

## Characteristics of injuries in adolescent basketball athletes

## Características de lesões em atletas adolescentes de basquete

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**ABSTRACT | INTRODUCTION:** Basketball is a physical contact sport that involves complex movements such as jumping, spinning, and changing directions, all of which frequently cause injuries. **OBJECTIVES:** This study aims to understand the characteristics of injuries on adolescent basketball athletes. **METHODS:** This study uses a descriptive method with a cross-sectional study approach using a web-based questionnaire (Google Forms) consisting of close-ended questions to examine the history, types, factors, and treatments of the injuries experienced by the adolescent basketball athletes at the Student Sports Training Center (Pusat Pelatihan Olahraga Pelajar or PPOP) of DKI Jakarta. The subjects are 14 male and female athletes with an average age of 15.9±1.1 years old, an average height of 172.29±9.33 centimeters, and an average weight of 65.71±10.06 kilogram. The research instrument is a questionnaire distributed online in the form of Google Forms. A validity test was conducted on the questionnaire using Aikens. Data Questionnaire result data were analyzed using a percentage analysis on the answers to each question in the questionnaire. **RESULTS:** The results revealed that 76% of the athletes experienced injuries in the lower limb, with the most frequent injury in the ankle joint (45%). Furthermore, the athletes also stated that sprains/twists are the most experienced type of injury (42%). The training sessions were when 79% of the athletes experienced their injuries, whereas the other 21% experienced them during the matches. **CONCLUSIONS:** The results of this study cannot generalize the findings because it only involved 14 participants, which is also a limitation of this study, but these findings report that the greater injury that occurs during exercise is the ankle joint, so the authors suggest doing an adequate warm-up. Before starting a training session or during a competitive training session, preventing injuries is the best approach for athletes to reduce their occurrence.

**KEYWORDS:** Lower limb. Ankle. Injury. Characteristics.

**RESUMO | INTRODUÇÃO:** O basquetebol é um esporte de contato físico que envolve movimentos complexos como pular, girar e mudar de direção, que frequentemente causam lesões. **OBJETIVOS:** Este estudo tem como objetivo compreender as características das lesões em atletas adolescentes de basquete. **MÉTODOS:** Este estudo usa um método descritivo com uma abordagem de estudo transversal, usando um questionário baseado na web (Formulários Google) que consiste em perguntas fechadas para examinar a história, tipos, fatores e tratamentos das lesões sofridas pelos adolescentes atletas de basquete do Centro de Treinamento Esportivo de Estudantes (Pusat Pelatihan Olahraga Pelajar ou PPOP) do DKI Jakarta. Os sujeitos são 14 atletas do sexo masculino e feminino, com idade média de 15,9 ± 1,1 anos, altura média de 172,29 ± 9,33 centímetros e peso médio de 65,71 ± 10,06 quilogramas. O instrumento de pesquisa é um questionário distribuído online na forma de Formulários Google. Um teste de validade foi realizado no questionário usando Aikens. Os dados dos resultados do questionário foram analisados por meio de uma análise percentual das respostas a cada questão. **RESULTADOS:** Os resultados revelaram que 76% dos atletas sofreram lesões em membros inferiores, sendo a lesão mais frequente na articulação do tornozelo (45%). Além disso, os atletas também afirmaram que as entorses / torções são o tipo de lesão mais experiente (42%). Os treinamentos ocorreram quando 79% dos atletas experimentaram as lesões, enquanto os outros 21% as vivenciaram durante as partidas. **CONCLUSÕES:** Os resultados deste estudo não podem generalizar os achados, pois envolveu apenas 14 participantes, o que também é uma limitação deste estudo, mas esses achados relatam que a maior lesão que ocorre durante o exercício é a articulação do tornozelo, por isso os autores sugerem fazer um aquecimento adequado. Antes de iniciar uma sessão de treinamento ou durante uma sessão de treinamento competitivo, prevenir lesões é a melhor abordagem para os atletas reduzirem sua ocorrência.

**PALAVRAS-CHAVE:** Membro inferior. Tornozelo. Lesão. Características.

## Introduction

Team sports, or basketball, in particular, are entertaining in Indonesia. Commonly held in various events at the school or university level, this sport has always attracted many participants and drawn the spectators' enthusiasm. Such enthusiasm makes this sport highly competitive, not to mention the body contacts involved in the game, leading to numerous injuries in the training sessions and matches. The high level of participation in basketball has caused most injuries, considering that basketball poses one of the highest risks in team sports, with a frequency rate of between 7 to 10 cases per 1000.<sup>1,2</sup> The players use their bodies to steal the ball from the opponent.<sup>3</sup> Several studies in orthopedic literature reported the epidemiology of various injuries in professional basketball.<sup>3-6</sup> A study with a population of NBA, the most prestigious league in basketball, found that the common injuries experienced by the players are in the upper extremity (15.45%) and lower extremity (62.4%).<sup>3</sup> Sports injuries also affect the consistency and system of the training process, as well as the improvement of athletes' training and performance.<sup>7</sup>

A study by Newman & Newberg revealed that the athletes in their lower bodies experience many injury risks due to the jumping and landing movements.<sup>8</sup> To be more specific, landing after doing a shot, bouncing and rolling with the ligament anterior cruciate (ACL), pivoting, stealing the ball, and doing attack and defense patterns contribute 60% to the occurrence of ankle joint injuries. Powell and Barber-Foss found that boys experience injuries more in shooting (jumping and landing), whereas girls experience injuries more in dribbling.<sup>9</sup> These previous studies show that body contacts, spinning techniques, and high intensity of basketball pose the risks of injuries in competitions.<sup>10</sup>

Injury risks in adolescents may render them difficult to achieve their maximum peak of achievement.<sup>11</sup> Many athletes who excel when they are junior cannot continue to compete when they are senior. One of the causes is injuries. Several injury cases in the NBA led to the athletes' withdrawal (<https://www.indosport.com/basket/20200510/4-bintang-nba-yang-kariernya-hancur-karena-cedera>). A study in this area in the scope of Indonesia is hoped to be an illustration and the next step to planning athletes'

careers and insurance as a means of anticipation towards injuries that might happen to the athletes.<sup>10</sup>

Every sport poses different risks and characteristics<sup>5</sup>, which consequently has its own preventive and recovery measures. The current study attempts to provide the coaches, athletes, parents, and relevant sports authorities with a detailed illustration regarding the consequences of poor training management. The central roles of training, recovery and management prevent undesired consequences. One of the measures that can be taken is to foster collaboration between the coaching staff and other relevant parties to protect the athletes with insurance so that the injury risks can be overcome as quickly as possible. Such a measure is of paramount importance in the career journey of an athlete, as implemented in overseas professional athletes.<sup>12,13</sup>

Studies regarding the characteristics of injuries in basketball, especially in Indonesia, have yet to provide an in-depth explanation, especially on regionally trained adolescent athletes who have the best achievement at the national level. A study conducted in Indonesia related to basketball injuries investigated the relationship between warming up and the risk of ankle injury<sup>14</sup>, which is why this study needs to be done. Other studies have focused on retrospective, sport-related epidemiological studies in basketball players<sup>15</sup>, analysis of differences in basketball player injuries based on surface electromyography<sup>16</sup>, and the association between foot posture and lower extremity-related injuries in male professional basketball players.<sup>17</sup> There are still not many who have studied the injury characteristics of adolescent basketball athletes so that this study will investigate the injury experience of adolescent basketball athletes. This study limits the causes of injury in stretching both before and after training sessions and matches. The stretches offered in the research question are static stretching and dynamic stretching so that the discussion of the occurrence of injury is only related to the type of stretching. This study involved regionally trained adolescent athletes who have a well-coordinated busy schedule, meaning that they are prepared for a professional level. Due to the pandemic, data were collected using Google Forms to make the athletes feel comfortable to be included as samples and provide them with a flexible time and place.

This study is hoped to serve as a reference for coaches, athletes, parents, and managers in taking preventive measures and considering future steps in planning the athletes' careers sustainably. Therefore, the objective of this study was to investigate the characteristics of injuries on adolescent basketball athletes.

## Methods

### Design

This study was conducted using a descriptive method with a cross-sectional study approach, using a web-based questionnaire (Google Forms) consisting of close-ended questions to examine the history, types, factors, and treatments of injuries experienced by the adolescent basketball athletes at the Student Sports Training Center (Pusat Pelatihan Olahraga Pelajar or PPOP) of DKI Jakarta.

This study is approved by the Ethical Review Board of Poltekkes Kemenkes Semarang, Indonesia. All of the participants had been informed about the benefits and risks of their participation before they submitted a written approval to be included in this paper.

### Participants

The participants involved in this study are all 14 athletes at the Student Sports Training Center (Pusat Pelatihan Olahraga Pelajar or PPOP) of DKI Jakarta. Purposive sampling was used to determine the participants' criteria: 1) a 15-20-year-old athlete, and 2) has experienced an injury during their time at the PPOP of DKI Jakarta.

**Table 1.** Profile of Adolescent Basketball Athletes

Variables (X±SD)	Sex N (%)	
	M = 5(55.5)	F = 4(44.5)
Age (yrs)	15.8±0.8	15.9±1.3
Height (cm)	181.2±8.5	167.3±5.3
Weight (kg)	72.8±10.8	61.8±7.6
BMI (kg/m <sup>2</sup> )	22.1±2	22±2.2

### Research instruments

The research instrument is a questionnaire adopted and modified from Nowak and Hanief & Umar.<sup>18,19</sup> A validity test was conducted on the questionnaire using Aikens, in which three panelists were involved. The Aikens test score is 0.81 (high). The definition of sports injury taken for this study is as follows: A sports injury is a physical illness from a match or training that forces an athlete to suspend or change their regular training plan for at least one unit of training.<sup>20,21</sup> Prior to filling in the questionnaire, an online meeting was held with all participants to inform them about the procedure of filling in the questionnaire on Google Forms. Then, a link to the questionnaire was sent to all participants through a WhatsApp Group.

## Statistical analysis

Data were analyzed using a percentage analysis for the answers to each question in the questionnaire. Microsoft Excel was used to analyze and represent every answer item based on the number of respondents.

## Result

The percentage analysis based on the history of the injuries is shown in Table 2 as follows.

**Table 2.** Percentage Analysis Based on the History of Injuries

Question	Answer	N	%
How many times a week do you train?	1-2 times per week	0	0
	3-4 times per week	4	29
	5-6 times per week	7	50
	7 times per week	3	21
	Total	14	100
What part of your body was injured?	Head	0	0
	Back	1	6
	Chest and/or stomach	0	0
	Upper limb	3	18
	Lower limb	13	76
Total	17	100	
If you have experienced an injury to the lower limb, which part was injured?	Hip joint and groin	1	5
	Thigh	2	9
	Knee	8	36
	Lower leg and/or Achilles tendon	1	5
	Ankle joint	10	45
	Feet and/or toes	0	0
Total	22	100	
Have you ever experienced the same injury in the past?	Yes	8	57
	No	6	43
	Total	14	100
How many weeks did you have to leave the trainings due to the injury?	Less than 1 week	6	43
	1-2 weeks	4	29
	3-4 weeks	3	21
	More than 4 weeks	1	7
	Total	14	100
How severe was your injury?	Could not train for more than 1 days	13	93
	Could not participate in the matches for more than 1 days	1	7
	Required a surgery	0	0
	Total	14	100
How long did it take for you to stretch individually before experiencing the injury?	10 minutes	6	43
	10-20 minutes	8	57
	20-30 minutes	0	0
	More than 30 minutes	0	0
	Total	14	100
What kind of stretching did you do prior to the injury?	Static stretching	8	57
	Dynamic stretching	4	29
	Static and dynamic stretching	2	14
	Total	14	100

Athletes trained 5-6 times a week (50%), and 76% of them experienced injuries in the lower limb, specifically in the ankle joint (48%) which caused them unable to train for more than 1 days (93%) or less than a week (43%) as seen in table 2. A detailed explanation on the types of injuries can be seen in Table 3.

**Table 3.** Percentage Analysis Based on the Types of Injury

Question	Answer	Number of answers (N)	Percentage of answers (%)
Which of your body structures experienced the injury?	Bone	1	7
	Joint and/or ligament	3	22
	Muscle and/or tendon	9	64
	Skin	1	7
	Nerve	0	0
	Total	14	100
What type of injury have you ever experienced?	Sprain/twist	8	42
	Contusion/Bruises	6	32
	Strain (a tear in the muscle and/or tendon)	4	21
	Bone fracture	1	5
	Dislocation (a bone that slips out of its position)	0	0
	Total	19	100
Did you face any difficulties in participating normally in the training and competitions due to the injury?	Full participation without any issues	3	21
	Full participation with the injury	6	43
	Less participation due to the injury	4	29
	Could not participate due to the injury	1	7
	Total	14	

Table 3 shows that the muscle and/or tendon (64%) are the body structure that experiences most of the injuries, with sprain/twist as the most frequently experienced type of injury (42%). Such a condition also forced 43% of the athletes to participate with the injury fully. The factors that caused the injuries are presented in Table 4.

**Table 4.** Percentage Analysis Based on the Factors Causing the Injury

Question	Answer	Number of answers (N)	Percentage of answers (%)
How did the injury happen?	Fall/collision with an object	8	42
	Physical contact with another athlete	4	21
	Overuse	7	37
	Total	19	100
When did the injury happen?	During a training session	11	79
	During a match	3	21
	Total	14	100

The most frequent cause of the injuries is fall/collision with an object (42%), whereas physical contact with another athlete and overuse were (21%) also reported to be other causes, albeit not primary. The athletes reported that they had experienced injuries both in the training sessions and matches, with most injuries occurring during the training sessions (79%). These athletes also reported how they treated their injuries (Table 5).

**Table 5.** Percentage Analysis Based on the Treatments

Question	Answer	Number of answers (N)	Percentage of answers (%)
To what extent did you reduce your training volume due to the injury?	No reduction of training volume	3	21
	Slight reduction of training volume	5	37
	Moderate reduction of training volume	3	21
	Significant reduction of training volume	3	21
	Could not participate or did not train at all	0	0
	Total	14	100
To what extent did the injury affect your performance?	No effect	4	29
	It kind of affected the performance	6	43
	To a moderate extent	3	21
	The majority of the time, it affected the performance	1	7
	It affected significantly, unable to participate	0	0
Total	14	100	
What type of stretching did you do after experiencing the injury?	Static stretching	7	50
	Dynamic stretching	3	21
	Static and dynamic stretching	4	29
	Total	14	100
Is the duration of your stretching longer or shorter after you experienced the injury?	Longer	10	71
	Shorter	0	0
	No change (the same as before experiencing the injury)	4	29
	Total	14	100
Do you stretch before the training sessions or matches?	Yes, always	14	100
	Yes, sometimes	0	0
	No	0	0
	Total	14	100
Do you stretch after doing sports?	Yes, always	13	93
	Yes, sometimes	1	7
	No	0	0
	Total	14	100
Do you implement any recovery strategies after training?	Yes	14	100
	No	0	0
	Total	14	100
How did you treat your injury?	I treated it myself	4	29
	I was treated by a doctor/physiotherapist	10	71
	Total	14	100
Do you think that the injury you experienced undermines your fitness?	Yes	5	36
	No	9	64
	Total	14	100

Most of the athletes were assisted by a doctor/physiotherapist (71%) in treating their injuries, and the others treated them themselves (29%). The injuries experienced by the athletes slightly reduced the volume of their training (37%) and only slightly affected their performance (43%). These athletes are disciplined in stretching before the training sessions or matches (100%) and after sports (93%). The majority of the athletes did static stretching after experiencing the injury (50%) with a longer duration (71%).

**Figure 1.** Injured Body Parts of the Adolescent Basketball Athletes

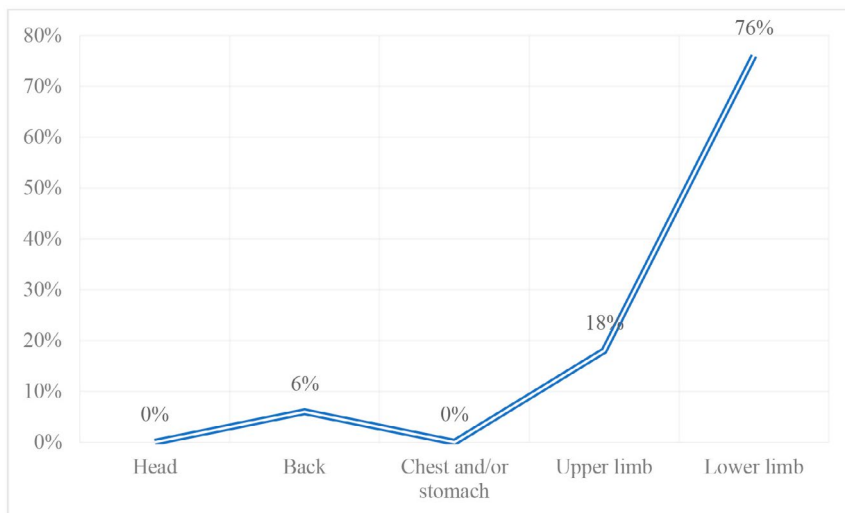
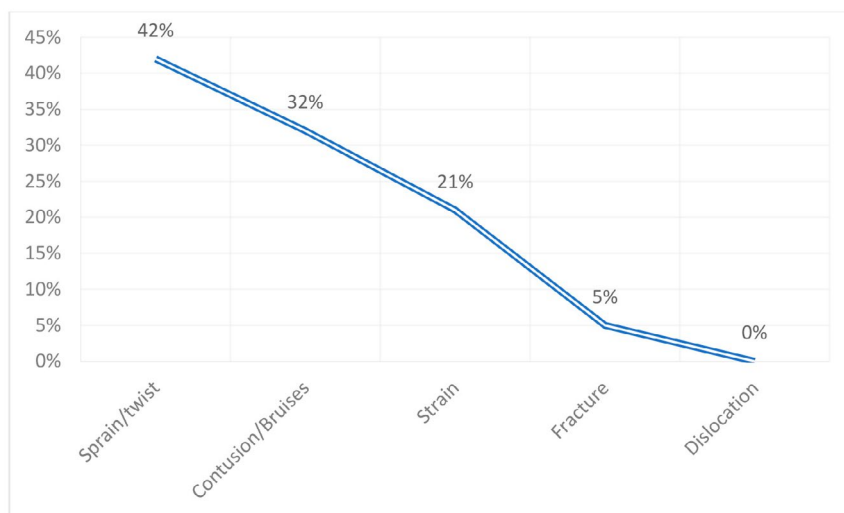


Figure 1 shows that most adolescent basketball athletes experienced injuries in their lower limbs (76%). The number of injury cases based on sex, there are 7 and 15 injury cases on male and female athletes, respectively. Both have experienced injuries in ankles (45%) and knees (35%). Adolescent male athletes also experienced injuries in their hip joints and groin, whereas adolescent female athletes never experienced injuries in those areas. The adolescent female athletes experienced injuries in Achilles' tendon and thighs.

The injured segments/body parts include the back (6%), upper limb (18%), and low limb (76%), as seen in figure 1. The lower limb is the segment most frequently injured, including ankle joint (45%) is a segment/body part in which injuries most frequently occur on adolescent basketball athletes, both male and female. The types vary, where 42% experienced sprain/twist, 32% experienced contusion/bruises, 21% experienced strain, and 5% experienced fracture (Figure 2).

**Figure 2.** Types of Injuries Experienced by the Adolescent Basketball Athletes



## Discussion

The study's findings involving adolescent basketball athletes at the PPOP of DKI Jakarta revealed that athletes had too many injuries to the lower limbs, with the ankle joints as the most frequently injured body parts (45%).

Furthermore, the athletes also stated that sprain/twist is the type of injury they often experience (42%). The training sessions were when 79% of them experienced those injuries, whereas the rest (21%) occurred in the matches. These results are in line with the findings of Nowak et al., who found that adolescent male basketball players (17±1.4 years old) experienced lower limb injuries (54%), with ankle injuries being the most common injury.<sup>19</sup> Basketball poses relatively high risks, considering it a sport that involves quick movements and frequent physical contact.<sup>24</sup> Ankle injuries are the most frequently injured segment, due to the foot being the segment with a high-performance load when playing basketball. One of the causes of injury to the ankle area is incorrect landing.<sup>24</sup> The study conducted by McKay et al. reported the mechanism of ankle injury due to twists/turns, collisions, falls, sudden stops, and trips.<sup>24</sup> Not only does the physical demand pose the risks of ligament and joint injuries, but it also has the risks of bone injuries due to the repeated pressures during the game.<sup>23</sup>

Basketball is a contact sport that involves complex movements, including jumping, spinning, and changing directions, all of which frequently cause musculoskeletal and joint injuries in all parts of the body.<sup>25</sup> Pivoting, guarding, and stealing the ball, jumping, and landing involve the lower limbs. These movements might lead to the incidence of sprains, strains, contusions, fractures, and dislocations (injuries). However, it should be noted that, in addition to the movement factors, poor technique mastery and training might also cause injuries.<sup>26</sup>

The 15-20-year-old basketball players do not only participate in clubs but also at their schools. This double participation is also one factor contributing to the increased risks of injuries on adolescent athletes.<sup>12,27</sup> Thus, young athletes and their parents should compare the benefits of a specialized sports skill to the potentials of its injury risks and long-term health consequences.<sup>12</sup>

Sports injuries are a complex phenomenon and appear as a "scourge" for athletes and coaches alike. It is important to identify the complexity of sports injuries by predicting injuries that occur in a sport. Bittencourt et al., in their study, illustrate the complexity of anterior cruciate ligament (ACL) injuries citing several determinants of ACL injury in basketball.<sup>28</sup> For basketball athletes, the typical Unanticipated Environmental Events (UEE)<sup>29</sup>, the presence of Dynamic Knee Valgus (DKV)<sup>29</sup>, and Hip Weakness (HW) are the main elements comprising the web of determinants.



Dynamic knee valgus (DKV) is a pattern of lower extremity movement, potentially consisting of a combination of femoral adduction and internal rotation, knee abduction, anterior tibial translation, external tibial rotation, and ankle eversion<sup>30</sup>, which is one of the movement patterns that are incorrectly recognized as a risk factor for lower extremity injury. The presence of DKV is influenced by fatigue, hip muscle strength, neuromuscular control (ability to recruit the required muscles properly), foot complex anatomical alignment, and training load.<sup>28</sup>

However, a single risk factor (e.g., DKV) does not guarantee the occurrence of injury. On the other hand, identifying a risk profile can inform the likelihood of injuries, such as foot misalignment, level of anxiety, inciting event, sex, fatigue, age, training load, and neuromuscular ability.<sup>28</sup>

Based on the findings, this study recommends that an injury prevention program should be taken into consideration. Preventing sports injuries is the best approach for basketball players to reduce the incidence of sports injuries.<sup>7</sup> For example, a special injury prevention program significantly lowers the incidence of sprains in the ankle joints of basketball players, as suggested by a study by Eils et al., which involved seven athletes in a 9-week balance training program to prevent ankle joint injuries.<sup>31</sup> A prevention program that emphasizes proprioception and balance training has also successfully reduced the incidence of ankle joint injuries in other high-risk multidirectional sports, including football and volleyball.<sup>32-34</sup>

Safety in sports and physical activities is an essential prerequisite to continue participating and maintaining an active and healthy physical lifestyle.<sup>35</sup> For this reason, preventing, reducing, and controlling sports injuries is important for the overall society. New advances in sports medicine have discussed the need to study injury prevention. Understanding the factors causing injuries and their characteristics on basketball athletes develops the athletes' and coaches' awareness about the importance of preventing injuries.<sup>7</sup> Coaches can include an injury prevention program in their training plans. Therefore, a more advanced study that presents a general review of the risks of sports injuries and their preventions is needed.

## Conclusion

Basketball poses relatively high risks, considering it is a sport involving quick movements and frequent physical contact. This study finds that adolescent basketball athletes experience injuries in their lower limbs. The specific body part that often experiences sprains/twists is the ankle joint, knee, thigh, hip joint, and groin. These findings cannot be generalized given the small involvement of participants, but at least these findings can provide a perspective on one type of injury experienced by basketball athletes among adolescents. Sports injuries are a complex phenomenon, and it is important to identify the complexity of sports injuries by predicting injuries that occur in a sport. Foot misalignment, level of anxiety, inciting event, sex, fatigue, age, training load, and neuromuscular ability are predictors of sports injuries.

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## Author contributions

Hanief YN was responsible for conducting research, processing and interpreting results, editing the final version, and writing conclusions. Widiawati P was responsible for formulating the methods and analyzing the data.

## Competing interests

No financial, legal, or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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