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Original article

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The characteristics of Indonesian para-cycling athletes' injuries

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Abstract

Introduction: Amputee cyclists with different types of disabilities compete in same category in the Paralympics Games, and para-cycling has the highest risk of injury. This is because the areas used for training are velodromes and highways. The nature of these injuries is closely related to the recovery rate, absence from training, and even the end of a career. This study aimed to determine the characteristics of sports injuries sustained by para-cycling athletes when joining the Indonesia National team.

Material and methods: The sample was a group of 19 athletes (16 males and three females) with a mean age of 30 ± 5.02. A questionnaire consisting of 25 questions was used to obtain data, which was adapted from Nowak's questionnaire. Data analysis was represented in the form of numbers and percentages, and Fisher's exact test was used to determine the relationship between variables.

Results: The results showed injuries are most common in the lower limbs (57%) by falling (73%). The effects of the athletes' falls are bruises (42%), twists or sprains (17%), and fractures (17%).

Conclusions: Para-cycling athletes experience the lower extremity injuries. An athletes' fall affects the lower extremities leading to contusion or bruises (on the knee and lower leg, when falling during training), twist or sprain (in the ankle, occurs during a training session), and fracture (caused by a fall during a training session).

Keywords: lower limb, stretching, injury prevention, para-cycling

Introduction

Cycling with any form of limb amputation has advanced from activity of relaxation or rehabilitation to elite level competition [1]. Cyclists with limb amputation of different types of disability backgrounds compete in the same category [2] in the Paralympics Games program. In Para-sports, athletes are categorized into sport classes based on the degree of physical, visual, or cognitive impairment [3]. Para-cycling is the third largest Paralympic sport which is governed by the International Cycling Federation (UCI) [4]. Cyclist race in three various disciplines; bicycling, hand-cycling, and tri-cycling. Medical Doctors, physiotherapists, and sports technicians are assigned by UCI to be classifiers to classify athletes with physical impairments in hand-bike, tricycle, and cycle [4]. Para-cycling is contested in 2 categories; track and road races. Road races

are contested for four categories: 1) Cycle class (C) is normal cycling for amputees with abnormalities/impairment of leg and arm muscle function, 2) Blind class (B) is tandem bikes race for the athletes who are blind, 3) Handcycle/hand-bike class (H) is intended for athletes with the impairment of torso and lower extremities/amputees, and 4) Tricycle class (T) is race for cerebral palsy (CP) athletes with a weak balance [3]. Furthermore, track races (velodrome) are only for class C and class B. Each class is further divided into heavy to light numbers classification, for instance, class C consisting of C1-C2-C3-C4-C5, in which C1 has athletes with the greatest impairment [5]. In addition, class B consists of B1-B2-B3, class H consists of H1-H2-H3-H4-H5 [5], and class T consists of T1-T2-T3 [5]. The specification for each of these and any assistive technology required is clearly defined [5].

All sports carry an inherent risk of injury and this is no different for Para sport [6]. The characteristics of sport injuries are closely related to the duration of recovery, the absence from training, and even the end of career [7,8], so such characteristics should be identified as preventative measures.

Bicycle setup refers to the athlete anatomic position on the bicycle, and it plays an important role in both performance and susceptibility to injury [6]. Regarding the para-cycling class category, each has different bicycle settings. The C class uses a standard bicycle, B uses a tandem type which can be ridden by two people, with a "pilot" in the front seat. Furthermore, T class uses a tricycle to provide more balance than a two-wheeled bicycle, and H class pedals with the hands lying down (class category H1-H4) and kneeling (class category H5). The different bicycle arrangements affect susceptibility to injury [6]. One study found that a deviation from the optimal anatomic distance between the saddle and the pedals predisposes cyclists to a higher risk of knee pain [7].

Research on the characteristics of injuries in Para-cycling athletes is rare. However, similar studies on other sports have been widely published. Nowak et al., analyze the injuries characteristics of young adult male basketball athletes [8]. Furthermore, Nowak et al. conclude that basketball is a sport with physical contact that causes injury in the lower limbs [8]. The types of injuries experienced by 33.9% of the subjects are ankle sprain. Orr & Cheng conduct research on the Rugby League [9]. In the study, the subjects are the junior athletes of New South Wales Rugby League in 2012, consisting of 15 clubs and 368 players with mean ages of 15.8 ± 1.0 years. Ankle and head/face injuries are the most common injuries (13%) in which ankle injuries cause the highest losses in matches. Contusions often occur (38%) and ligament injuries are also impressively experienced. Hamid, Jaafar & Ali compare the level of injury during the FELDA / FAM National Amateur Futsal Men's League in Malaysia to the previous Futsal Worlds Cup competition [10]. Physical contact with other players is concluded as a part of the injury. Tuakli-Wosornu et al. discussed Acute and Chronic Musculoskeletal Injury in Para Sport [6]. It was explained that the upper extremity is the area most frequently injured in all Para athletes. This is in contrast to large athletes who mostly sustain injury to the lower extremities. In fact, football 5-a-side, powerlifting, Goalball, Wheelchair fencing, and Wheelchair rugby are the highest risk summer sports, while ice hockey, alpine skiing, and snowboarding are the highest-risk winter Paralympic sports. Fagher & Lexell categorized the injury types based on walking athletes and those on wheelchair. They noted that lower extremity injuries were more common in walking athletes, whereas upper extremity injuries were more prevalent in those on wheelchair [11].

The aim of this study is to determine the sports injuries characteristics of Para-cycling athletes in Indonesia national team. The comprehensive analysis of the causes of sports injuries is the key to developing specific injury prevention strategies. More efficient implementation of injury prevention strategies by coaches and staff should lead to greater injury reduction and optimize health, safety, and well-being for Para-cycling athletes.

Material and methods

Participants

The study involved 19 Indonesia national Para-cycling team athletes. The profiles of 19 athletes can be seen in table 1. All the participants were athletes classified according to the Union Cycliste Internationale (UCI) system with at least one year experience in para-cycling events. All class categories involved in this study include C, B, H, and T. Coaches and athletes provided their approval to be involved in this research.

This study has received approval from Universitas Nusantara PGRI Kediri as a research quality assurance and community service institution with the number 031/LPPM UNP Kd/IV/2020.

Research instruments

The questionnaire is adopted from Nowak's questionnaire that has been modified and adjusted to the needs [8]. From the 28 question items, the researcher adopted 24 according to the research needs. Questions 1–4 are related to the athlete's anthropometry, 5–7 are related to the length of joining the team, class category, and the number of participated events. Furthermore, questions 8–13 are related to the type of injury suffered,

Tab. 1. Characteristics of Indonesian Para-cycling Athletes

Respondent	Age (yrs)	Height (cm)	Weight (kg)	BMI (kg)	Class Category
1	27	170	64	21	MB1
2	27	173	75	24	MT1
3	27	170	78	25	PilotB1
4	30	175	63	21	MC2
5	25	170	61	21	MC5
6	41	160	50	20	MH3
7	28	150	50	22	WC4
8	29	161	68	26	MC2
9	36	170	53	18	MC4
10	32	150	42	19	WC5
11	33	177	77	25	MC5
12	30	170	60	21	MC2
13	30	175	63	21	MC4
14	25	153	50	21	WB1
15	36	171	60	21	MC4
16	25	165	60	22	MC5
17	26	160	56	22	MB3
18	40	170	63	22	MC3
19	25	175	65	21	MB2
Mean (SD)	30 (5)	167 (9)	61 (10)	22 (2)	

yrs – years; cm – centimeter; kg – kilogram; MB1 – Man Blind Class Category 1; MB2 – Man Blind Class Category 2; MB3 – Man Blind Class Category 3; MT1 – Man Tricycle Class Category 1; MC1 – Man Cycle Class Category 1; MC2 – Man Cycle Class Category 2; MC3 – Man Cycle Class Category 3; MC4 – Man Cycle Class Category 4; MC5 – Man Cycle Class Category 5; MH3 – Man Handcycle Class Category 3; WC4 – Women Cycle Class Category 4; WC5 – Women Cycle Class Category 5; WB1 – Women Blind Class Category 1; PilotB1 – Pilot Blind Class Category 1.

the part that was injured, how and when the injury occurred (training or competition session), as well as how long it took to leave training. Question 14 is related to the frequency of training per week, and 15–21 are related to warming up before a training session or race, duration before and after injury, as well as the type. Question 22 is related to the post workout recovery strategies. In addition, 23–34 are related to how to treat injuries, and whether it affect the athlete's physical fitness. The following definition of sports injuries is taken for research purposes: Sports injuries are physical ailment from matches or training that force athletes to interrupt or modify their usual training plan for at least one training unit (definition of time loss) [13–15].

Statistical analysis

The statistical analysis tools used are Microsoft Excel and IBM SPSS Statistics 23. The results of data analysis represent numbers and percentages. Fisher's test was used because the participants were <20. Therefore, the appropriate statistical analysis to replace the chi-square was Fisher's test. Fisher's exact test was used to check the dependence between the type of responses given and group affiliation. The significance level is assumed at the level of $p < 0.05$.

Results

This study aims to determine the characteristics of sports injuries in Indonesian Para-Cycling athletes. 19 respondents were given several questions on their injuries experience. 15 athletes (79%) practiced 5–6 times a week. 73% of athletes are injured because of falling, 4% because of physical contact with other athletes, and 23% because of the overload. All of these injuries occurred during training. The most common injuries occur in the lower extremities (57%) and in the upper

Tab. 2. The answers to the question related to the competition and injury experienced by the tested Indonesia elite Para-cycling athletes

Question	Answer	Number of answers (N)	Percentage of answers (%)
How many times a week do you train?	1–2 times per week	1	5
	3–4 times per week	0	0
	5–6 times per week	15	79
	7 times per week	3	16
	Total	19	100
What part of your body was injured?	Head	1	4
	Back	2	10
	Upper limb	6	29
	Lower limb	12	57
	Total	21	100
What kind of an injury was it?	Twist/sprain	4	17
	Dislocation	2	8
	Rupture	0	0
	Break/fracture	4	17
	Contusion/Bruises	10	42
	Strain	1	4
	Others	3	12
	Total	24	100
How did the injury occur?	Falling down	16	73
	Physical contact with another player	1	4
	Overload	5	23
	Total	22	100
When did the injury occur?	During a training session	19	100
	During a match	0	0
	Total	19	100

extremities (29%). Contusion/bruises were experienced by 41.6% of athletes, break/fracture, and twist/sprain were each experienced by 16.7% of athletes. Questions in detail can be seen in table 2.

Based on table 3, most athletes practiced warm-up for about 10 to 20 minutes. 58% of athletes performed warm-up in post-injury longer than pre-injury. They did stretching (89%) before practicing or competing. Figure 1 shows the type of individual warm-up done before and after the sports injuries.

The longer warm-up exercise is an effort to minimize the occurrence of injuries again. Besides, most athletes (79%) also performed stretching after sports activities. This is proven by the fact that only 21% of athletes have suffered further injuries in the same area. While suffered from sports injuries, they lose less than a week of training time (58%). Additionally, athletes who experienced fractures (21%), must rest for more than 4 weeks. The success in minimizing the occurrence of injury is because the athletes carry out recovery strategies after training.

Tab. 3. The answers to the question related to the consequences of injuries and preventative actions taken by the surveyed Indonesia elite Para-cycling athletes

Question	Answer	Number of answers (N)	Percentage of answers (%)
Have you had the same injury again?	Yes	4	21
	No	15	79
	Total	19	100
How many average training days did you lose due to the injury?	<1 week	11	58
	1–2 weeks	4	21
	3–4 weeks	0	0
	>4 weeks	4	21
	Total	19	100
How much time did you spend performing an individual warm-up before the injury?	Up to 10 minutes	3	16
	10–20 minutes	12	63
	20–30 minutes	3	16
	Over 30 minutes	1	5
	Total	19	100
Is your warm-up longer or shorter after the injury?	Longer	11	58
	Shorter	2	10
	No change	6	32
	Total	19	100
Do you do stretching exercises before training sessions or matches?	Yes, always	17	89
	Yes, rarely	2	11
	No	0	0
	Total	19	100
Do you stretch after sports activities?	Yes, always	15	79
	Yes, rarely	4	21
	No	0	0
	Total	19	100
Do you use any post-exercise recovery strategies?	Yes	18	95
	No	1	5
	Total	19	100

The result of data analysis employing Fisher's exact test shows no single significant variable (table 4). The type of injury experienced by each class is different, it can be seen in table 5.

Based on table 5, class category C1 suffered the most frequent injuries. Contusion/bruises are experienced by all class categories. While the body parts that have been injured can be seen in table 6.

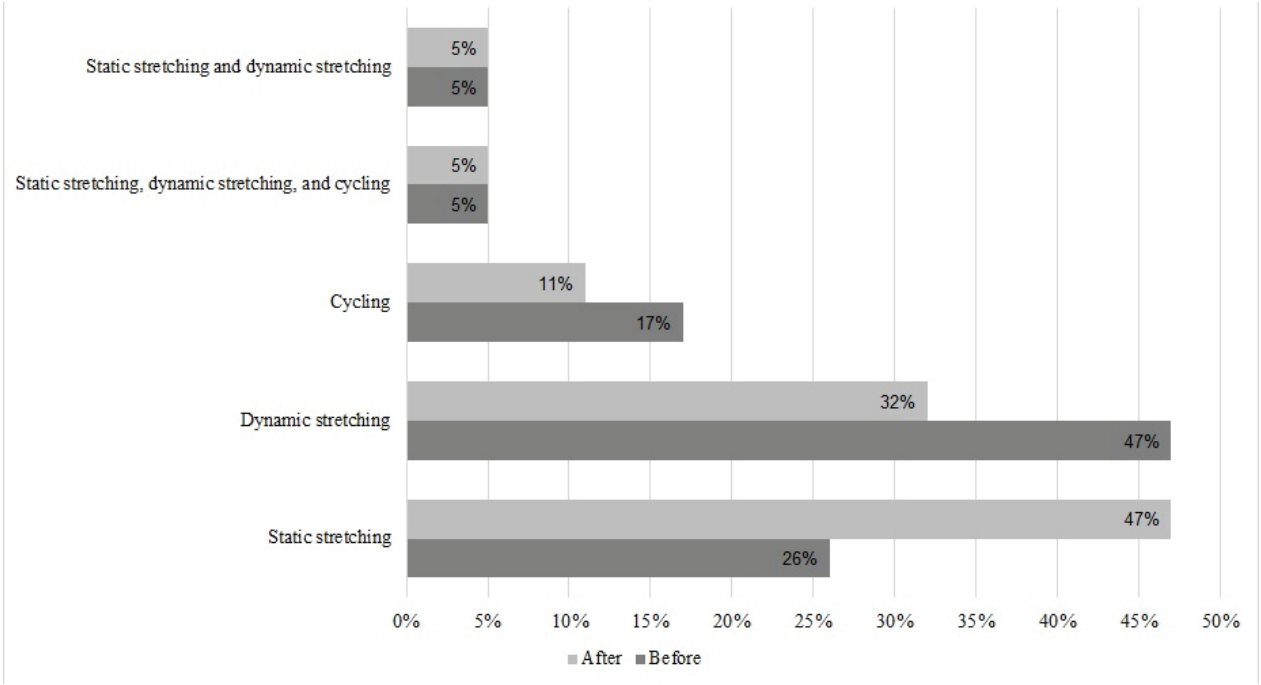

Fig. 1. Types of exercises performed during an individual warm-up before and after the injury

Tab. 4. The answers of respondents based on the frequency of training in a week

		Athletes practice 5–6 times a week (n = 10)	Athletes practice 7 times a week (n = 8)	Fisher
Do you do stretching before training sessions or matches?	Yes, always	9	7	1.00
	Yes, sometimes	1	1	
How many averages training days did you lose due to the injury?	<1 week	8	6	1.00
	1–2 weeks	2	2	
	3–4 weeks	0	0	
	>4 weeks	0	0	
Do you stretch after sports activities?	Yes, always	7	7	0.588
	Yes, sometimes	3	1	
Do you use any post-exercise recovery strategies?	Yes	9	8	1.00
	No	1	0	
Have you ever experienced the same injury again?	Yes	3	1	1.00
	No	7	7	
Do you think that the injury you experience reduces your fitness?	Yes	8	4	0.638
	No	2	4	

*$p < 0.05$.

Tab. 5. Distribution of injury types by class category

Class Category	Types of injuries					
	Dislocations	Contusion/Bruises	Twist/sprain	Fractures	Strain	Others
B1						1
B2			1			
B3		1				
C1	1	2	1	2	1	
C2						
C3				1		
C4		2	1	1		
C5		3				1
H3		1				
T1		1	1			
Pilot B1	1					1

B – blind; C – Cycle; H – Handcycle; T – Tricycle.

Tab. 6. Part that was injured

Class Category	Lower Limb				Upper Limb			
	Tigh	Knee	Leg	Foot	Arm	Shoulder	Head	Hand
B1			1					
B2				1				
B3		1						
C1								
C2	1	2		2	2			
C3					1			
C4		1		1	1			1
C5		1	1		1			
H3					1			
T1					1			
Total	12				8			

B – blind; C – Cycle; H – Handcycle; T – Tricycle.

Discussion

The most important finding in this study is in the form of the characteristics of sports injuries in Para-Cycling athletes when joining the Indonesia national team. The statistical analysis states that Indonesian Para-Cycling athletes often experience injuries in the lower extremities (57%) by falling (73%) either in the velodrome or other areas such as highways (table 2). Contusion/bruises (42%), twist/sprain (17%), and break/fracture (17%) are the effect of the fall experienced by the athlete. Contusion/bruises are experienced by all class categories (B-C-H-T). Uniquely, the injuries suffered by all of these athletes occurred during training sessions (100%), not in the matches. Previous studies reinforce these findings that youth athletes often experience injuries in training sessions [16,17]. However, another study mentions that injuries experienced by adults occur in the matches, not in training sessions [18,19].

The type of injury experienced by each class is different. Category B (blind) is contusion or bruises and twist or sprain (falling from a bicycle). Meanwhile,

category C has varied types of injuries. The athletes in H experienced contusion or bruise injuries, while T experienced bruises and twist or sprain injuries. Most of the injuries were to the lower extremities, including the ankles, lower legs, and toes.

This is often caused by high speed, which causes the rider to experience muscle tension, impact, and falls [20]. Another factor is a combination of inadequate preparation, inappropriate equipment, poor technique, and overuse [21]. The knee is most commonly injured as a result of overuse, with an estimate of 40% to 60% [22,23]. This is caused by increased pressure across the patellofemoral joint, poor patellofemoral tracking, or a combination of both [21]. Another uncommon entity with clinical features similar to medial tibial stress syndrome, is stress fracture. This injury is caused by a sudden increase in activity coupled with the bone inability to appropriately respond to stress [21].

Most people do stretching exercises before and after sports activities [24]. They believe that stretching exercises should be done in order to prevent injury and to maximize the performance. Usually, people perform stretching exercises before training to prevent muscle pain, but some do after the training [24]. 79% of Indonesian Para-cycling athletes also perform stretching exercises after training. Such exercise reduces pain one day after training [24].

Exercise also causes damage that leads to delayed-onset muscle soreness [25]. A post-exercise strategy is the best way to prevent injuries. In sports, cooling represents considerable therapy for athletes. Leeder et al. conclude their meta-analysis that post-exercise strategy (cold-water immersions) is an effective strategy to reduce DOMS symptoms after a series of strenuous and exhausting exercises [26]. 95% of Indonesian para-cycling athletes delivered a positive response in doing post-exercise strategy, although the implemented strategy was not specifically explained.

The study also observed the differences between athletes who trained for 5–6 times and those who trained for 7 times a week in terms of stretching. A total of 9 athletes always start the training session with warm-up. The analysis results with Fisher's exact test showed that none of the processed data were significantly based on the training frequency. This means that injuries are not caused by warm-up factors, but by a combination of inadequate preparation, improper equipment, poor technique, and overuse [21].

58% of Indonesian para-cycling athletes lost less than a week of training due to injuries. Contusion/bruises and twist/sprain are the main reasons to leave the training. Five studies report the average number of absent days due to injury as an indicator of injury severity [27–31]. Studies say that injuries may exclude players from long-term training [17], even end their careers [32]. Therefore, prevention of injury to athletes is very important [8]. Some coaches excessively focus on improving their techniques mastery and physical conditions, thereby ignoring the importance of injuries prevention during training sessions and matches. In addition, athletes' knowledge related to injury prevention is very low, so that they are unable to take care of themselves by staying fit and avoiding the injury risk. The coaches can adopt to prevent injury and Enhance Performance (PEP) as an effort to prevent injury [33].

Every athlete has the risk of experiencing re-injury [34]. Previous injuries have consistently been identified as important risk factors for injuries [35,36]. Re-injury is a repeat episode of a fully recovered index injury, and exacerbation is worsening in the state of a non-recovered index injury [37]. Preferably, the athletes undergo rehabilitation before returning to practice. A study states that the rehabilitation program carried out by the coach succeeds in reducing the risk of re-injury in amateur soccer players [34].

The coach and team members play an important role in preventing injury. Ideally, every sports team has a sports therapist. The aim is to implement an injury prevention and rehabilitation program. In addition, the frequency of exercise, post-exercise recovery strategies, and the duration of the warm-up are important elements in preventing injury.

Limitation and Recommendation for Future Researches

The lack of subjects, in view of that this team was only formed in 2017, is a limitation of this study. To compose future beneficial studies, the researcher should observe the exercise equipment used in the stretching method or the frequency of post-training recovery (proper rest interval between training/matches and electrotherapy). Besides, actions taken by Para-cycling athletes to prevent injury before, during, and after training need to be analyzed. An equally important study to be observed is the coach's reaction when encountering his/her athletes' injuries.

Conclusion

The lower extremity is a character of sports injuries experienced by Para-cycling athletes. An athletes' fall affects the lower extremities leading to contusion or bruises (on the knee and lower leg, when falling during training), twist or sprain (in the ankle, occurs during a training session), and break or fracture (caused by a fall during a training session). A warm-up and post-exercise strategy are one of the ways to prevent injury.

It is expected that future research will analyze the types of post-exercise strategy and injury prevention.

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Conflicts of interest
The authors declare no conflict of interest.

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