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<https://ejournal.upi.edu/index.php/penjas/article/view/45402>DOI: <https://doi.org/10.17509/jpjo.v7i2.45402>**Female Athlete Triad (FAT) Screening Using LEAF Questionnaire:
A Cross-Sectional Study in Indonesia Pencak Silat Athletes**Itsna Rosyada^{1*}, Sapta Kunta Purnama¹, Budiyantri Wiboworini²¹Department of Sport Science, Faculty of Sport, Universitas Sebelas Maret, Indonesia²Department of Medicine, Faculty of Medicine, Universitas Sebelas Maret, Indonesia**Article Info***Article History :**Received April 2022**Revised August 2022**Accepted August 2022**Available online September 2022**Keywords :**female athlete triad, injury risk, menstrual disorder, pencak silat***Abstract**

Health information acquired from a health examination or screening is one of the requirements for participating in the Pencak Silat tournament. Unfortunately, the most common health tests cover only vital signs and weight checks. Those tests cannot accurately describe a person's health status, such as digestive and menstrual disorders, common among female athletes due to intensive physical training and the pressure to maintain body weight according to the tournament category. The Female Athlete Triad (FAT) is the name given to this condition. This is the first study to use the LEAF questionnaire to assess the risk of FAT in female Indonesian Pencak Silat athletes. This is an observational study using a cross-sectional design. Data were collected online from 207 participants using a purposive random sampling approach. According to the findings of this study, 53.6% (N = 111) of 207 respondents were at risk of FAT. The risk variables were closely associated with the number of exercise hours per week (P = 0.012) and education level (P = 0.023). The high prevalence of FAT and its high risk indicate the necessity for FAT screening as a requirement for competing in the Pencak Silat tournament and prevention of early osteoporosis and uterine function abnormalities in female Indonesian Pencak Silat athletes. Furthermore, FAT screening on female athletes in all sports is required to prevent the long-term clinical implications of FAT.

INTRODUCTION

Energy deficiency is a condition in which the body lacks energy availability, which occurs when the amount of energy consumed (energy intake or EI) is less than the amount of energy required to exercise (exercise energy expenditure) (Beals, 2013; Brown et al., 2014; De Souza et al., 2019). The American College of Sports Medicine (ACSM) has stated since 1992 that this energy deficit is positively correlated with impaired menstrual function and decreased bone density, a condition known as the "Female Athlete Triad" (FAT) syndrome (De Souza et al., 2014). FAT is a health condition that affects three things: the amount of energy stored, menstrual function, and bone health, all of which occur in stages and are linked across the spectrum. Energy deficiency, whether caused by eating disorders or not, can lead to irregular menstrual cycles (amenorrhea) and decreased bone density/osteoporosis in the long run (de Souza et al., 2014; Joy & Nattiv, 2017; Nazem & Ackerman, 2012; Williams et al., 2019).

FAT is found in sports based on physical endurance (such as marathon running), weight classification (such as boxing, taekwondo, Pencak silat, etc.), and aesthetic sports (such as figure skating, artistic gymnastics, etc.) (Daily & Stumbo, 2018). The presentation of one or more of the three FAT spectrums has clinical implications and impacts the athlete's performance (Beals, 2013; Blauwet et al., 2017; De Souza et al., 2014; Gibbs et al., 2013). Also, FAT has been linked to an increased risk of bone stress injury (Barrack et al., 2014), infertility (Boutari et al., 2020), a pulsatile decrease in the hormones GnRH and LH (Gordon et al., 2017; Loucks & Thuma, 2003), menstrual dysfunction, metabolic disorders, blood disorders, psychological disorders, cardiovascular disorders, and an increased risk of stress urinary incontinence when compared to athletes with adequate energy stores (Ackerman et al., 2019; Carvalhais et al., 2019).

Identifying FAT disorders is difficult because the initial symptoms are not physically visible and difficult to diagnose, particularly the energy deficit assessment, which cannot be measured solely based on body weight or BMI (BMI) (Statuta et al., 2020). The major procedures for establishing this diagnosis of FAT are laboratory-based examinations, such as the use of Dual X-Ray Absorptiometry (DXA) to determine bone density and

other uterine/menstrual function tests. However, early FAT assessment is critical as a preventive measure for the clinical consequences of energy deficits and a supporting tool for decision-making in subsequent examinations. The Low Energy Availability in Females-Questionnaire (LEAF-Q) by Melin et al. is a widely used FAT screening questionnaire that has been validated with a specification of 90 per cent and a sensitivity of 78 per cent (Melin et al., 2014). However, there is still debate about the ability of LEAF-Q to identify FAT thoroughly. Due to a lack of specifications in calculating the amount of energy availability, Appaneal (Appaneal et al., 2021) stated that LEAF-Q can only represent bone disorders and the menstrual cycle, but Sarah (Staal et al., 2018) demonstrated a harmony between low predicted (pRMR) and measured Resting Metabolic Rate (RMR) ratios (mRMR) with a high potential FAT score >8 , indicating LEAF-Q is capable of representing energy deficit among these distinctions, Warrick (Warrick et al., 2020) identified four types of screening, namely LEAF-Q, Triad Consensus Panel screening questionnaire, PPE and PHE IOC. All those types of screening are feasible to use according to their needs, with LEAF-Q and Triad Consensus Panel Screening being more efficient for short screening. In contrast, PPE and PHE IOC are used for comprehensive annual screening. Although more research is needed to determine the effectiveness of the FAT identification questionnaire, it is critical to conduct early detection of FAT, one of which is by using the LEAF-Q questionnaire (Łuszczki et al., 2021a).

Research on FAT screening or energy deficiency using the LEAF questionnaire has been widely studied in various countries (Black et al., n.d.; Drew et al., 2017a; Folscher et al., 2015; Łuszczki et al., 2021b; Sharps et al., 2021; Witkoś et al., 2022), but FAT research is still relatively limited in Indonesia (Dieny et al., 2021; Gita Ayu Rosalinda Ratu Saputri & Fillah Fithra Dieny, 2012; Nugroho & Purwanto, 2020). In addition, no one has ever conducted a large-scale FAT screening study on Indonesian Female Athletes using the LEAF Questionnaire. This lack of literacy about FAT increases the danger of FAT occurring among female athletes in many sports (including Pencak Silat) in Indonesia, which is yet unknown, even though Indonesia has many female athletes and winners.

Also, in much of the previous research, FAT

screening was done manually, but it was done digitally in this study. Therefore the screening process could be more effective and reach many female Pencak Silat athletes from around Indonesia. Thus, this study aimed to find a previously unknown elevated risk of FAT in female Indonesian Pencak Silat athletes and examine the association and odds ratio of the risk variables. As a result, the long-term clinical effects of FAT can be avoided and increased female athletes' knowledge of FAT.

METHODS

This research is a non-experimental/observational research using a cross-sectional design survey method. The survey was conducted online by distributing the LEAF questionnaire to female Pencak Silat athletes in Indonesia via various social media platforms and organizational collaborations. The use of the cross-sectional approach is based on the effectiveness of studies on female athletes, Pencak Silat, which are widespread in all areas of Indonesia in large numbers at the same period. The Ethics Commission of the Faculty of Medicine, Universitas Sebelas Maret, issued this study ethics authorization under the number 109/UN27.06.6.1/KEP/EC/2021.

Participants

Participants in this study complied with the inclusion criteria of female Pencak Silat athletes from the provincial and national levels in Indonesia, aged 12- 18 years old and not presently pregnant. These participant requirements were chosen because Pencak Silat is an original Indonesian sport with female athletes extensively spread throughout Indonesia. It employs a weight classification system as a competition regulation, making it extremely likely to meet energy deficit or FAT. Because peak bone density occurs at maturity, screening in adolescence is necessary as a preventive measure against early osteoporosis. Two hundred seven respondents met these criteria.

Purposive random sampling was used in this study. The minimum sample size is calculated using the Lemeshow formula for an unknown population with a 95% confidence level and a 10% sampling error. According to the calculations, the minimal sample size is 96 respondents. However, according to the distribution of the questionnaire link in this study, 210 respondents

filled out the questionnaire, with 207 meeting the inclusion requirements and three being disqualified due to age. As a result, this survey's total number of respondents was 207.

Instrument

The Low Energy Availability in Female Athletes Questionnaire (LEAF-Q) developed by Melin (Melin et al., 2014) produced 78% sensitivity and 90% specificity to detect FAT used in this research. The systematic assessment utilized is the injury risk category: 0-1 low risk and > 2 high risk; 0-3 low risk and > 4 high risks for menstrual disorders and the use of oral contraceptives; and the overall score category is 8 low-risk FAT > 8 high-risk FAT. The total number of question points is 25. Test the validity of the LEAF-Q questionnaire using the Pearson Product Moment and the reliability test with the Chronbach Alpha formula at a significance level of 0.05. The validity test findings at each point revealed $p < 0.05$, indicating that the questionnaire was valid. The reliability test results showed an $r > 0.60$, indicating that this questionnaire was reliable.

Procedure

Data collection was carried out using a questionnaire from December 2021 to the end of January 2022. The researcher collaborates with the Pencak Silat organization's administrators to disseminate information about hiring participants. Female athletes who met the inclusion criteria were directed to a Google Form link provided by the researcher to complete an Informed Consent form. Following the completion and submission of the Informed Consent form to the researcher, participants were directed to access the link www.its-triaddetector.com, a web-based application containing the Indonesian LEAF questionnaire and educational tools about FAT.

Similar to the English LEAF questionnaire by Melin et al. (2014), this digital Indonesian LEAF questionnaire consists of questions about injury history, gastrointestinal function, oral contraceptives, and menstrual function. The screening scoring system is also the same as the original questionnaire, i.e., scores >2 for high-risk FAT in the history of injury category, >2 for high-risk FAT in the gastrointestinal function category, and >4 for oral contraceptive use and menstrual function. The results of the high-risk FAT screening were obtained if the respondent scored >8 on the entire series

of questions on the LEAF questionnaire.

The findings of this FAT screening will be presented immediately on the respondent's device's screen and saved in the screening history feature, allowing each respondent to observe the progress of each screening performed. In addition, the findings of each screening will be delivered automatically to each respondent's e-mail and the researcher's e-mail, in addition to being shown on the device screen and saved in the screening history feature.

Data Analysis

The collected data were analyzed qualitatively using SPSS version 22 using a univariate test (frequency distribution) to determine the proportion of data and a bivariate test (Chi-Square test) to determine the strength of risk factor relationships. Of the respondents in this study were 207, they were included in the study with a large sample. Therefore, to improve the data presentation, the frequency distribution must be calculated so that the data findings can be more readily understood and studied. Furthermore, the Chi-Square test was utilized to assess the variables connected to the screening findings (high/low risk of FAT with related factors).

RESULT

Partisipant Characteristic

Of the 207 participants, 53.6% (N = 111) were provincial athletes and 46.4% (N = 96) were national athletes, with an academic background ranging from junior high 17.4% (N = 36), senior high 29% (N = 60), and student college 53.6% (N = 111). The average height and weight of the participants were 155 cm and 51 kg, respectively.

FAT Risk Value Based on LEAF-Q

According to the questionnaire results, 92.3% (n = 191) of respondents were at risk of FAT in the injury category, with the most common cases being muscles, tendons, and ligaments (n = 178; 93.2%); 49.3% (n = 102) of respondents were at risk of FAT in the gastrointestinal category with a type of symptoms that does not occur concurrently, and 19.8% (n = 41) were at risk of FAT in the menstrual function category. According to these findings, physical injury is the most common con-

dition female Indonesian Pencak Silat athletes suffer, followed by gastrointestinal illnesses and irregular menstrual cycles (Table 2). However, 15% of respondents (n = 31) reported having a history of menstrual irregularities (primary amenorrhea), and 2.9% (n = 6) had not had menstruation for three months in a row (secondary amenorrhea), indicating clinically significant FAT. Therefore, the percentage of the total risk of FAT in female Indonesian Pencak Silat athletes was 53.6% (N = 111) based on the aggregate value of injury history and gastrointestinal and menstrual function.

Table 1. Partisipant Characteristics

Characteristics	N=207 Mean + SD
Height (Cm)	155.39 + 5.8
Weight (Kg)	51.13 + 7.4
BMI by age	64.44 + 19.8
N (%)	
Age (Years)	
12-13	5 (2.4%)
14-15	63 (30.5%)
16-17	82(39.6%)
18	57 (27.5%)
BMI (Kg/m²)	
Underweight (<18,4)	74 (35.7%)
Normal (18,5-24,9)	132 (63.8 %)
Overwight (25-29.9)	1 (0.5%)
Match Level	
Provincial	111 (53.6%)
National	96 (46.4%)
Education	
Junior High School	36 (17.4%)
Senior High School	60 (29.0%)
College	111 (53.6%)

Risk Factor of FAT

The chi-square test was performed to establish the correlation between risk variables and FAT risk scores using SPSS version 22. The characteristics investigated were the level of competition, education level, age, body mass index (BMI), and exercise hours a week. Hours of exercise (p 0.012) and background education (p 0.023) were the only two risk variables that exhibited a significant correlation (P 0.05) with the risk of FAT. Increased weekly training hours and education level were substantially related to an increased risk of FAT.

Table 2. Result of LEAF-Q

Risk of FAT	Percentage n (%)
History of Injury	
High Risk (score >2)	191 (92.3 %)
Low Risk (score 0-1)	16 (7.7%)
Gasto-intestinal Function	
High Risk (score >2)	102 (49.3%)
Low Risk (score 0-1)	105 (50.7%)
Menstrual Function	
High Risk (score >4)	41 (19.8%)
Low Risk (score <3)	166 (80.2%)
Total Score	
High Risk (score >8)	111 (53.6%)
Low Risk (score <7)	96 (46.4%)
Details of FAT Risk	Percentage n (%)
Injury	
Not at all	16 (7.7%)
Once or twice	144 (69.6%)
3 or 4 times	40 (19.3%)
5 times or more	7 (3.4%)
Kind of Injuries	
Muscle, tendon and ligament	178 (93.2 %)
Bone	13 (6.8 %)
Feeling Gaseous	
Rarely/Never	189 (91.3 %)
1 or twice a week	14 (6.8%)
>3 times a week	4 (1.9%)
Stomach Ache	
Rarely/never	165 (79.7%)
1 or twice a week	39 (18.8%)
>3 times a week	3 (1.45)
Bowel (average)	
Once a day	133 (64.3%)
Several times a day	21 (10.1%)
Every second day	41 (19.8%)
2 times a week	12 (5.8%)
Normal Stool	
Normal/soft	112 (54.1%)
Diarrhoea-like	39 (18.8%)
Hard and dry	56 (27.1%)
Contraceptive Use	
Ever/currently using	0 (0%)
Never	207 (100%)
Age of First Mens	
<11-14 years	174 (84%)
>15 years	31 (15.0%)
Don't remember	2 (1.0%)
Never menstruated	0 (0%)
Stop Mens >3 months	
Never	172 (83.1%)
Ever	29 (14.0%)
Currently	6 (2.9%)
Mens. Changes due to increasing physical exc.	
Yes	118 (57.0%)
No	89 (43.0%)
Changes of mens	
Bleed more	15 (7.2%)
Bleed less	61 (29.5%)
Stop Mens	42 (20.3%)

Table 3. Risk Factor of FAT

Risk Factor	Risk of FAT		N	P.
	(+)	(-)		
Match Level				
Nasional	47	49	96	0.21
Provinsi	64	47	111	
Educational background				
Junior High School	26	10	36	0.02
Senior High School	26	34	60	
Student Collage	59	52	111	
Age (years)				
12	-	-	-	0.12
13	3	2	5	
14	19	6	25	
15	17	21	38	
16	12	15	27	
17	27	29	56	
18	33	23	56	
BMI				
Underweight	41	33	74	0.53
Ideal	70	62	132	
Overweight	0	1	1	
Hours of exercise a week				
<6 hours a week	30	42	72	0.01
>7 hours a week	81	54	135	
Total	111	96	207	

DISCUSSION

History of Injury

Regarding injury history, just 7.7% (N = 16) of the total 207 respondents had never been injured during training or competition. Apart from the hours of practice, this is due to the unique qualities of martial arts tournaments, such as Pencak Silat, which require much physical contact between players. As a result, soft tissue injuries, such as muscles, tendons, and ligaments, are the most common types of injuries (Table 2). Meanwhile, bone injury, one of the three FAT spectrums, had the lowest incidence percentage of 6.3% (N = 13). However, this high injury rate is undoubtedly deleterious to athletes in various ways, from health to financial, due to the higher potential of early retirement due to physical injury (Baihaqi et al., 2021; Syaifei et al., 2020).

Similar research has found that the prevalence of moderate and severe injuries in martial arts is higher than in non-martial arts, with a higher proportion of female athletes injured than males (Abdullah et al., 2020), and that soft tissue injuries are more common

than bone injuries (Keay et al., 2020a, 2020b). The physiological and structural variations between men and women are assumed to alter the physical capacity to adapt to mechanical loads (Drew et al., 2017b; M. L. Mountjoy, 2015), and there is no injury evaluation performed at least four weeks after the exercise dose is raised (Drew & Finch, 2016).

Aerobic capacity (VO₂ Max), blood volume, bone density, and muscle strength are more dominant in males, but body fat percentage and joint flexibility are more dominant in females. Because muscle fibres are smaller in females than males, their muscle mass accounts for 25–40% of total body weight (M. L. Mountjoy, 2015). In addition, the fluctuating levels of the hormone estrogen in women's menstrual cycles are also thought to significantly impact soft tissue strength, muscular function, and proprioception (Shahraki et al., 2020). So, to predict the increase in injuries in female athletes, an examination of the incidence of injury after increasing the training dose is required because match preparation determines the athlete's chances of success when confronting a match (Ray-Smith & Drew, 2016).

Gastrointestinal Disorders

The final result of the FAT assessment's gastrointestinal category revealed that half of the total respondents (49.3%, N=102) were at high risk of FAT. Although not all gastrointestinal illnesses occur simultaneously, the presence of several conditions might be interpreted as a high risk of FAT. The LEAF questionnaire analyzed gastrointestinal issues such as the frequency of abdominal pain, flatulence, the frequency of bowel movements that were either too infrequent or too frequent, and the shape of the stool was not normal. In this survey, 21 respondents (10.1%) reported defecating many times per day, 41 respondents (19.8%) reported defecating every two days, and 12 respondents (5.8%) reported defecating twice a week.

Athletes' gastrointestinal issues are caused by various factors, including daily fibre intake, food consumed, stress levels, and changes in vagal tone caused by increased physical activity (van Houten et al., 2015a). As long as the body is in a state of exertion, parasympathetic activation mechanisms will reduce gastrointestinal performance to near nil. High-intensity physical activity or a fast increase in activity without appropriate rest can reduce vagal activity at rest and interfere with proper intestinal permeability. As a re-

sult, athletes who have an imbalance in their eating, resting, and physical activity are more likely to have signs of these gastrointestinal illnesses, such as irregular bowel movements, soft or hard stools, and frequent feelings of bloating or stomach pain (Diduch, 2017; van Houten et al., 2015b).

Menstrual Disorders

The menstrual assessment results show that 0% of respondents have never had menstruation, 174 respondents had menstruation in the typical age range (11–13 years), and all respondents do not utilize contraception to stimulate their first period (table 2). Suppose the respondent is a pre-adolescent athlete under 11. In that case, several interpretations are conceivable because the LEAF questionnaire assigns a score of 8 to female athletes who state that they have not had menstruation. So, in this context, the efficacy of employing LEAF-Q on pre-adolescent athletes or girls needs to be investigated further.

As many as 15% (N = 31) of respondents had their first menstruation when they were over 15 (primary amenorrhea). However, they did not utilize contraception to cause their first menstruation. This is in stark contrast to most female athletes outside of Indonesia, who frequently use contraception to regulate the menstrual cycle (Larsen et al., 2020a; Schaumberg et al., 2013; Statham, 2020). Regarding menstruation frequency in the previous year, 39 respondents (18.8%) reported having their last menstrual period 2-3 months ago, while nine respondents (4.3%) reported having their last menstrual period 1-2 months ago. Of the 39 respondents who had menstruation 2-3 months ago, six were experiencing menstrual cessation for more than three consecutive months (secondary amenorrhea), 29 had previously experienced cessation of menstruation for more than three months, and the rest had never stopped menstruating for more than three months. Three months in a row.

The regularity of menstruation is something that coaches rarely consider with their athletes, especially if the coach is male (Pantano, 2017). This is due to apprehension about asking more questions about topics that are considered taboo to talk about with the opposite sex (such as menstruation), as well as the assumption that the absence of a menstrual cycle throughout the match preparation phase is a natural and normal occurrence (Larsen et al., 2020b). Furthermore, many coaches are

unaware that menstrual cycle irregularities, whether caused by excessive physical activity or eating disorders, might impact an athlete's bone health (Pantano, 2017). Excessive physical activity reduces the frequency of menstruation for a year and affects the quality of menstrual bleeding in a single cycle. When the degree of the exercise was increased, 118 respondents (57%) reported a change in the quality of menstrual bleeding, with 42 respondents (20.3%) stopping menstruation and 61 respondents (29.5%) experiencing less bleeding. Furthermore, 19.8% of high-risk FAT respondents (N=41) and 80.2% of low-risk (N=166) were identified from the entire FAT screening questions for oral contraceptive use and menstrual function. As a result, 53.6% of Indonesian Pencak Silat female athletes have a high risk of FAT (N = 111), and 46.4% have a low risk of FAT (N = 96).

Weekday Training Hours and Educational Background as a Dominant Risk Factor

The duration of training hours per week and level of education were the risk factors that exhibited a strong link with the results of the FAT screening score in this study, but age, level of competition, and BMI did not. BMI is not a definite marker of energy deficit in identifying FAT. However, adolescents with a BMI of 17.5 kg or 85% of expected body weight or weight loss of 10% of initial body weight can be an early indication of an energy deficit (Melin et al., 2014; M. Mountjoy et al., 2018; Tenforde et al., 2017). A study of a young non-athlete population (55 years old) found no association between body weight and bone density levels, which is assumed to be attributable to a lack of enough estrogen (Cherukuri et al., 2021). This is why it is difficult for coaches and health teams to screen athletes with an energy deficit/FAT in plain sight, especially if they have an average body appearance and good competition performance.

This is why it is difficult for coaches and health teams to screen athletes with an energy deficit/FAT in plain sight, especially if they have a normal body appearance and good competition performance. Tosi et al. (Tosi et al., 2019) discovered that young adult athletes (18–25 years) are more at risk of FAT than teenage athletes (12–18 years) when it comes to the age factor for the risk of energy shortage and FAT. According to him, more young adult athletes are away from parental care (due to education or other reasons). Therefore their eat-

ing habits are less than optimal compared to adolescent athletes who receive adequate parental attention. The age component did not demonstrate a substantial link with the FAT risk value (p. 0.129) in this study because the majority of the respondents were in their teens (table 1), but the level of education did (p 0.028).

Aside from age and BMI, another characteristic that did not show to be associated with the incidence of FAT was the level of the match (p. 0.211). This might be attributed to a lack of understanding of daily energy requirements, which each individual should be aware of (Headrick et al., 2013). Athletes at provincial and national levels frequently do not understand the quantity of calorie intake and energy expenditure required by their bodies. This understanding of the importance of daily energy intake and expenditure will make it easier for coaches and the health staff to maintain a consistent energy supply for each athlete and raise awareness of energy insufficiency before and after the match.

Finally, the number of hours of physical exercise per week was significantly linked with an elevated risk of FAT (p. 0.012). Giving exercise doses that are not by the athlete's initial physical capacity, managing the athlete's inability to gradually increase exercise doses, the athlete's lack of knowledge about the amount of calorie intake and exercise energy expenditure, and a lack of attention to diet patterns to regulate body weight are all fundamental things that are not well applied. Suppose the understanding of FAT among athletes and coaches at the provincial or national level has increased. In that case, the assessment of the relationship between these factors and the results of the FAT risk score may alter. Even though it is only confined to screening that distinguishes high-risk athletes from those with low FAT, the LEAF-Q questionnaire was consistent with manual energy calculations using the answers from the LEAF-Q questionnaire screening (Jurov et al., 2020).

CONCLUSION

According to the findings of this study, the risk of FAT in female Indonesian Pencak Silat athletes is 53.6%, with weekly activity hours being the most important risk factor (p. 0.012). This study's findings are not a major clinical diagnosis but rather an early detection for mapping female athletes at high or low risk of FAT. Continuous monitoring is still required to have a

clear image of the FAT status of Indonesian Pencak Silat female athletes, and FAT screening must be done routinely.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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