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Analysis of Plantar Pressure Based on Injury Recovery for Physical Fitness

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ABSTRACT

The study investigates how plantar pressure distribution during walking can inform injury prevention and recovery strategies among footballers. Given soccer's high injury risk, the research emphasizes using modern computer based pressure analysis to assess foot stress patterns unique to individual athletes. By integrating this data into motion models, the study aims to offer personalized, evidence based recommendations to reduce overtraining and enhance rehabilitation.

The methodology involved collecting gait data from football players and non athlete college students using the RSCAN gait analysis system. The gait cycle was divided into four phases, with findings showing that footballers spend significantly more time in the initial contact and full foot support phases 88% of the cycle than students. This prolonged forefoot contact is associated with increased stress and an increased risk of injury, particularly among players with prior ankle injuries, who exhibit reduced protective gait adaptations.

Results from real time data collection on 300 athletes demonstrate the model's efficiency in processing foot pressure data quickly (under 2 seconds), validating its potential for practical use in training environments. The study concludes that plantar pressure analysis is a reliable predictor of injury severity and a valuable tool for tailoring recovery protocols. It underscores the need for large scale, ethnically representative datasets to refine injury prevention strategies and to support the professional development of football in China.

Keywords: Plantar Pressure, Injury Recovery, Gait Analysis, Footballers, Foot Stress, Motion Modelling, Physical Fitness

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1. Introduction

Soccer ranks among the most widely played yet high risk sports worldwide [1]. In soccer, players must adequately prepare for this demanding sport, as they are prone to injury. Using modern computer technology, the distribution of foot pressure during walking by soccer players can be examined [2]. By analyzing the plantar pressure distribution of athletes during their walks, it becomes feasible to preemptively safeguard players' feet based on individual data unique to each athlete, ensuring a longer sports career for soccer players. This approach offers athletes a safe and effective training strategy [3].

Examining the plantar pressure distribution in soccer players while walking can help avert injuries before training and provide a clinical estimate of recovery duration [4]. Data on foot stress distribution in players will be integrated into a motion model for appropriate data collection [5], and, using a systematic and rational analysis method, professional recommendations can be made for those who are overtraining. Implementing this strategy would enhance the injury treatment process and significantly foster the growth of soccer in China.

2. Literature Review

The plantar structures and functions of soccer players can be assessed by reviewing plantar pressure distribution during walking [6]. The physiological and pathological traits of athletes can also be examined, allowing for a thorough evaluation of their physical condition through various data analyses. The support ratio for soccer players may shift during extended periods of physical training [7]. This means that the duration of foot-ground contact and the time of lift-off can help protect the front of the foot. At present, the analysis of foot pressure in our country is relatively underdeveloped, lacking adequate large scale datasets for evaluating soccer players' foot pressure [8]. Variations in plantar pressure differ among ethnic groups. Therefore, pressure analysis during walking should be founded on extensive data collection [9]. Consequently, it is essential to gather sufficient data to analyze detailed, gradual pressure metrics for a better assessment of soccer players. A connection between soccer players' training regimens and foot pressure analysis has been established, revealing fundamental correlations within this framework [10]. The model developed in this manner is well-suited, although the data may be challenging to process.

2.1 Injury Recovery and Prevention in Physical Fitness

Injury recovery in physical fitness is a complex process that encompasses physical rehabilitation, psychological preparedness, and the influence of pre-injury fitness levels. Modern research emphasises the necessity of an integrated biopsychosocial approach that considers not only physiological healing but also emotional health and social support.

2.11. The Role of Pre-Injury Fitness and Training Load

Pre-injury physical fitness significantly influences recovery outcomes. For instance, a study of 102 patients found that individuals with medium to high pre-injury fitness levels experienced better recovery from whiplash injuries [11] Similarly, better aerobic fitness has been associated with a reduced risk of injury. However, the evidence remains limited [12] .

Moreover, appropriately graded high training loads can enhance physical resilience, minimise injury risk, and improve performance in competitive settings [13]

2.12 Physical Rehabilitation and Injury Management

Effective rehabilitation is essential for restoring optimal form and function following sports related injuries. Early intervention, coupled with a phased approach including immobilization, restoration of range of motion, strength rebuilding, and a structured return to activity is critical for minimizing reinjury and ensuring full recovery [14]. Integrating rehabilitation with complementary therapies further enhances outcomes and supports long term functional integrity.

2.13 Psychological and Psychosocial Dimensions

Psychological readiness plays a pivotal role in injury recovery. Psychosocial interventions have been shown to foster positive emotional states and improve adherence to rehabilitation protocols, as demonstrated in a systematic review of eight studies [15]. Social support also significantly bolsters athletes' motivation and capacity to manage psychological distress during recovery [16]. In line with this, Kraus [17] proposes conceptualizing rehabilitation as a sport-like process, emphasizing goal setting, discipline, and mental engagement.

2.14 Barriers and Realities of Post-Injury Recovery

Despite the availability of evidence based strategies, adherence to rehabilitation programs remains a critical challenge [18] (Fisher, n.d.). Real world data reveal that 55% of individuals report reduced physical activity three months post-injury, with recovery influenced by factors such as living situation, injury type, and post-injury health status [19]. Notably, even when positive attitudes toward injury prevention exist as in camogie, where coaches and players express support actual implementation of prevention programs remains low (34% of coaches and 11.8% of players), according to a cross-sectional survey [20].

2.15 Integrated Frameworks for Recovery and Prevention

Recent scholarship advocates for holistic frameworks that combine physical rehabilitation, psychological resilience, and nutritional support to minimize injury recurrence and enhance long term athletic performance [21]. Such comprehensive models are grounded in theoretical and empirical research and aim to address the full spectrum of factors affecting injury outcomes [22]

This restructured synthesis presents a more straightforward narrative that moves from individual factors (fitness, psychology) to systemic approaches (rehab protocols, prevention programs), emphasizing the interconnectedness of physical, mental, and social elements in injury recovery.

3. Methodology

3.1 Analysis of Plantar Pressure Distribution of Football Players During Walking

Before analyzing the foot pressure distribution of soccer players, foundational data from Asian foot analysis must be collected, requiring information from pressure measurement devices. Initially, it is crucial to compare data from soccer players with that from students without a training background. The data collection process is outlined as follows.:

State sequence:

$$FS = \{RS, LS, DS, \phi, Err\} \qquad (1)$$

In this formula, RS and LS denote that only the right (left) foot is in contact with the ground. At the same time, DS indicates that both feet are in contact, signifying jumping (without foot contact), and Err accounts for non-synchronous movement. *Si* (*k*) represents the *K* element of this sequence. Algebraic relationships illustrate the two modes of motion mixing. The method of foot stress analysis is depicted in Figure 1 below:

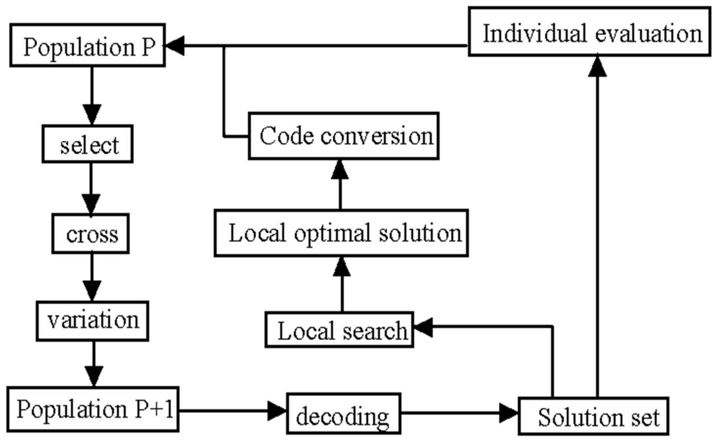

Figure 1. Plantar pressure distribution of football players during walking

Furthermore, following a sports-related injury, the duration of recovery and healing was assessed clinically. By integrating the foot stress distribution data commonly utilized by football players into the motion model, this mathematical relationship adheres to the following principles: DS acts as a neutral element, possessing the lowest priority and can be influenced by any movement; in contrast, regardless of other movements, it presents a jump; it encompasses all activities and various forms of athletic endeavors, while Err primarily pertains to a specific subset..

$$\{RS, LS, DS\} \quad (2)$$

$$\forall k, \quad S_1(k) \oplus S_2(k) \neq Err \quad (3)$$

An error arises when the movements are misaligned; LS and RS are mutually exclusive and cannot coexist. Based on the commutativity of algebraic relations, the essential and sufficient prerequisite for the synchronization of *A*1 and *A*2 requires two distinct computers, Alpha and Beta, to develop the model so that the two systems can interchange the file in a connected manner. They employ a data synchronization algorithm grounded in *DeDupe* technology. In the process design, the *Rsync* model system is initiated. According to the amalgamation of algebraic relations, *nA* sequences can be articulated as the essential and sufficient conditions for synchronizing *nA* actions based on the aforementioned equations. LS and RS are mutually exclusive and cannot coexist. In accordance with the commutativity of algebraic relations, the essential and sufficient prerequisite for synchronizing *A*1 and *A*2 necessitates the use of two separate computers, Alpha and Beta, to construct the model, allowing for file sharing in an interconnected manner. They utilize a data synchronization algorithm based on *DeDupe* technology. The *Rsync* model system is integrated into the process design. Based on the combination of algebraic relations, *nA* sequences can be articulated based on the two previous equations, representing the necessary and sufficient conditions for the synchronization of *nA*.

$$\forall k, \bigoplus_{\varepsilon\{1, n\}} S_i(k) \neq Err \qquad (4)$$

Only while gathering data does it conform to the equation. In studying plantar pressure, injuries among football players can be recognized for foot examination. It is believed that Delta (X) denotes the variance vector of the motion vector set X for footballers' foot stress analysis. The subsequent equation can be derived:

$$\delta(X) = \frac{1}{2}\sum_{n-1}^{N}\left[X_n(i) - X(i)\right]^2 \qquad (5)$$

The ratio of support will fluctuate for football athletes throughout extended periods of physical training. In other words, the duration of the foot's contact with the ground and the time for takeoff can be crucial for football players in safeguarding the front part of their feet. The physical condition can be accurately predicted from the gait cycle during typical walking. Upon completing the above calculations, X represents the weight value of each index table. A consistency verification of the data is performed, and the reliability formula is analyzed in the following manner:

$$CR = C_{in} / R_{IN} \qquad (6)$$

The aforementioned form CIN serves as the evaluation metric for the n-order judgment matrix; RIN is the consistency index derived from the N-countdown reciprocal matrix. It can be determined that the evaluation aligns with the real situation, and the precision of the outcomes can be assessed through the analysis; on the other hand, if the evaluation level is inadequate, the model may require further revision. The soccer foot stress analysis model utilizes the optimal vector for data selection and research focus. The cost function for the influencing factors is applied in the following equation:

$$H(V_{sf}) = \sum_{p-1}^{d/2} \delta_{sf}(X)(P) \qquad (7)$$

In summary, the interrelation among factors that influence foot injuries is optimized in the analysis of foot stress distribution among football players. Thus, based on foot-stress analysis of football athletes, a comprehensive assessment of their physical condition is conducted. To conclude, the factors impacting athletes' foot injuries necessitate complex calculations. The group method identifies the optimal vector wavelet kernels that influence the risk factors for foot injuries among football players. It conducts relevant data collection on the pressure across various regions. Coupled with rigorous scientific analytical techniques, professional guidance will be provided to football players, thereby significantly advancing football development in China.

3.2 Influence of Plantar Pressure Distribution of Football Players on Walking

The gait analysis system was tested using RSCAN by the Belgian Forster company. The runway was set up on both sides of the force plate during testing. Subjects removed their shoes and socks, thereby allowing collection of the entire gait-support duration while walking normally. Each individual was tested three times, with averages taken. As per relevant literature, the complete gait support duration is divided into four phases: the initial stage (time stage 1), the forefoot contact phase (time stage 2), the foot contact phase (time stage 3), and the ground phase (4). In conjunction with the experimental design, four gait supports during normal walking were chosen as the research targets. Specific time values for each phase and the percentage of the support duration were selected as the analysis indices. A single-factor analysis of variance was conducted among the various groups, with data analysis carried out using SPSS20.0 statistical software. Throughout the entire gait cycle, the most significant portion of the football players' support phase occurs during the initial stage (time 4), followed by the full contact phase (time 3); together, these account for 88% of the entire gait support cycle, representing the highest proportion of the support cycle. The contact stage for college students (3) is noted in the gait cycle, with the second stage being the ground-to-ground phase (4); these two stages account for approximately 92% of the total supporting duration. The durations of both the complete contact phase and the ground departure stage have been previously illustrated. Consequently, the longer football players maintain contact with the ground, the greater the force they exert. Increased duration of pressure correlates to heightened stress on the forefoot. An examination of ground based gait characteristics and foot pressure distribution suggests potential risks in the forelimb region, prolonged contact times, and emphasizes the need for enhanced protection for the forefoot. A phased analysis is depicted in the given Figure two:

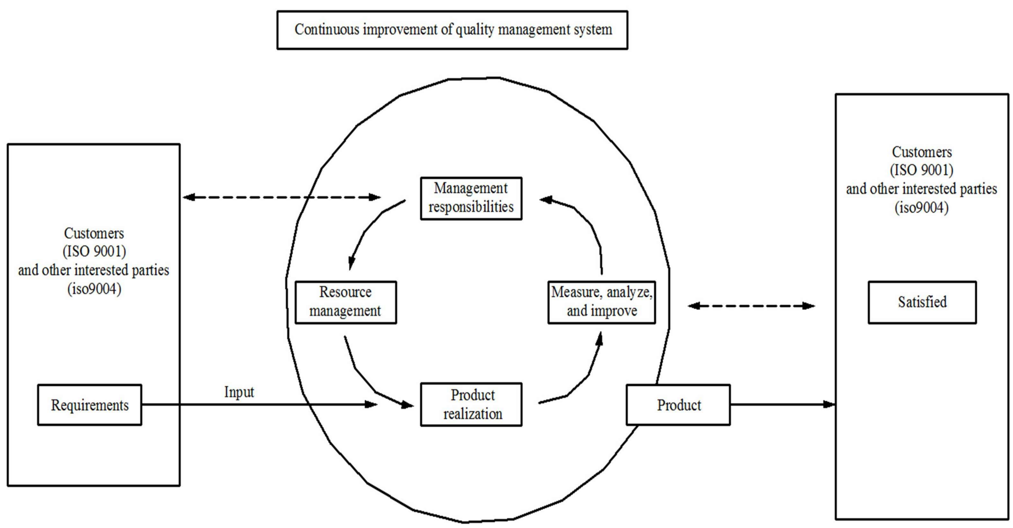

Figure 2. Plantar pressure distribution of football players during walking

Thus, during regular walking, the contact duration of the forefoot is minimized. The self-protection capability is notably effective. In a study analyzing foot stress in young footballers who have sustained recurrent ankle injuries, Zhou Junjie observed that players with repeated ankle injuries exhibited extended front foot contact and shortened ankle bracing time, indicating a diminishing protective response from footballers following multiple ankle injuries. The conclusion highlights the clinical significance of preventing ankle injuries among football players. When comparing the time spent at each stage during the gait support period between football players and college students, only the duration of the foot contact phase (phase 3) differs significantly. A comparison of the timing of each phase with the percentage of the support period revealed notable differences between the foot contact phase (third stage) and the departure stage (time 4).

An analysis of the application proportions and values of both methods indicated discrepancies in application duration. The value ratio relative to the gait support period helps eliminate errors caused by individual variation and accurately reflects changes in time based indicators. The analysis of factors influencing foot injuries was refined by assessing foot stress distribution in football players. Consequently, based on the foot stress analysis of these athletes, a comprehensive evaluation of their physical condition was conducted. In summary, the factors contributing to athletes' foot injuries require complex calculations. The grouping method identifies the optimal set of vector wavelet kernels for forecasting foot injury factors in football players, thereby informing data collection on the strength of foot components.

4. Result Analysis and Discussion

Following the development of a foot pressure distribution analysis model based on the walking patterns of football players, it is essential to validate the model, as any design may present issues in its initial stages. This testing is crucial for refining the model and enabling enhancements, which will facilitate its broader application in football training. Initially, it is important to evaluate the algorithm's effectiveness and data processing speed; thus, the study was structured as a cross sectional data collection, encompassing 300 football athletes from various regions. A data collector was attached to the pressure sensitive areas of the foot, capturing real-time dynamic foot data from the start of the dribble to the shot. These collected data were then analyzed and documented; the findings are presented in Table 1 below.

Data Collection	The data acquisition time	The data on cutting time	The real-time data generation time	The virtual model generation time
2	0.01s	0.001s	0.002s	1s
4	0.02s	0.002s	0.004s	2s
6	0..03s	0.003s	0.005s	3s
8	0.05s	0.005s	0.006s	4s
10	0.06s	0.007s	0.008s	5.5s

Table 1. The Real-time Data Generation Time

As indicated in the table, the analysis of foot pressure distribution among football players during walking was condensed into the 2S during the data-gathering phase. Even with an increase in the foot-stress data from the collector, the minimum time required to process the total stress data from training across the entire foot will also increase, depending on the acquisition duration. Consequently, the research outcomes represent a significant advancement over the calculation techniques previously examined by scholars. From the test results, it can be inferred that, even when acquiring more than 80% of the athlete's movement data points, the designed algorithm can still perform calculations and model generation efficiently within a brief period, without significantly increasing processing time, despite the precision of the collected data. While this duration is already relatively short, future research will aim to enhance the algorithm to reduce the overall time to under 1 second, achieving seamless real-time synchronization. During the testing phase, the performance diagram for each node is shown in Figure 3.

After analyzing and testing the developed model, it is crucial to compare the data obtained by the model with the actual movement patterns. Following that, the model's accuracy should be assessed. Subsequently, data from five motion types were fed into the algorithm, and the entire interconnected five node structure was selected. An eight-node cube was structured as a bifurcated tree, and the experimental results were subsequently recorded. The results are depicted in Figure 4.

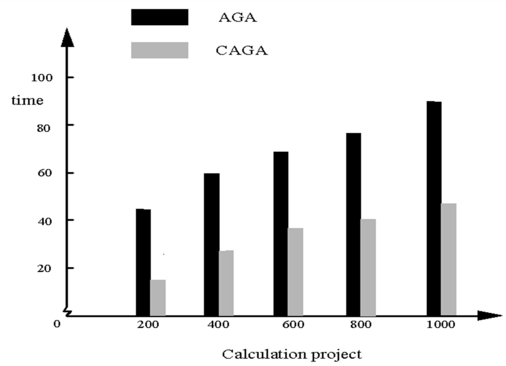

Figure 3. Plantar pressure distribution of football players during walking

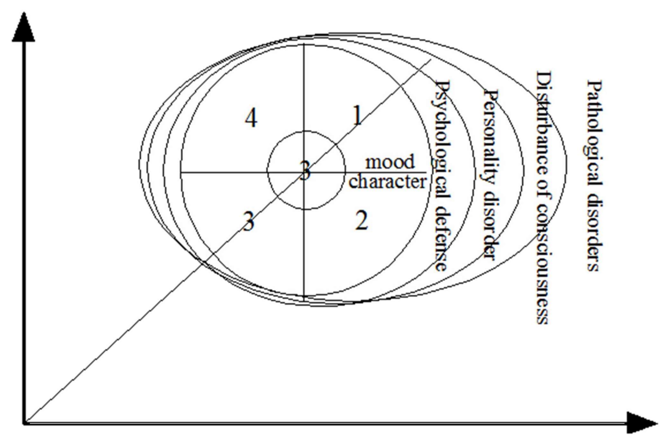

Figure 4. Plantar pressure distribution of football players during walking

From the figure above, it is evident that the model simulated by the algorithm falls between the upper and lower limits, which, to some degree, indicates that the algorithm demonstrates reliability in accurately simulating the motion model, as there exists a specific saturation value that is contingent upon the interconnected structure of the algorithm model. If the value exceeds a certain threshold, data accuracy improves with increasing information volume; therefore, the algorithm model we developed this time reflects a potential value of the deep mining system that has not yet been explored by prior technologies. Drawing on the series of evaluations mentioned earlier, the configuration of the research system is highly reliable and provides substantial support for the day to day training of soccer athletes.

5. Conclusion

With the ongoing evolution of football, the current physical conditioning for players has become standardized. It is essential to assess plantar pressure throughout this process. By examining the distribution of plantar pressure during ambulation, one can investigate the structures and functions of footballers' feet. Additionally, both the physiological and pathological dimensions of athletes can be studied. Various data analyses enable a practical assessment of their physical state. The level of support for football players will vary over a prolonged period of physical training. Consequently, it is crucial to analyze plantar pressure distribution during walking among soccer players an evaluation of foot pressure while walking was conducted for these athletes. The pressure measurement device was positioned on the plantar surface, and following data processing by the computer system, the related pressure model was examined, yielding a precise stress analysis to aid in the recovery from injuries sustained by football players. The test results indicated that this research successfully predicts the severity of athletes' injuries.

References

[1] Pankova, B., Koudelka, T., Pavelka, K., et al. (2016). Exploitation of Stereophotogrammetric Measurement of a Foot in Analysis of Plantar Pressure Distribution. III-5, 153-158.

[2] Tománková, K., Pøidalová, M., Svoboda, Z., et al. (2017). Evaluation of Plantar Pressure Distribution in Relationship to Body Mass Index in Czech Women During Walking. *J Am Podiatr Med Assoc,* 107 (3), 208-214.

[3] Li, B., Chen, D. W., Yang, Y. F., et al. (2016). Effect Of Second Toe-to-hand Transfer On The Plantar Pressure Distribution Of The Donor Foot. *Acta Ortopedica Brasileira*, 24 (1), 39-42.

[4] Stewart, S., Dalbeth, N., Vandal, A. C., et al. (2016). THU0530 Spatiotemporal Gait Parameters and Plantar Pressure Distribution during Barefoot Walking in People with Gout and Asymptomatic Hyperuricaemia: A Cross-Sectional Observational Study. *Journal of Foot & Ankle Research*, 9 (1), 15.

[5] Namkoong, P. L. R. (2017). The Effect of Stretching and Elastic Band Exercises Knee Space Distance and Plantar Pressure Distribution during Walking in Young Individuals with Genu Varum. 12 (1), 83-91.

[6] Po, D. P. L., Prp, C., Vmlm, F., et al. (2017). Evaluation of the isokinetic muscle function, postural control and plantar pressure distribution in capoeira players: a cross-sectional study. *Muscles Ligaments Tendons J,* 7 (3), 498-503.

[7] Tonga, E., Özgül, B., Timurta, E., et al. (2016). FRI0618-HPR The Short-Time Effects of Kinesiotaping on Hallux Valgus Degree, Pain Intensity and Plantar Pressure Distribution in Rheumatoid Foot: A Pilot Study. *Annals of the Rheumatic Diseases*, 75 (Suppl 2), 1277.2-1277.

[8] Zverev, Y. (2016). Laterality and Plantar Pressure Distribution During Gait in Healthy Children: Comment on Mayolas Pi, Arrese, Aparicio, and Masià (2015). *Perceptual & Motor Skills,* 123 (1), 121.

[9] Azevedo, R. R., Da, R. E., Franco, P. S., et al. (2016). Plantar pressure asymmetry and risk of stress injuries in the foot of young soccer players. Physical Therapy in Sport Official Journal of the Association of Chartered *Physiotherapists in Sports Medicine*, 24, 39-43.

[10] Iijima, Y., Shiina, T., Tsubo, H., et al. (2017). PS8-1 Measurement of Plantar Pressure Distribution Based on Grayscale Plantar Images *(PS8: Poster Short Presentation VIII, Poster Session)*. 2015. 8, 353.

[11] Geldman, Mark., A., Cheek, Moore, Liz. (2008). The effect of pre-injury physical fitness on the initial severity and recovery from whiplash injury, at six-month follow-up, *Clinical Rehabilitation*.

[12] Lentz, L., Jason, R., Randall, D., Gross, A., Senthilselvan, D., Voaklander. (2018). The relationship between physical fitness and occupational injury in emergency responders: A systematic review, *American Journal of Industrial Medicine*.

[13] Gabbett, T. (2016). The training injury prevention paradox: should athletes be training smarter and har- der? *British Journal of Sports Medicine*.

[14] Defi, I. R. (2023). Rehabilitation Role in Sport Injury, *Orthopaedic Journal of Sports Medicine*.

[15] Sonora, M., Gennarelli, Symone., M., Brown, M. Mulcahey. (2020). Psychosocial interventions help facilitate recovery following musculoskeletal sports injuries: a systematic review, *Physician and sports medicine*.

[16] Kola, Nikhilraj., N. Seema. (2023). Facilitating Social Support during the Transition of Sports Injury Recovery: A Systematic Review, *International Journal of Human Movement and Sports Sciences*.

[17] Kraus, Aidan., D. (2022). Recovery as Sport: A Comprehensive Psychological Rehabilitation Process for Injured Athletes, *Journal of Sport Psychology in Action*.

[18] Fisher, Craig., A., Ph. D., Mary, A., Domm, M. S., Deborah, A. (1988). Wuest EdD Adherence to Sports-Injury Rehabilitation Programs, *The Physician and Sportsmedicine,* 16:7, 47-52,

[19] Harcombe, H., Samaranayaka, A., Derrett, S. (2016). Predictors of Reduced Frequency of Physical Activity 3 Months After Injury: Findings From the Prospective Outcomes of Injury Study, *Physical Therapy,*.

[20] O'Connor, S., Whyte, E., O'Hanlon, S., Fortington, L. (2020). Coach and Player Views Toward Injury Prevention Exercise Programs in Camogie: A Cross-sectional Survey, *Athletic Training & Sports Health Care*.

[21] Forelli, Florian., Moiroux-Sahraoui, Ayrton., Nielsen-Le Roux, Mathias., Miraglia, Nicholas., Gaspar, Maxime (2024). Stay in the Game: Comprehensive Approaches to Decrease the Risk of Sports Injuries, *Cureus*.

[22] Lang, C. (2022). Rehabilitation after Injuries of the Musculoskeletal System Sustained During Fitness Training, Physikalische medizin, rehabilitationsmedizin, *kurortmedizin*.