   - ☐ No

2. Age Category:
   - ☐ <18
   - ☐ 18-30
   - ☐ 31-40
   - ☐ 41-50
   - ☐ 51-60
   - ☐ 61-70
   - ☐ 71-80
   - ☐ 81-90
   - ☐ More than 90

3. Gender
   - ☐ Male
   - ☐ Female

4. Hand Dominance
   - ☐ Right Handed
   - ☐ Left Handed

5. Do you have any shoulder activity limitation/pain in your:
   - ☐ Right side
   - ☐ Left side
   - ☐ None

6. Backhand Technique
   - ☐ Double Handed
   - ☐ One Handed

7. Forehand Technique
   - ☐ Double Handed
   - ☐ One Handed

8. Height (m): _____

9. Weight (kg): _____

10. In your shoulder, have you been diagnosed with any of the following:
    - ☐ Fracture
    - ☐ Dislocation
    - ☐ Infection
    - ☐ Frozen shoulder
    - ☐ Systemic disease
    - ☐ Neoplasm/Tumor
    - ☐ None

OSTRC Overuse Injury Questionnaire: Shoulder Problems

Please answer all questions regardless of whether or not you have problems in your shoulders. Select the alternative that is most appropriate for you, and in the case that you are unsure, try to give an answer as best you can anyway.

The term "shoulder problems" refers to pain, aching, stiffness, looseness or other complaints in one or both of your shoulders.

11. Have you had any difficulties participating in normal training and competition due to shoulder problems during the past week?
    - ☐ Full participation without shoulder problems
    - ☐ Full participation, but with shoulder problems
    - ☐ Reduced participation due to shoulder problems
    - ☐ Cannot participate due to shoulder problems

12. To what extent have you reduced you training volume due to shoulder problems during the past week?
    - ☐ No reduction
    - ☐ To a minor extent
    - ☐ To a moderate extent
    - ☐ To a major extent
    - ☐ Cannot participate at all

13. To what extent have shoulder problems affected your performance during the past week?
    - ☐ No effect
    - ☐ To a minor extent
    - ☐ To a moderate extent
    - ☐ To a major extent
    - ☐ Cannot participate at all

14. To what extent have you experienced shoulder pain related to your sport during the past week?
    - ☐ No pain
    - ☐ Mild pain
    - ☐ Moderate pain
    - ☐ Severe pain

15. Please rate your pain intensity on a scale of 1-10 (0=no pain, 10=severe pain):

☐ 0	☐ 4	☐ 8
☐ 1	☐ 5	☐ 9
☐ 2	☐ 6	☐ 10
☐ 3	☐ 7	