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<https://ejournal.upi.edu/index.php/penjas/article/view/56086>DOI: <https://doi.org/10.17509/jpjo.v8i1.56086>**Overuse Injury and Its Association with Possible Identified Risk Factors In College Athletes: a Pilot Study****Nawanto Agung Prastowo\*, Ignatio Rika Haryono**

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**Article Info***Article History :**Received March 2023**Revised March 2023**Accepted March 2023**Available online April 2023**Keywords :**college athletes, competitive sport, injury rate, injury sites, risk factors***Abstract**

Participating in sporting competitions exposes college students to body collisions and complex movements, leading to a higher risk of musculoskeletal injury. If not appropriately treated, acute injuries could evolve into overuse injuries. It can interfere with student activities and academic performance. This study aimed to investigate the overuse injury rate and its association with possible identified risk factors in college athletes. This study is a cross-sectional study involving 100 college athletes from four different sports, including badminton (26 athletes), basketball (21 athletes), futsal (30 athletes), and volleyball (23 athletes). The injury rate was presented as a number of injuries/1000 athletes-exposure (A-E) and 1000 hour-exposure. Possible identified risk factors, gender, age, body mass index (BMI), sports type, and activity were documented. Data on injury rate and student identity were obtained using a questionnaire. Weight and height were measured. Chi-square was applied to analyze the relationship, while binary logistic regression was used to estimate the magnitude of the risk of overuse injury using a reference value. Significance was determined at  $p < 0.05$ . The incidence of overuse injury was 26.2% of all injuries (28 cases). The overall injury rate was 2.58/1000 A-E or 1.41 1000 h-exposure. According to A-E exposure, the highest overuse injury rate was in basketball (3.97/1000 A-E), while the lowest (1.8/1000 A-E) was in futsal. Meanwhile, based on 1000 h-exposure, volleyball was the highest (2.17/1000 h-exposure) and badminton was the lowest (0.85/1000 h-exposure). The overuse injury was mainly found in the lower limb (53.6%). No possible identified risk factors were found to have a relationship with overuse injury (gender,  $p=0.922$ ; age,  $p=0.344$ ; BMI,  $p=0.223$ ; sport type (contact/non-contact),  $p=0.983$ ; sport type (team/individual),  $p=0.364$ ; and circumstance (training/competition),  $p=0.325$ ). The overuse injury rate in college athletes varies depending on the type of sport, with the lower limb being the most affected site. No association was found between possible identified risk factors and overuse injury.

## INTRODUCTION

Muscle injury is the most frequent cause of decreased performance in sports games and competitions. Among all injured tissue, soft tissue injury accounted for 30% to 50% of all sport injuries (Herring & Nilson, 1987). Not a few athletes, amateurs, and professionals are forced to resign and cease their careers prematurely due to muscle injury. It is estimated that approximately 35% of young athletes retire from the sport by specific causes related mainly to injury (Breuner, 2012). Musculoskeletal injuries may also cause student-athletes to lose their school time. However, an injury prevention program in college needs more attention.

Overuse injury has a significant impact on disturbing performance and often causes athletes to retire early. An overuse injury is common and occurs in all levels of competition, including in collegiate athletes. The overuse injury prevalence in collegiate athletes is estimated at 29%, with a rate of 18.5 per 10.000 A-E or 1.85 per 1000 A-E (Yang et al., 2012). An overuse injury is usually associated with several risk factors. A higher overuse injury rate often occurs in sports involving repetitive movement patterns and long-term training sessions, such as long-distance running, swimming, throwing, and others (Jacobsson et al., 2011; Ristolainen et al., 2010). An overuse injury is also more prevalent in team sports than individual sports (Dupont et al., 2010; Theisen et al., 2013; Visnes & Bahr, 2013). Overuse injury might be associated more with competition in competitive sports (Theisen et al., 2013). Gender is also considered as a risk factor. Females are more susceptible to overuse injury, with the rate almost double than of males (Roos et al., 2015; Yang et al., 2012).

The participation of students in sports has also been increasing in Indonesia. Many sports competitions are held regularly. More information regarding injury in collegiate athletes is needed, especially overuse injuries. A better knowledge of overuse injury patterns and risk factors is essential for the prevention program. Injury reports are often expressed one way as a rate of 1000 per athlete exposure (A-E) or per 1000 h exposure (h-1000). The difference in reporting the injury rates sometimes makes it difficult for readers or writers to make comparisons. Thus, this study aimed to investigate the injury rate and risk factors of overuse injury in collegiate athletes and report the injury rate in two ways.

## METHODS

This cross-sectional study involved 100 collegiate athletes (36 females, 64 males) from 4 sporting events, namely badminton, basketball, futsal, and volleyball. The participants were students of School of Medicine, Atma Jaya Catholic University of Indonesia, Jakarta, who engaged in sport activities organized by the campus. Participants had to regularly practice and undergo competitions according to the schedule. Athletes who agreed to participate received an explanation before filling in the consent form. Each participant voluntarily provided written informed consent before participating. The Atma Jaya ethical committee approved the study (03/02/KEP-FKUAJ/2022).

### Materials and Apparatus

Participants completed a written questionnaire distributed through the sport team coordinator. The questionnaire was validated and presented in Indonesian language. The questionnaire consisted of three parts, including personal data (five open questions), sport activities (five open questions), and injury characteristics (seven questions with multiple choice). Injury characteristics included injured body parts with specific sites, mechanisms of injury, event of injury occurrence, type of injury, symptoms, functional limitation, and injury care. Participants were instructed to report their injuries within twelve months. Athletes who reported injury were then clarified and examined to obtain data regarding the injury characteristics.

Weight was measured using a digital scale (SECA Robusta 813, Hamburg, Germany) in minimal clothing, expressed in kg. Height was measured using a stature meter (General Care, General Care Product Co., Ltd, Parked Nonthaburi, Thailand) in the Frankfort position, expressed in cm. Participants were in minimal clothing and barefoot during height measurements. Body mass index (BMI) was obtained by dividing weight (kg) by the square of height (m). Overweight and obese were defined as having a BMI  $\geq 23$  kg/m<sup>2</sup> and  $\geq 25$  kg/m<sup>2</sup> (Nishida et al., 2004).

### Procedures

Injury data were obtained from questionnaire and interviews to explore the further information. Written injury questionnaire was consisted of the student identi-

ty (gender, age, sport types) and injury characteristics, such as location, symptoms, functional disturbances, duration of symptoms, circumstances when the injury occurred, and acute first aid).

Injury surveillance was reported as incidence (expressed as a percentage) and rate (expressed as 1000 A-E and 1000 h-exposure). Athlete exposure (A-E) is the possibility of one student being exposed to injury during training or competition. Exposure is calculated by multiplying the number of athletes with total training and competition participated by total athletes. One A-E is one athlete participating in one training or competition session (Kerr et al., 2014, 2017). Participants had to report the number of practice and training days as well as competition days. Exposure is also presented per 1000 hours in practice/training and competition for one athlete (Phillips, 2000). One 1000-H exposure is one athlete with 1000-h participating in practice/training and competition. Overuse injury is defined as injuries due to repetitive trauma without a single and identifiable trauma (Aicale et al., 2018; Difiori et al., 2014).

Data for exposure were obtained from the attendance list for practices/trainings and competitions. The competitions in which the athletes participated included regional competitions, inter-faculty competitions, and inter-class-level competitions. The prevalence and injury rate, according to sports, were presented. The sport types were classified as non-contact sports (badminton and volleyball) and contact sports (basketball and futsal), also as individual sports (badminton) and team sports (basketball, futsal, and volleyball). The circumstance in which injury occurred was subdivided into practice (or training) and match.

**Data Analysis**

Data were presented as frequency (percentage) for categorical data. The Chi-square was used to analyze the association among variables. Possible identified risk factors for overuse injury were listed, including gender, age, BMI, sports type, first aid for early injury, and circumstance. The effect of those possible identified risk factors was computed using a binary logistic regression. Reference value (1.00) was determined; female for gender, age ≤20 years for age group, BMI<23 kg/m2, non-contact sport, and individual sport for a type of sports, RICE for first aid, and practice/training for injury circumstance. Significance was set at p<0.05. Statistical

analysis was computed using a Statistical Package for Social Sciences (SPSS) version 17.

**RESULT**

This study involved one hundred collegiate athletes from four-sport events (badminton, basketball, futsal, and volleyball). The distribution of gender, age, BMI, and injury is shown in Table 1. The distribution of gender and BMI classification were different in sport groups. More male athletes participated in badminton, basketball, and futsal (p<0.01). Also, there were more athletes observed with overweight and obese, especially in badminton and basketball (p=0.046).

**Table 1.** Characteristics of the participants across the sports

	Badminton (n=26)	Basketball (n=21)	Futsal (n=30)	Volleyball (n=23)	p
<b>Gender</b>					
Female	8	4	10	14	<0.010
Male	18	17	20	9	
<b>Age</b>					
20 years or less	22	12	20	16	0.216
>20 years	4	9	10	7	
<b>BMI</b>					
<23 kg/m2	9	9	20	15	0.046
≥23 kg/m2	17	12	10	8	
<b>Injury</b>					
No injury	11	5	4	4	0.066
Injury	15	16	26	19	

**Table 2.** Injury surveillance in a sports event

	Badminton	Basketball	Futsal	Volleyball	Overall
<b>Number of injuries (cases)*</b>	23	27	30	27	107
<b>Number of overuse injuries (cases)</b>	4	8	7	9	28
<b>Overuse injury incidence</b>	17.4%	29.6%	23.3%	33.3%	26.2%
<b>Total length of exposure</b>					
A-E	1.664	2.016	3.840	3.312	10.832
h-exposure	4.680	5.670	5.400	4.140	19.890
<b>Overuse injury rate</b>					
Rate/1000 A-E	2.40	3.97	1.82	2.72	2.58
Rate/1000 h exposure	0.85	1.41	1.30	2.17	1.41

**Table 3.** Injury amount and rate by region among the sports

Body area	Badminton n (rate)	Basketball n (rate)	Futsal n (rate)	Volleyball n (rate)	Overall n (rate)
Upper limbs	3 (1.80/1000AE or 0.64/1000 h-exp)	-	1 (0.26/1000AE or 0.185/1000h-exp)	3 (0.91/1000AE or 0.72/1000h-exp)	7 (0.65/1000AE or 0.35/1000 h-exp)
Lower limbs	1 (0.6/1000AE or 0.21/1000 h-exp )	5 (2.48/1000AE or 0.88/1000 h-exp)	5 (1.30/1000 AE or 0.93/1000 h-exp)	4 (1.21/1000AE or 0.97/1000 h-exp)	15 (1.38/1000AE or 0.75/1000 h-exp)
Trunk	-	1 (0.50/1000AE or 0.18/1000 h-exp)	1 (0.26/1000AE or 0.185/1000h-exp)	1 (0.31/1000AE or 0.24/1000h-exp)	3 (0.28/1000AE or 0.15/1000 h-exp)
Multiple sites	-	2 (1.0/1000 AE or 0.36/1000 h-exp)	-	1 (0.31/1000AE or 0.24/1000 h-exp)	3 (0.28/1000AE or 0.15/1000 h-exp)

**Table 4.** The logistic regression of the determinant factors

Variables	Acute injury (n=48)	Overuse injury (n=28)	Adjusted OR (95% CI)	P
Gender	Male	33	1.00	0.922
	Female	15	0.95 (0.34-2.64)	
Age	20 years or less	34	1.00	0.334
	>20 years	14	1.75 (0.56-5.46)	
BMI	<23 kg/m2	24	1.00	0.223
	≥23 kg/m2	24	0.54 (0.20-1.46)	
Sport type	Non-contact	21	1.00	0.983
	Contact	27	0.99 (0.35-2.83)	
Sport type	Individual	11	1.00	0.364
	Team	37	1.80 (0.50-6.46)	
First aid	RICE	17	1.00	0.706
	Others	31	1.25 (0.40-3.90)	
Circumstance	Practice/training	35	1.00	0.325
	Match	13	0.55 (0.17-1.80)	

Overuse injury surveillance has been shown in Table 2. The highest number and incidence of overuse were in volleyball (9 and 33.3%, respectively), but the highest injury rate was in basketball (4.0/1000 exposure). The total cases of overuse injury were 28 cases, while the incidence and injury rates were 26.2% and 2.6/1000 exposure, respectively.

The injury region among the sports is described in Table 3. The highest overuse injury incidence was in the lower limb (15 athletes/53.6%). Lower limb injury occurred in all sports. Multiple sites of overuse injury and overuse injury in the trunk affected athletes with the same amount (3 athletes/10.7%). Volleyball had the most overuse injury (9 athletes/32.1%) and injuries in all sites, whereas badminton had the least injury (4 ath-

letes/14.3%) and injury sites (upper and lower limbs).

Possible determinant factors for overuse injury were documented and analyzed using binary logistic regression (Table 4). No significant results were found. However, there was a tendency that males (67.9%), athletes aged 20 years or less (60.7%) with lower BMI (64.3%), and athletes of a team sport (85.7%) were more likely to experience overuse injury. Overuse injury also occurred more likely during practice (78.6%).

## DISCUSSION

An overuse injury is an enormous problem for athletes. When untreated appropriately, overuse injury can lead athletes to early retirement. Overuse injury often

develops from an acute injury, which is compounded by intrinsic and extrinsic risk factors. Some studies have linked overuse injury with gender, anthropometric size, posture abnormality, physical performance, type of sports, and everything related to training, practice, and games (Bahr & Krosshaug, 2005). Our study showed that the overall overuse injury rate was 2.58/1000 A-E or 1.41/1000-h exposure. Basketball had the highest rate based on AE (3.97/1000 AE), while volleyball had the highest rate based on 1000-h exposure (2.17/1000-h exposure). Further analysis indicated that gender, age, BMI, sport types, first aid, and activity in which injury occurred were not evidenced as risk factors.

Overuse injury incidence in sports has been reported. Overall, a prior study reported an overuse injury rate in collegiate athletes of 1.85/1000 A-E (Yang et al., 2012). The results of the recent study demonstrated that the overuse injury rate was 2.58/1000 A-E. Overuse injury rate varies in different sports. Thus, the overuse injury rate in specific sports was also reported. The injury rate in basketball in youth players was reported by 1.51/1000-h exposure (Leppänen et al., 2017), while in this recent study, 1.41/1000-h exposure. In badminton, a past study reported an overuse injury rate estimated at 1.6-2.9 injuries per 1000 A-E (Jorgensen & Winge, 1987). Miyake et al. reported that Japanese collegiate badminton players had a higher risk of overuse injury by 8.9-27.0/1000 A-E (Miyake et al., 2016). In this study, the overuse injury rate was 2.40/1000 A-E. In volleyball, a study by Aagaard and Jorgensen reported the incidence of overuse injury rate in elite volleyball players by 1.8 per 1000-h exposure (Aagaard & Jørgensen, 1996). At the same time, Verhagen et al. estimated an injury risk of a mean value of 0.6 per 1000-h exposure (Verhagen et al., 2004), while in our study, 2.17/1000-h exposure. In futsal, overuse injury in female futsal players was found by 6.7/1000-h exposure (Ruiz-Pérez et al., 2019). Our study found that overuse injury rate in futsal by 1.3/1000-h exposure. The current injury rate among sports was in range with the previous studies except for badminton which was much lower than those in Japan (Miyake et al., 2016). The characteristics of subjects, level of competition, methods of injury assessment, training and game programs, reporting injury rate, and defining the term 'overuse' may affect the discrepancy of the results among studies (Neil et al., 2018; Roos et al., 2015).

The lower limb is the most frequent site affected by an overuse injury. A higher incidence of overuse in the lower limb has been reported by Leppanen et al. by 55-65% (Leppänen et al., 2015). Some studies also confirm similar results. Previous studies indicated that the lower limb incidence was the highest in most sports, including badminton, basketball, futsal, and volleyball (Briner & Kacmar, 1997; Goh S.L et al., 2013; Senior Lecturer et al., 2009; ULUÖZ, 2016). This study also found the lower limb as the most frequently injured site overall. Even, most sports in this study were not footing sports, but these sports had a high demand on legs and feet to run, lunge, and jump. Also, the essential function of the lower limbs is to bear body weight. These cause the lower limbs to be the body region most susceptible to injury. Nevertheless, in this recent study, lower limb injury was found only in 1 badminton athlete (25%). We suggest lower exposure and level of competition in badminton in our study.

Overuse injuries develop due to the contribution of several risk factors. We analyzed the possible identified risk factors, such as gender, age, BMI, sport type, first aid, and circumstance in which injury occurred. Our findings suggest that those possible risk factors have no contribution to the development of overuse injury. These findings follow prior literature, except for BMI (Leppänen et al., 2017; Roos et al., 2015; Ruiz-Pérez et al., 2019; Schroeder et al., 2015; Stevenson et al., 2000; Yang et al., 2012). Our findings, that lower BMI tended to be at a higher risk than those with higher BMI, were less consistent with a previous finding (Hollander et al., 2020). A clear explanation for this phenomenon is needed. We suggest that some overuse injuries, especially in a team sport, are provoked by body contact. Therefore, athletes with higher BMI and muscle mass will have an advantage over those with lower BMI and muscle mass (Wallner-Liebmann et al., 2013). Also, higher BMI in athletes indicates greater muscle mass and strength, considered as protective factors against muscle injury (Lehance et al., 2009).

Several limitations of this study are noted. The initial injury severity could not be determined due to the difficulty of performing an initial examination at the time of injury. The severity of the injury is the most influencing factor for the development of overuse injuries. Information on the recurrent injury, sports equipment, and sports clothing contributing to overuse injury

is also unavailable. Our study did not examine the posture alignment and physical fitness that substantially contribute to overuse injury. Also, data on time loss from participation used to investigate the injury severity were not reported. Subjects for each sport might need to be more sufficient for statistical significance.

Due to their limitations, the results of this study should be interpreted with caution. However, this study provides data on overuse injury and its possible identified risk factors in collegiate athletes in Indonesia. These results can develop an injury prevention program for collegiate students, particularly for overuse injuries.

## CONCLUSION

In conclusion, the overuse injury rate varied among different sports. The injury rate indicated by 1000 A-E was different with 1000 h-exposure. The highest overuse injury rate was in basketball (1000 A-E exposure) or volleyball (1000 h-exposure), whereas the least was in futsal (1000 A-E exposure) or badminton (1000 h-exposure). Lower limbs were the most affected site by injury. The possible identified risk factors (male, age, low BMI, sport type, first aid, and injury circumstance) were not associated with overuse injury rate.

## RECOMMENDATION

Based on the limitations, future studies should include the acute injury severity, possible risk factors for overuse injury development, and lost study time to detect negative impacts on learning process. Also, the study should involve larger sample and a more thorough injury examination to increase the likelihood of significant results and provide a more specific injury diagnosis.

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## CONFLICT OF INTEREST

The authors declared no conflict of interest.

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