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EDUCATION AND LEARNING IN BIOMECHANICS: ENHANCING ATHLETES' CONFIDENCE THROUGH Q-ANGLE INTERVENTION

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Abstract. Futsal's popularity is growing, with over 12 million registered players globally, including a rising number of female players. Despite its growth, futsal poses significant injury risks, especially to the lower extremities, which can impact athletes' performance and self-efficacy. This study aims to explore the effect between the knee Q-angle intervention on self-efficacy in professional female futsal players. This observational and correlational study involved 11 athletes from the professional futsal club Muara Enim United in Indonesia. The procedure of this study participants trained regularly for at least 2 hours per week and were excluded if injured or had prior lower extremity surgery. The study measured Q-angles and self-efficacy using the Athlete Self-Efficacy Scale before and after league matches over 14 days. Data were analyzed using paired sample t-tests to assess changes in self-efficacy. Normality tests confirmed that pretest and posttest data were normally distributed. Descriptive statistics indicated a mean pretest score of 43.33 and a posttest score of 36.31. Paired sample t-tests revealed a significant decrease in self-efficacy post-intervention ($p=0.017$). The significant reduction in posttest scores suggests the intervention was less effective in enhancing self-efficacy. This decline highlights the need for improved intervention strategies to bolster self-efficacy in female futsal athletes. Self-efficacy is crucial for performance and injury management, as it influences motivation, stress management, and persistence in athletes. This study underscores the necessity for rigorous evaluation of interventions aimed at improving self-efficacy among professional female futsal players. Understanding the relationship between the knee Q-angle and self-efficacy can inform the development of better training and injury prevention programs, ultimately enhancing athletes' well-being and performance. Future research should address external variables and use larger sample sizes to validate these findings.

Keywords: Futsal, Self-Efficacy, Q-Angle, Injury Prevention, Female Athletes, Sports Psychology

I. INTRODUCTION

Futsal has become one of the most popular team sports in the world, with over 12 million registered players across more than 100 countries (Amin, Wahyuri, Irawan, Welis, & Oekta, 2023; Iqbal et al., 2024; Kurniawan et al., 2024; Oktadinata et al., 2024). This is reflected in the performance levels of both men and women (Amin, Wahyuri, Irawan, Welis, Gusni, et al., 2023a; Insani et al., 2024b; Karisman et al., 2024; Safitri et al., 2024). In the last few decades, futsal has increased in many Asian countries, such as Iran, Japan and Kuwait. Futsal is also the fastest growing indoor sport in the world (Al Zaki et al., 2023; R. R. Illahi et al., 2023; Likardo et al., 2023; Rambe et al., 2024). In Indonesia, women's futsal has been steadily

rising, achieving a world ranking of 14 (*FIFA Launches FIFA Futsal World Ranking*, 2024). Specifically, women's futsal has garnered increasing attention in global media, and investment in this modality has been enhanced across all international confederations (Alnedral et al., 2024; Hidayat et al., 2024; Oekta et al., 2024; Triani et al., 2023; Umar et al., 2023). There has been an expansion in women's futsal, evidenced by the creation of championships, leagues, national teams, and federation clubs (Amin, Wahyuri, Irawan, Welis, Gusni, et al., 2023b; Atradinal & Oekta, 2024; Chinta et al., 2024; Hadinata et al., 2024). Elite-level futsal competition demands players to face intense physical challenges, such as sudden accelerations, decelerations, tackles, kicks, and rapid changes in direction, which increase the risk of injury, particularly in

collision situations with other players (Arabi & Piert, 2010) (Doğramacı & Watsford, 2006) (Barbero-Alvarez et al., 2008). The presence of intermittent high-intensity motor actions (kicks, jumps and sprints) means that physical strength and speed are extensively evaluated and trained in the preparation of athletes in this modality (Ferdian et al., 2023; R. F. Illahi et al., 2024; Pranoto et al., 2024; Purwanto & Ockta, 2024).

With unique characteristics such as unlimited player substitutions and a smaller playing field, futsal maintains a high rhythm and intensity throughout the match, placing greater physical demands on futsal players compared to athletes in other team sports (Barbero-Alvarez et al., 2008) (Junge & Dvorak, 2010). The narrow space of the futsal field makes the transition from attack to defence and from defence to attack extremely fast allowing each player to master attacking and defending (Fitri et al., 2021). The injury rate, reaching 44.9 and 10.3 injuries per 1000 match hours for male and female players respectively, makes futsal a high-risk sport for injuries (Ruiz-Pérez et al., 2023). The majority of these injuries tend to occur in soft tissues through non-contact mechanisms, primarily affecting the lower extremities (Ruiz-Pérez et al., 2023). Additionally, this overload can lead to lower extremity injuries, such as those occurring at the tibial tubercle (Rössler et al., 2016) and the anterior inferior iliac spine (ASIS) (Gudelis et al., 2022). Misalignment of the lower extremities can be measured using the Q-angle (Bottaro, Larsen & Madhur, 2008).

The Q-angle is measured by assessing the axis between the ASIS and the center of the patella, as well as the axis of the patellar tendon and the tibial tuberosity (Saki et al., 2021). Futsal training can influence this angle in subjects during their growth phase, with evidence showing differences in this angle between athletic and non-athletic adolescents (Orlandi et al., 1998). Observing the joints that make up the knee terms, the patellofemoral joint is susceptible to suffer a higher rate of injuries of mechanical origin, affecting mainly women, in approximately 58%. Because of this, the lateral force on the patella can be changed according to two characteristics: hips slightly wider in relation to height (characteristic in women) and the femur in medial rotation position (Alvares et al., 2024). The impact of high injury rates can have negative short-term and long-term consequences for futsal players and their team's performance (Drew et al., 2017; Häggglund et al., 2013; Podlog et al., 2015). Therefore, a primary goal for futsal practitioners is to design specialized training programs aimed at reducing the risk of injury or minimizing its severity, with the hope of enhancing team success (Woods et al., 2004).

In the world of elite sports, maintaining long-term health in an industry that heavily emphasizes consistent performance optimization is a complex and often contradictory challenge (Everard et al., 2021)(Theberge, 2008). In this context, injuries pose a significant threat to an athlete's career success. The impact of injuries can range from minor to life-altering, and from quickly resolved to chronic conditions. The origins of these injuries can vary from overuse to a single wrong move during training or competition (López-Valenciano et al., 2020). Injuries can also play a crucial role in an athlete's decision to retire from sports (Budiman & Ockta, 2024;

Pitnawati et al., 2023; Ramadaniaty et al., 2024; Sasmita et al., 2023).

One factor that can lead to undesirable outcomes in sports is the concern about injuries, especially in contact sports like futsal. However, there are several strategies that can be implemented to address this concern, such as enhancing self-efficacy (Zulkarnaen, 2013). Research shows that individuals with high self-efficacy take responsibility for their actions and believe that many aspects of their lives depend on their decisions and actions. In contrast, individuals with low self-efficacy attribute their failures to external circumstances (Alvares et al., 2024). Self-efficacy plays a crucial role in optimizing one's potential, and one aspect of life influenced by self-efficacy is achievement (Febriani et al., 2024; Insani et al., 2024c; Nusri et al., 2024; Sari et al., 2024; Ulfani et al., 2024). The role of self-efficacy in injury has recently been examined and is the focus of this research (Sordoni et al., 2000) (Milne et al., 2005). Self-efficacy is defined as an individual's belief in their ability to perform tasks effectively and is considered to play a significant and prominent role in various aspects of human behavior (Bandura, 1998). Self-efficacy has been widely studied in sport psychology research (Escarti & Guzman, 1999) (Escarti & Guzman, 1999). Higher levels of self-efficacy are associated with increased pain tolerance and pain management (Escarti & Guzman, 1999).

Previous research has only used male subjects as the sample, and it is hoped that future studies will include female samples (Adrizal et al., 2024; Haris et al., 2024; Insani et al., 2024a; Khani et al., 2024; Ockta & Hardiansyah, 2023; Revalina et al., 2024). Women have a different hip posture, being wider than men, which results in a larger Q-angle in women. Women typically have a Q-angle that is 2.0° to 8.5° greater than that of men (Grelsamer et al., 2005) (Sharma et al., 2023). By combining biomechanical and psychological aspects, this study aims to contribute significantly to the understanding of the relationship between the knee Q-angle, injury assessment, and self-efficacy in professional female futsal athletes. The results of this study are expected to provide a scientific basis for developing more effective training programs and injury prevention strategies, while also enhancing the understanding of factors that can motivate and increase the self-efficacy of female futsal athletes in facing competitive challenges.

II. METHODS

This research was designed as an observational and correlational study to evaluate the relationship between the observed variables, including the Q-angle in athletes of the professional futsal club Muara Enim United. The study involves measuring the Q-angle and completing a self-efficacy questionnaire by all subjects before and after their participation in the league matches. Measurements were taken from the pre-season to the start of the season, with a total study duration of 14 days. Data were analyzed to evaluate whether there was a correlation between the Q-angle and the level of self-efficacy and whether other factors influenced these variables.

The study involved 11 athletes from the professional futsal club Muara Enim United (Indonesia). As an inclusion criterion, participants were required to train regularly for at least 2 hours per week. Subjects who were injured at the time of the study or had undergone surgery on their lower extremities were excluded from the study (Noon et al., 2018). All subjects and their legal representatives in the case of minors were informed verbally and in writing about the nature of the study. All athletes and their legal representatives who agreed to participate signed consent forms, and authorization was obtained for the use of data and images in this research.

The participants had an average age of 24.2 years, with ages ranging from 21 to 31 years. Their average height was 1.55 meters, ranging from 1.50 to 1.63 meters, and their average weight was 56.1 kilograms, ranging from 48 to 80 kilograms. The players occupied various positions on the team: Flank (6 players), Goalkeeper (2 players), Anchor (2 players), and Pivot (1 player). Their years of training varied widely, with an average of 8 years and a range from 4 to 13 years. The Q-angle measurements for the participants were as follows: 21.6°, 29.5°, 23°, 26.6°, 36.2°, 25.2°, 21.1°, 12.3°, 22.9°, 24°, and 23.3°.

All participants completed the Athlete Self-Efficacy Scale questionnaire (Koçak, 2020). All athletes agreed to the use of their data and images in this study. Weight and height were measured before photos were taken for the Q-angle measurement. A calibrated digital scale (SECA® 861, Vogel and Halke, Hamburg, Germany) was used to measure weight, and a wall-mounted stadiometer (SECA® 222, Vogel and Halke, Hamburg, Germany) was used to measure height. For the photo session, three reflective stickers, each with a diameter of 15 mm, were placed at each athlete's lower limb at the following locations: one on the ASIS, one on the center of the patella, and one on the anterior tibial tuberosity (Andica et al., 2024; Apriady et al., 2024; Arfi et al., 2024; Ismail et al., 2024; Yuliana et al., 2023). All athletes agreed to the use of their data and images in this study. Weight and height were measured before photos were taken for the Q-angle measurement. A calibrated digital scale (SECA® 861, Vogel and Halke, Hamburg, Germany) was used to measure weight, and a wall-mounted stadiometer (SECA® 222, Vogel and Halke, Hamburg, Germany) was used to measure height. For the photo session, three reflective stickers, each with a diameter of 15 mm, were placed at each athlete's lower limb at the following locations: one on the ASIS, one on the center of the patella, and one on the anterior tibial tuberosity (Ashnagar et al., 2017). The camera was set 3 meters from the subject on a tripod at a height of 80 cm and calibrated with a bubble level. The camera's vertical axis was aligned with the midpoint between the participant's lower limbs. The images were zoomed in to the closest capture so that the stickers were clearly visible and always set in the same position. The data were then exported to a computer for digital Q-angle measurement using KINOVEA® software. To determine inter-rater reliability, two independent evaluators analyzed the same photo of each participant. Intra-rater reliability was calculated by having one evaluator measure two photos of each participant. The procedure was based on previous

research (Febryani et al., 2024; Hambali et al., 2024; Safitri et al., 2023; Sepriani et al., 2024). The results were communicated to all players. After undergoing matches, players who met the criteria indicating a risk of injury completed the Athlete Self-Efficacy Scale questionnaire (Koçak, 2020). The study was conducted from pre-season to early season.

Data are presented as mean ± standard deviation for continuous variables. The Shapiro-Wilk test was performed to assess the normality of the distribution and all variables displayed normal data. The mean difference between groups in baseline and post-tests was assessed with an independent sample t-test to examine group differences. A paired sample t-test was used to identify significant differences within the groups' baseline and post-tests.

Based on the table above, for motivational climate X (males) and mental health X (males), they have the same Pearson correlation value and sig, which are -0.042 and 0.859 respectively. Meanwhile, for motivational climate Y (females) and mental health Y (females), they also have the same Pearson correlation value and sig, which are -0.326 and 0.160 respectively. Motivational climate X and mental health X have a Pearson correlation of -0.042, thus it can be concluded that these variables do not have a correlation relationship. Whereas for motivational climate Y and mental health Y, they have a Pearson correlation value of -0.326, indicating a weak correlation between these variables. A positive value indicates that the higher the motivational climate, the higher the mental health, and vice versa, while a negative value indicates that the higher the motivational climate, the lower the mental health, and vice versa. The sig value for both motivational climate and mental health, for both X and Y, is greater than 0.05. Thus, it can be concluded that these variables do not have a correlation relationship based on the sig value.

III. RESULT AND DISCUSSION

The pretest and posttest data are normally distributed. This is evidenced by the Sig. values for pretest being 0.623 and for posttest being 0.405, both of which are greater than 0.05, suggesting that the data do not deviate from a normal distribution.

Table 1. Paired Samples Statistics

	Mean	N	Std. deviation	Std. Error Mean
pretest	43.33	11	11.624	3.504
posttest	36.31	11	7.688	2.318

Table 1. Paired Samples Statistics provides descriptive statistics for pretest and posttest. The mean value for pretest is 43.33 with a standard deviation of 11.624 and a standard error mean of 3.504. Meanwhile, the mean value for posttest is 36.31 with a standard deviation of 7.688 and a standard error mean of 2.318.

Table 2. Paired Sample Test

	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pretest – posttest	7.022	8.191	2.843	10	.017

Table 2. Paired Sample Test shows the results of the paired t-test comparing the pretest and posttest values. The mean difference between pretest and posttest is 7.022 with a standard deviation of 8.191. The obtained t-value is 2.843 with a degree of freedom (df) of 10. The significance value (2-tailed) is 0.017, which is less than 0.05, indicating that there is a significant difference between the pretest and posttest values.

IV. CONCLUSION

Overall, this study shows a significant decrease in posttest scores compared to pretest scores after the intervention. This indicates that the intervention may have been less effective in enhancing the self-efficacy of professional female futsal players in facing injury risks (Jamil et al., 2024; Martati et al., 2024; Noepratomo et al., 2024). These results underscore the importance of careful evaluation of intervention effectiveness and highlight the need for further research to understand the factors contributing to these outcomes. This research aims to significantly contribute to understanding the relationship between the knee Q-angle as an injury review and self-efficacy in professional female futsal athletes. The results of this study are expected to provide a scientific foundation for developing more effective training programs and injury prevention strategies, as well as to enhance understanding of the factors that can motivate and increase the self-efficacy of female futsal players in facing competitive challenges (Darajat et al., 2024; Sabillah et al., 2024; Saputra et al., 2025). Thus, this effort is expected to help improve the well-being and performance of female futsal athletes and reduce the risk of injuries that may occur during matches.

Future research should aim to explore the underlying factors that may influence the effectiveness of interventions on self-efficacy in professional female futsal players. This includes investigating the role of psychological conditions, coaching styles, and the overall training environment. Additionally, studies with larger sample sizes and diverse populations will be essential to increase the generalizability of findings. Research could also benefit from longitudinal designs to track changes in self-efficacy and injury rates over time, providing deeper insights into the long-term impacts of various interventions. Exploring technological advancements, such as wearable sensors and data analytics, could also offer innovative approaches to monitoring and enhancing athlete performance and injury prevention. Ultimately, a multidisciplinary approach integrating physical, psychological, and technological factors will be crucial in developing comprehensive strategies to support the health and success of female futsal players.

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