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INVESTIGATING THE CAUSATIVE FACTOR OF MUSCULOSKELETAL INJURY FOR INDONESIAN TRADITIONAL MARTIAL ARTS

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Abstract

Background. The interest in Pencak Silat is growing significantly, however, followed by the elevation of injury cases with 7.7% for females and 17.8% for males.

Study purpose. The study explores the injuries profile of musculoskeletal, including type, form, location, mechanism, and risk factors, across genders.

Materials and methods. Two hundred and twenty-nine athletes including 148 males and 81 females in 4 different Sports Schools and Clubs (age 21.3±3.7 years old, BMI 21.12±1.56 kg/m^2, normal resting heart rate), who had ever attended the national competition, voluntarily participated. The personal data was collected by a research assistant, the training load was recorded by coaches, while the injuries profile was legitimated with the OSTRC-Questionnaire by medical rehabilitation specialists, and Postural Investigation was confirmed by certified clinical staff with FMS-Score-test.

Results. The Incidence Rate (IR) for males was higher with 48.5 (95% CI: 45.8–51.3) and was 35.2 injuries/1000 hours for females, males had 3.1 times higher severity level than females (2.3±1.2) and had longer injuries duration (4.8±2.6 weeks) than females. The contusion brought the most frequent incidence at 32.9/1000 hours (36.7%), hematoma at 19.9 injuries/1000 hours (95%CI:17.9-23.1), and muscle soreness (12.1/1000 hours). The lower limbs were the most damaged areas with 33/1000 hours and the upper limbs (26,5%) with 5-14 injuries/1000 hours. The previous injury has a risk effect with 3.0 times higher contributed to the on-set current injury, followed by Excessive training. A kick by the opponent (25%) and offensive kick (19%) were a frequent mechanism of injuries.

Conclusions. The Injury Rate (IR) was significantly different between the genders. The findings strengthen the study of injuries, which are specially characteristic of Pencak Silat, that may contribute to delivering injuries profile.

Keywords: Musculoskeletal, injuries, location, mechanism, Pencak Silat.

Introduction

Pencak Silat is one of the most Indonesia prominent traditional combat sports amidst another modern martial art, recognized by UNESCO as one of the cultural heritage of martial art surrounding the Southeast Asian Archipelago (Wilson, 2015). The increase of interest growing by 47% yearly in line with the policy of the ministry of education which requires Pencak Silat as a compulsory Extracurricular Program. Similarly, the number of school competitions, juvenile, youth, and adults has shown an elevation to date (Keilbart, 2019).

The study reported the Incidence Rate of injury (IR) was up to 67% in both genders yearly, including youth by 7.7%, and elite by 17.8% (Chan et al., 2020), and were known to vary from 24 %-77% (Del Vecchio et al., 2018). It was identified in Tae Kwon do that the lower extremity was the most prevalent injury of youths (29 cases), juniors (74 cases), and elites (41 cases) (Lystad et al., 2009). Another study has established the injuries' location in karate of upper limbs into specific locations such as craniofacial (31%), Head (11%), Neck (6%), Nose (9%), Jaw (4%), and Lips (3%) (Thomas & Ornstein, 2018). Meanwhile, the middle body is documented in hips (6%), forearm (4%), hand (3%), elbow (2%) and followed by lower limbs (Miguel-Andrés et al., 2020) such as the thigh (11%), Ankle (5%), shin splint (7%), and patellofemoral (19%) (Cierna et al., 2018). Furthermore, a cases study in karate and Kempo found that soft tissue injuries such as hematoma and contusion were the most prevalent injury, meanwhile, muscle soreness was the second most common injury, sprains and strains were the most prevalent in juveniles and teens (Cierna & Lystad, 2017).

The postural classification according to gender is frequently overlooked as a trigger factor of injuries by a

previous study (Meshkati et al., 2010). Despite other studies clarifying that postural classification has no significant effect on injury (Buist et al., 2010), however, different pieces of training management in individual cases (Anggraeni et al., 2019) often result in improper load (Kusuma et al., 2018) and contribute to a high risk of injury (Tabor et al., 2019). Other findings highlight differences impact of age and gender on injuries (Sterkowicz-Przybycien & Fukuda, 2016), which are related to physical fitness, motor coordination, and technical quality (Subekti et al., 2020), and as factors that may underlie biomechanical movement in Pencak Silat to prevent injuries incidences (Zheng et al., 2020; Kusuma, 2021b),

The limitation of the study is a lack of hypotheses related to the injuries profile that have not been identified in Indonesia to date. A subjective prognosis was confirmed based on the similarity of kicking technique between Pencak Silat and taekwondo, as well as the punching techniques with karate, therefore a similar injury could be hypothesized can also occur in Pencak Silat. The study aimed to investigate the causative factors of injury incidences starting from type, forms, number, risk factors, mechanism, and anatomical location for both males and females.

Materials and methods

Study participant

Two hundred and twenty-nine athletes including 148 males and 81 females in 4 different Sports Schools and Clubs (age 21.3±3.7 years old, BMI 21.12±1.56 kg/m^2, normal resting heart rate), had ever attended the national competition, voluntarily participated in this prospective cohort injury surveillance for 6-consecutive months. The study information has been delivered both orally and in written initially and completed with the confirmation of willingness by signing informed consent.

Study organization

The personal data, method of training, the number of sessions, competition, and training load from January to September were documented by the coaches and research assistants through an online questionnaire. Meanwhile, the health status, anthropometry, injury type, number, location, and injury mechanism were legitimated by rehabilitation staff using the Questionnaire of Oslo Sports Trauma Research Center (OSTRC) v=0.95, r=97 recorded in written informed consent. The study started with delivering an OSTRC (Madaleno et al., 2021) and was validated through on-site interviews and inspection of the craniofacial, trunk, hips, upper limb, and lower limb. The Postural Investigation including body stability, mobility, and range of motion was evaluated by FMS-certified staff using FMS-Protocol (v=0.89, r=0.88) (Wu et al., 2021). Injury exposure was reported as the number of injuries per 1000 hours of participation, while the magnitude of risk was expressed as a relative risk (RR) and its 95% confidence interval (CI).

The study was approved by the Institutional Review Board of Human Ethics Committee (Nr: KE/01211/13/2021) with the Declaration of the World Medical Association of Helsinki on the ethical conduct of research involving human subjects, while the clinical data were assembled in a secured institutional database according to General Data Protection Regulation (GDPR).

Statistical analysis

Statistical calculation was performed using the SPSS Software Version 26 for Windows. Descriptive statistics were employed to describe the characteristics and size of the samples and variables and were presented as mean standard deviations. The normality value was evaluated using the Shapiro-Wilk test, meanwhile, the chi-square test in SPSS software was used to make distinctions at a confidence interval of alpha ($p<0.05$).

Results

The respondent's profile (Table.1) shows the productive ages of males (20.3±3.7 years), and females (19.6±2.1 years), have a normal health status (BMI 22.5±2.6 kg/m^2) of males and 20.2±1.4 kg/m^2 of females, were not in fatigue state as reported by a basal pulse rate of 63.4±6.8 bpm. Samples have varied in weekly training hours (14.2±4.6 hours) for

Table 1. The Descriptive Profile of Samples

Variables	Number		Mean's ± SD	
	Males	Females	Males	Females
Age (years)	148	81	20.3±3.7	19.6±2.1
Height (cm)	148	81	178.3±.5.1	164.5±.4.4
Weight (Kg)	148	81	72.7±7.2	52.4±5.6
BMI (kg/m^2)	148	81	22.5±2.6	20.2±1.4
Resting Heartrate (pulse/minutes)	148	81	63.4±6.8	67.1±4.2
Weekly Training (hours/weeks)	148	81	40.6±4.6	38.7±2.3
Annual Competition (hours/year)	148	81	18.2±2.4	17.5±2.7
Chronis Injuries (express in number)	148	81	49.5±3.2	32.7±2.9
Acute Injuries (express in number)	148	81	17.4±5.1	13.2±4.6
Multiple Injuries (express in number)	148	81	12.8±2.5	9.3±3.1
Level of Injuries (Injury Score) *	148	81	3.1±1.7	2.3±1.2
Injury Duration (express in weeks)	148	81	4.8±2.6	2.6±1.4

*ISS: Injury severity score (rated with 1 being minor injury and 5 severe injuries)

Table 2. The Type of Musculoskeletal Injuries (In Average)

Type of Injuries	Number		Total (%)		IR* (95%CI)	
	Male	Female	Male	Female	Male	Female
Contusion (Bruise)	54	28	36.7	28.7	33 (30.2-35.8)	18 (14.8-20.2)
Hematoma	33	14	20.5	17.3	20 (17.9-23.1)	8.9 (5.9-11.1)
Muscle Soreness	20	18	13.3	20.6	12 (9.8-15.2)	11 (8.7-14.3)
Skin Scrapes	16	8	9.6	12.5	10 (7.3-11.7)	5.1 (3.2-7.8)
Nose Bleeding	10	7	7.2	1.7	6.1 (5.9-7.1)	4.5 (3.4-5.6)
Concussion	6	3	4.8	5.2	3.7 (2.4-4.6)	1.9 (0.3-2.7)
Torsion	5	2	4.2	2.6	3.7 (2.0-4.0)	1.3 (0.8-1.2)
Dislocation	3	1	2.4	1.4	2.9 (0.8-2.2)	1.6 (1.2-1.8)
Fracture	1	0	1.2	0	1.2 (0.9-1.1)	0
Total	148	81	100%	100%		

*IR: incidence rate per 1000 participation hours; CI: confidence interval

Table 3. The Anatomical Areas of Minor Injuries

Areas		Number and (Percentage)		IR* (95%CI)	
		Male	Female	Male	Female
Lower Limbs	Outer thigh	19 (14.4)	13 (12.7)	12 (9.2-13.8)	8.3 (6.8-10.2)
	Knee	16 (11.8)	7 (7.7)	10 (7.9-11.1)	4.5 (2.9-6.1)
	Inner thigh	7 (4.2)	9 (9.3)	4.3 (2.8-6.2)	5.7 (3.7-7.3)
	Shin-splint	6 (3.6)	4 (5.3)	3.7 (2.3-4.7)	2.6 (1.2-3.8)
	Calf	4 (2.4)	2 (3.6)	2.4 (1.4-3.6)	1.3 (0.3-2.7)
	Ankle	3 (1.8)	1 (2.8)	1.8 (0.8-2.2)	0.6 (0.1-1.6)
Upper Limb	Upper arm	16 (11.8)	10 (10.1)	9.7 (8.3-10.7)	6.4 (5.2-7.8)
	Forearm	12 (8.4)	4 (5.3)	7.3 (6.9-8.1)	2.6 (1.4-3.6)
	Shoulder	7 (4.2)	6 (6.9)	4.3 (3.4-5.6)	3.8 (2.3-4.7)
	Wrist	6 (3.6)	3 (4.5)	3.7 (2.2-4.8)	1.9 (0.8-1.8)
	Elbow	5 (3)	2 (3.6)	3.0 (2.8-4.8)	1.3 (0.2-1.9)
Trunk	Side Chest	14 (10.6)	9 (9.3)	8.5 (7.8-9.2)	5.7 (2.7-8.3)
	Hips	10 (6.4)	5 (6.1)	6.1 (5.3-7.7)	3.2 (1.2-5.8)
	Front Chest	4 (2.4)	2 (3.6)	2.4 (1.9-3.1)	1.3 (0.4-2.6)
	Back	4 (2.4)	1 (2.8)	2.4 (1.4-3.6)	0.6 (0.3-1.7)
Craniofacial	Head	5 (3)	1 (2.8)	3.0 (2.0-4.0)	0.6 (0.8-1.2)
	Neck	4 (2.4)	2 (3.6)	2.4 (1.8-4.2)	1.3 (0.2-1.8)
	Jaw	3 (1.8)	0 (0)	1.8 (0.8-2.2)	0 (0)
	Eyebrows	3 (1.8)	0 (0)	1.8 (0.3-2.7)	0 (0)
	Total	148	81		

*IR: incidence rate per 1000 participation hours; CI: confidence interval

males, and females (12.5±2.3 hours), meanwhile males spent more repetitive competition (14.2±2.4-hours), females (12.5±2.7-hours). The male participants spent 1642.2 hours; the female was 1565.5 hours. The IR of the male was 48.5/1000 hours (95% CI: 45.8–51.3), 35.2 (95% CI: 33.4–37.3) for the female. Chronic injuries were the most frequent mode of males (35.1%), and females (40.4%), contrarily females have more multiple injuries (11,9%) than males (8,8%). The male has high severity level (3.1±1.7) than female (2.3±1.2), and the male has longer injuries duration (4.8±2.6) weeks and 2.6±1.4 weeks than females.

The type, location, and the number of percentages which were experienced in the competition and training could be seen in the following table 2.

Contusion contributes 36% as the most injuries type with 32.9 incidences/1000 hours for males, while a female has 28.7% with 17.9 incidences/1000 hours. The hematoma has 19.9/1000 hours as the second most prevalent with 20,5% followed by muscle soreness (12.1/1000 hours) and impacted 13,3% of male injuries. The female shows were slightly different in muscle soreness (20.6%) as the second most frequent incidence (11.5 injuries per 1000 hours),

Table 4. Multivariate Test for Variable of Injuries Mechanism

Injuries Mechanism	Number and Percentage (%)		RR* (95%CI)	p
	Male	Female		
Defensive a kick	36 (26.6)	20 (20,3)	2.5 (0.7-7.6)	0.01
Offensive a kick	26 (19.2)	17 (25,7)	2.2 (0.5-7.4)	0.01
Defensive a hit	23 (13)	11 (13,4)	1.9 (0.7-7.6)	0.07
Offensive a hit	17 (12.6)	8 (9,7)	1.3 (0.3-5.4)	0.15
Techniques inadequacy	14 (8.2)	7 (8,5)	1.0 (0.6-7.1)	0.03
Slammed by opponents	11 (7.1)	5 (6,5)	1.0 (0.6-7.1)	0.02
Uncontrolled attack	8 (8.6)	4 (4,9)	1.7 (0.7-7.6)	0.27
Improper Fall	7 (4.2)	3 (3,8)	1.0 (0.6-7.1)	0.42
Unknown	6 (3)	6 (7,3)	1.0 (0.6-7.1)	0.52

* RRadj: adjusted relative risk. CI: confidence interval

hematoma (17.3%) recorded with 8.9 injuries in 1000 hours. The investigation of the injury location associated with major injuries was split into four sections for more comprehensive analysis as shown in Table 3.

The outer thigh was the highest injury location expressed with 8-12 injuries/hours in both genders. The knee (11,8%), and inner thigh (9,3%) brought 4-10 injuries/1000, shin-splint (3,6%), calf (2,4%), and ankle (1,8%) with 5 incidences/1000 hours', meanwhile inner thighs (12,7%) are the second most location, followed by outer thigh (9,3%), shin-splint (5,3%), calf 3,6) and ankle (2,8%) with less than 5 injuries/1000 hours for female. The upper arm was the most location found in males (11,8%), while the female (10.1%) with 6-10 injuries/1000 hours, followed by the forearm (8,4%) for males, and shoulder (6,9%) in females with less than 7 injuries/1000 hours. The wrist and Elbow were the lowest anatomical damage in both with 4 cases /1000 hours. Both genders have the side chest as the most injured locations with 8,5% and 5,7% cases, followed by male hips (6,1%), front chest (2,4%), back (2,4%), and female's hips (3,2%), front chest (1,3%) and back (0,6%). The highest injury exposure in the trunk was 8 injuries/1000 hours for the side chest and less than 6 injuries/1000 hours in the hips for both athletes. The craniofacial was also indicated as the highest injury location for both genders with 3 injuries/1000 hours, while the neck was the second most frequent with 2,4% for males and 3,6% for females with 2 cases in 1000 hours. The further injuries mechanism can be seen in Table 4.

The kick by the opponents was the most frequent injury mechanism in both males (26,6%), and females (20,3%) and have an injury risk factor of 2.5 times greater, followed by an offensive kick in males (19,2%) and females (25,7%) and have the risk for the injury of 2.5 times. The defensive hits have a rate of relative risk of 2.2 higher risks to bringing injuries for both males (13%) and females (13.4%), while offensive hits showed a contribution rate injury of 12,6% and 9,7% respectively and have a risk value of 1.3 times. Uncontrolled attack (6%), improper falling position (4,2%), and unknown risk factor (3%) were stated to have the least injuries mechanism for both genders with a relative risk of around 1.4 times more risk of being injured.

Discussion

The Incidence Rate (IR) of injuries in Pencak Silat was relatively higher with 32.9 incidences/1000 hours compared with Taekwondo and Karate with an IR rate of 29,7 injuries/1000 hours (Hammami et al., 2018). The previous study relies on the physician's complaint after competition and might overlook the causative factor of chronic injuries (Sari et al., 2019), therefore this prospective study seems to have a higher level of injury rate than the previous. The athlete's profile that suffered traumatic syndrome shows that contusion (36%) is the most frequent injury type, followed by hematoma (28%), and soreness (17%) with IR at 11-19 injuries/1000 hours. The high of IR certainly needs to be deliberated comprehensively due to has similarities of IR for Taekwondo and Kempo at the Olympics event (Drury et al., 2017), although Pencak Silat has not been classified as an Olympic Sport (Altarriba-Bartes et al., 2014). The lower limb injuries were the most frequent location (32.9 injuries/1000 hours), followed by the outer thigh as the highest location in both genders (11.7 injuries/1000 hours). Since FMS shows a reduction range of motion of the tensor fascia latae and rectus femoris due to a traumatic incident (Kusuma, 2021a), therefore, further investigation is still unestablished (Lystad et al., 2009). The high IR of the lower extremity was associated with the different art of leg attacks compared to other combat sports (Vitale et al., 2018; Listiandi et al., 2019), since Pencak Silat uses the unique style for leg attack, kicking, sweeping, cutting, slamming the opponent (Soo et al., 2018), and are elaborated to have a higher risk factor to lower extremity injury (Tulendiyeva et al., 2021).

Knee injuries of males (IR 9.8/1000 hours), shin-split, and ankle (IR 2.4-3.7/1000 hours) are assumed as an impact of being kicked by opponents repeatedly (excessive defensive kick) with a relative ratio (RR) of 2.5 times more risk, as reported in injury cases of muay Thai (Strotmeyer & Lystad, 2017). The inner thigh injuries in females (IR 5.7/1000 hours) are predicted due to overuse of groin muscle while kicking opponents (Gavagan & Sayers, 2017), which has an injury ratio of 2.2 times more risk. The data was accepted recently since almost all of the current findings reported significant results referring to the relationship between the lower extremity (Kusuma, 2021a), hamstring, and groin muscle with

a high rate of incidences in common martial-art (Čierna & Lystad, 2017). The differences of IR in the upper arm, forearm and, shoulder at 3.1/1000 hours, wrist (1.9/1000 hours), elbow (1.3/1000 hours), therefore further confirmation is necessary, considering both defensive and offensive hits have no significant effect on Pencak silat injury (95%CI, p>0.01), even though shown 1.2 times more risk to injury, and was justified in an injuries review (Noh et al., 2015) that hits have a twofold times effect on the injury incidences (Piejko, 2019) in the other combat sports competition (Del Vecchio et al., 2018)

Interestingly, the relatively higher incidence rate in the side chest, front, hips, and lower back comparing other combat sports, needs to be studied deeply even though wearing a similar body protector in competition (Garcia-Isidoro et al., 2021) (Hölbling et al., 2017). On the contrary, the head, and neck injuries were found comparatively lower (IR 2.1/1000 hours), the jaw, and brow (IR 1.3/1000 hours) compared to Muay Thai (Gavagan & Sayers, 2017), karate Kempo (Lockwood et al., 2018), where Pencak Silat is not equipped with head protector in competition (Ediyono & Widodo, 2019). The defensive and offensive kicks, technical inadequacy (10.5%), and being slammed by opponents (8%) have 1 time more risk. Although offensive hit (12.5%), uncontrolled attack (6.4%), and improper fall (5%) have no significant effect, however considering the varying number of injuries that occurred, therefore a comprehensive mechanism of exams is recommended (Thomas & Ornstein, 2018). The different techniques and styles used to justify the variation of the number, type, locations, mechanisms, and injury incidences in Pencak Silat (Dzakiya et al., 2021)

Over the years an investigation of the injuries profile in modern martial arts has been observed, however, not been implemented yet in Pencak Silat. It worth mentioning was the fact in this study that the longer and heavier training hours, contributing to more hours of slamming, and kicking consequently had a higher risk of injury. This aspect has not been addressed, and thus requires further study on a sizeable study group divided into weight categories in the future. Comprehensive data are required to investigate the effect of weight classes, experience on injuries, and the type of rehabilitation that has been conducted. RCTs are also required for interventions such as training and feedback on performance data to reduce injury rates.

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Conflict of interest

All authors declare no conflict of interest.

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ДОСЛІДЖЕННЯ ПРИЧИННОГО ФАКТОРА ТРАВМ ОПОРНО-РУХОВОГО АПАРАТУ В ІНДОНЕЗІЙСЬКИХ ТРАДИЦІЙНИХ БОЙОВИХ МИСТЕЦТВАХ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 7 с., 4 табл., 39 джерел.

Історія питання. Інтерес до пенчак-силату значно зростає, проте супроводжується зростанням випадків травматизму на 7,7% для жінок і 17,8% для чоловіків.

Мета дослідження. У цьому дослідженні вивчають профіль травм опорно-рухового апарату, включаючи тип, форму, локалізацію, механізм і фактори ризику, для різних статей.

Матеріали та методи. У дослідженні добровільно взяли участь двісті двадцять дев'ять спортсменів, серед яких 148 чоловіків і 81 жінка, у 4 різних спортивних школах і клубах (вік 21,3±3,7 років, ІМТ 21,12±1,56 кг/м2, нормальна ЧСС у спокої), які коли-небудь брали участь у національних змаганнях. Особисті дані збирав асистент-дослідник, тренувальне навантаження реєстрували тренери, тоді як профіль травм підтверджували за допомогою опитувальника Центру досліджень спортивних травм Осло (OSTRC) фахівці з медичної реабілітації, а постуральне дослідження було підтверджене сертифікованим клінічним персоналом за допомогою тесту на перевірку функціональних рухів.

Результати. Частота випадків травматизму (ЧВТ) у чоловіків була вищою з показником 48,5 (95% ДІ: 45,8–51,3) і становила 35,2 травм/1000 годин для жінок, чоловіки мали в 3,1 разу вищий рівень тяжкості, ніж жінки (2,3±1,2) і мали більшу тривалість травм (4,8±2,6 тижнів), ніж у жінок. Контузія давала найвищу ЧВТ на рівні 32,9/1000 годин (36,7%), гематома – на рівні 19,9 травм/1000 годин (95% ДІ: 17,9-23,1), а біль у м'язах – 12,1/1000 годин. Найбільш ушкодженими ділянками були нижні кінцівки з показником 33/1000 годин і верхні кінцівки (26,5%) з показником 5–14 травм/1000 годин. Попередня травма має ефект ризику з у 3,0 рази вищим сприянням отриманню поточної травми, наступними йдуть надмірні тренування. Частим механізмом травм були удар ногою суперника (25%) та нападаючий удар (19%).

Висновки. Частота випадків травматизму (ЧВТ) значно різнилася між статями. Результати підкріплюють дослідження травм, особливо характерних для пенчак-силату, яке може сприяти створенню профілю травм.

Ключові слова: опорно-руховий, травми, локалізація, механізм, пенчак-силат.

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