

Injury Prevention Program among Athletes in Malaysia: A Systematic Review

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ABSTRACT

Sport is responsible for the significant occurrence of acute and overuse injuries among athletes. The injuries during sport can result in long-term negative consequences that reduces the performance of sports. The burden of sport-related injuries is substantial, and there is a lack of studies assessing the effectiveness of injury prevention strategies. To date, cumulative information regarding injury prevention strategies is limited in Malaysia. This study aims to identify the characteristics of injury prevention programs among athletes in Malaysia. This research was systematically conducted utilising the electronic databases of Web of Science (WoS), Scopus, ClinicalKey, Cochrane Library, PubMed, SPORTDiscus, and Google Scholar. Two reviewers, MIS and HAY, independently selected articles based on the established inclusion criteria from 1st January 2015 to 31st December 2024. The study followed PRISMA guidelines and was registered with PROSPERO under registration number CRD42024513383. Nine eligible papers were included in the study and scored at least five points on the 11-point checklist of the CASP appraisal tool. Injury prevention programs, including neuromuscular training and sport-specific interventions, enhance strength, flexibility, and balance, reducing injury risk among athletes. It is recommended that injury prevention programs be adopted in every sport, especially during warm-up periods of training sessions. Future research should focus on individualised programs and technology for real-time feedback injury prevention strategies.

Keywords

Sports injury, Injury prevention strategies, Athlete, Malaysia

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INTRODUCTION

Sporting activity is responsible for the significant impact of injuries on adults and children.^{1,2} Previous studies show that athletes suffer acute and overuse injuries in individual and team sports.^{3,27} The combined prevalence of injuries in individual and team sports was 42.0% and 33.0%, respectively.³ Several studies demonstrate that acute and overuse injuries can have detrimental long-term effects that impair an athlete's performance, resulting in pain and dysfunction and, in certain situations, possibly ending an athlete's career.^{4,5,28} The prevalence of sport-related injuries is significant, and there is a shortage of research evaluating the efficacy of injury prevention techniques across all sports and age demographics in Malaysia.² Hence, evidence-informed injury prevention interventions, especially among athletes, are necessary to mitigate injury risk.

The four-step model is the basis for creating and assessing sport injury prevention programs. It involves gathering data on injuries in a specific population using surveillance systems and identifying the risk factors contributing to these injuries.^{6,7} This process leads to developing and validating injury prevention strategies using suitable surveillance systems to measure their impact on injury incidence. Thus, randomised controlled trials (RCTs) represent the most effective means to assess the success of a preventative plan, although they are not always practical or ethical. Other study designs, including quasi-experimental, cohort, and case-control, are employed to assess the effectiveness and efficacy of injury prevention programs. However, these designs possess intrinsic methodological limitations that induce biases and constrain the interpretation of study results to a certain degree.⁸

Players, coaches, and athletic organisations can readily adopt and sustain the best injury prevention program. Consequently, a significant focus has been on incorporating injury prevention studies into real-life environments.^{9,10} Injury prevention measures have demonstrated efficacy in lowering the frequency and severity of injuries.^{7,11} An increasing number of epidemiological studies have evaluated the effectiveness of injury prevention strategies among athletes, particularly in relation to musculoskeletal injuries. This evidence-based approach includes three primary themes: 1) Training strategies, 2) Enhancements to sports regulations and policies, and 3) Suggestions for equipment.⁷ Many of these strategies emphasise training modification that includes strength, endurance, and balance through exercise interventions such as neuromuscular training.⁷ To date, cumulative information regarding injury prevention strategies is limited in Malaysia. This study aims to identify the characteristics of injury prevention programs intervention among athletes in Malaysia. The findings can provide helpful insight to athletes, coaches, and healthcare practitioners in minimising the risk of injuries and effectively managing sports-related injuries.

MATERIALS AND METHODS

Search strategy

Eligible articles were systematically identified for inclusion in this study through electronic databases, including Web of Science (WoS), Scopus, ClinicalKey, Cochrane Library, PubMed, SPORTDiscus, and Google Scholar. The articles were identified by typing keywords using the primary search term (injury prevention program OR injury prevention strategies). The search strategy continued with the individual search terms (general OR sport specific), (athlete OR sports person) AND (Malaysia OR Malaysian). Articles will be chosen according to the inclusion criteria outlined in Table I. The criteria stipulate full-text articles authored in English and published within the last decade, specifically from 1st January 2015 to 31st December 2024. Articles must include athlete participants who participated in the competition within the past year. The studies should detail injury prevention programs implemented in Malaysia.

Table I: Criteria for the article's selection

1. An athlete who has participated in competitions at the school, university, district, state, or national level within the past year.
2. Studies published over the ten years (2015-2024)
3. Full-text articles written in English
4. Study conducted in Malaysia
5. Subject participates in general OR Sport specific Injury Prevention Program (IPP)

Data selection & extraction

Two reviewers, MIS and HAY, independently selected articles based on the established inclusion criteria. The analysis comprised screening titles and abstracts of articles, followed by a detailed examination of the full texts of eligible articles for inclusion and subsequent review. Excluded articles comprise abstracts, narrative reviews, non-English publications, commentaries, and studies lacking descriptions of injury prevention programs for athletes. The articles were compared during a consensus meeting among researchers. Articles were included based on mutual agreement between both reviewers, with disagreements resolved through discussion. The research followed the PRISMA guidelines for systematic reviews and meta-analyses.¹² The study was registered with PROSPERO (International Prospective Register of Systematic Reviews) under registration number CRD42024513383. Information from the chosen articles was collected based on structured sheets that included demographic data such as age, total number of participants, and study locations. Furthermore, the research encompassed intervention details, assessment tools, study results and recommendations.

Study Evaluation

The methodological quality of the selected article was evaluated using the Critical Appraisal Skills Programme (CASP) appraisal tool to systematically assess the quality of the randomised control trial studies. The checklists consist of 11 questions encompassing three primary components: bias associated with selection and allocation, administration of intervention/exposure, and the assessment, detection, and measurement of outcomes, as well as participant retention in randomised control trial

studies.¹³ The articles that meet the reviewer team's predetermined weight will be included.

RESULTS

Study selection

The analysis of the computerised bibliographic database identified a total of 211 articles. Following the elimination of duplicate articles, commentaries, and conference proceedings, a total of 200 articles underwent additional screening, resulting in the identification of ten articles based on their titles and abstracts. After a comprehensive evaluation and screening of the full-text articles based on the inclusion criteria, nine eligible papers were identified for the study. All nine articles scored at least five points on the 11-point checklist of the CASP appraisal tool. Figure 1 is a PRISMA flowchart that outlines the process of selecting studies. Results are summarised in Table II, which includes a comprehensive overview of the nine articles, providing details regarding the type of sports involved, participants, the assessment tools, intervention details, outcomes, and study recommendations.

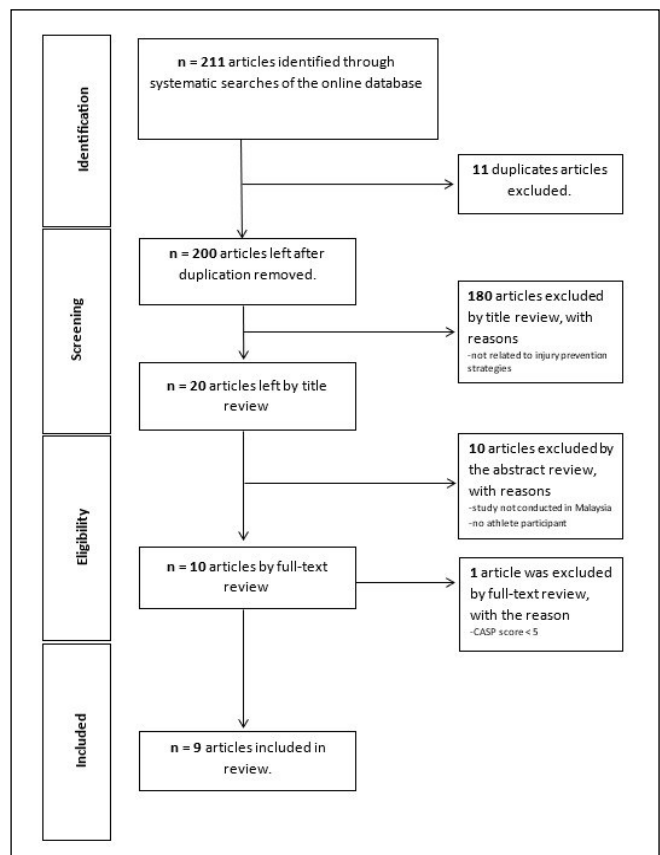


Figure 1: Flowchart illustrating the selection process of published articles from 1st January 2015 to 31st December 2024.

Type of sport

This section provides information regarding the type of sports involved in injury prevention programs. The results indicate that three studies reported injury prevention programs that involve a single type of sport, football¹⁶, volleyball²¹ and netball.³² Four studies^{14,15,18,19} reported injury prevention programs for multiple sports ranging from volleyball, futsal, football, basketball, hockey, netball, rugby, tennis, and athletics. The last two studies did not specify the type of sport in which the participants were involved in the injury prevention program.^{17,20}

Demographic information

The number of participants varies between studies, from as low as 10 to as high as 50. Four studies reported fewer than 20 participants,^{15,17,18,20} four studies had 20 or more participants,^{14,19,21,32} and one study reported a substantial amount of 50 participants.¹⁶ The studies have participants between 13 and 35 years old. Most of the studies reported mean average ages above 20 years old.^{14,15,17-19,21,32} Three studies were conducted at rehabilitation clinics,^{14,15,17} and the remaining were conducted at academic institutes.^{16,18-21,32}

Assessment tools

The findings indicate that most studies reported physical performance tests as assessment tools^{14,15,17-21}, and two studies reported the outcome using only a questionnaire.^{16,32} The physical performance test includes but is not limited to the standing long jump test,^{14,21} balance test,^{14,17-20} agility test,¹⁸ strength test^{14,15} and flexibility.²⁰ Four studies reported using questionnaires,^{14,16,20,32} one study involved a lab test on antioxidant enzymes' activity,¹⁵ a study in neuromuscular activity using surface electromyography (sEMG)²⁰ and a study implementing a pain rating scale using the visual analogue scale (VAS).²⁰

Intervention details

Sport-specific injury prevention programs were conducted in three studies.^{14,16,32} and the remaining six studies reported on conducting general injury prevention

Table II: Injury Prevention Program among Athletes in Malaysia

No	Author	Article title	Type of Sports	Participant (N, Age, Location)	Assessment Tools	Intervention Details	Outcomes	Recommendations
1.	(Teichman et al., 2016)	Unexpected-Disturbance Program for Rehabilitation of High-Performance Athletes	Multiple sports backgrounds	n=24; 16 male and 8 female Age 22.1 ± 4.10. Location Sports Medicine and Rehabilitation Clinic at the National Sports Institute of Malaysia	Physical Performance Test: Single-leg press (1-repetition maximum [1RM]), Standing long jump test, 20m sprint test, single leg balance test, Questionnaire: Perceived-Recovery Questionnaire.	Intervention group Each subject will undergo six to seven weeks of UDP, with a training volume of 8 to 10 weekly sessions, each lasting around two hours. Sport-specific Unexpected-Disturbance Program (UDP) encompasses exercises such as executing low and overhead shuttle shots in badminton, performing headers with hops or one-touch passing in football, executing kicking sequences in Tae Kwon Do, and engaging in shooting or rebound recovery in basketball.	Single-Leg 1RM Strength: Improved significantly (22%, $P < .05$) in male and female subjects. Standing Long Jump: Significant improvements by 4% in male subjects. 20-m Sprint: Time was markedly reduced by 3% in males and 4% in females. Single-Leg Balance: Minor yet inconsequential reduction in average anteroposterior and mediolateral sway. Perceived Recovery: Substantially elevated levels of bodily confidence	Training that resembles the nature of competitive sports helps elevate the fear of movement and reinjury and enhances neuromuscular firing properties and functions.
2.	(Lai et al., 2016)	Effect Of Platelet-Rich Plasma Treatment on Antioxidant Enzymes' Activity Following Hamstring Injury Among Malaysian Athletes	Multiple sports backgrounds (athletics, football, basketball, hockey, netball, rugby, tennis)	n=10; 7 male and 3 female Age Intervention: 22.8±4.03 Control: 24.8±6.42 Location Sport Medicine Clinic of the University of Malaysia Medical Centre	Lab Test: (Primary) Antioxidant enzymes' activity of the erythrocyte CAT and superoxide dismutase (SOD) Physical Performance Test (Secondary) Criteria for return to play (RTP) (Hamstring palpation; isometric hamstring contraction, active knee extension test and isokinetic dynamometer)	Intervention group Platelet-rich plasma treatment (PRP-T) with a rehabilitation program, including progressive agility and trunk stabilization (PATs) exercises weekly for four weeks. Control group Progressive agility and trunk stabilisation (PATs) exercises weekly for 4 weeks. Progressive agility and trunk stabilisation (PATs): Exercises that include side-stepping, grapevine stepping, forward and backwards stepping, single leg stand, prone abdominal body bridge, side bridges, icing in a sitting position, push-up stabilisation with trunk rotation, fast feet in the ground, proprioceptive neuromuscular facilitation trunk-pull downs, symptoms-free practice, icing if any symptoms of pain.	Primary outcomes measure: Week 2: The CAT activity in the control group was about the same as in the intervention group. There was a reduction in SOD activity (from W0 to W4) in both groups and no statistically significant difference between groups throughout the reference time frame. Secondary outcome measure: The mean time to RTP was 27.6±14.99 and 42.2±17.3 days for the intervention and control groups.	It was thought that PRP could be used as an extra treatment for injuries to shorten the time it takes to get back to playing (RTP).

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No	Author	Article title	Type of Sports	Participant (N, Age, Location)	Assessment Tools	Intervention Details	Outcomes	Recommendations
3..	(Ahmed F Farhan et al., 2017)	Prevention Of Soccer-Related Ankle Injuries in Youth Amateur Players: A Randomized Controlled Trial	Football	n=50 male Age 13.34±0.47 Location Sport School, Malaysia	Questionnaire: Incidence of injury and exposure time in a year.	Intervention group Football-specific training exercises, 15-20 minutes per session, five times weekly, for 12 weeks. Football-specific training: Core stabilisation, eccentric exercise of the thigh muscles, proprioceptive training, dynamic stabilisation, and plyometrics. Control group Continue regular training regime.	Prevalence of injury for the intervention group: Ankle: 31% Prevalence of injury for the control group: Ankle: 69% Total injuries per 1000 hours of exposure. Intervention group: 0.96 Control group: 2.16	The injury prevention program can be integrated into the training regimen and the pre-participation assessment of athletes to mitigate risk factors associated with injuries.
4.	(Saha et al., 2016)	Effectiveness of Neuromuscular Training Program in Young Athletes Suffering from Lower Lateral Ankle Ligament Injury	not reported	n=18 Age 23.2± 2.46 Location Hospital of Universiti Sains Malaysia	Physical Performance Test: Y-balance test and proprioception assessment utilising Biodex 4 Isokinetic Equipment	Intervention group 12 sessions; 30 min/day; two days/week for six weeks. Neuromuscular training program: Level 1: squats, heel raises, and toe raises. Levels 2 and 3: unilateral exercises on stable surfaces. Levels 4 and 5: intricate unilateral workouts on both stable and unstable surfaces.	Neuromuscular therapy utilising a bosu-ball balance trainer is recommended to enhance proprioception in athletes with lateral ankle injuries.	Neuromuscular controlled exercise training perhaps helped restore lost proprioception.
5.	(Baharudd in & Junaid, 2018)	Effect of Neuromuscular Training to Prevent Anterior Cruciate Ligament Injury Among Female Athletes	Multiple sports backgrounds (volleyball, futsal and basketball)	n=16 Age 23.2± 2.46 Location Universiti Pendidikan Sultan Idris	Physical Performance Test: Star Excursion Balance Test (SEBT) for dynamic balance. T-Test for agility.	Intervention group Four weeks; two sessions every week of neuromuscular training. Neuromuscular training program: Double leg jumps forward; lunges step; side-to-side box; knee lift on the box; single jump forward; lunges step forward; unilateral leg side-to-side box jump; squat jump; lateral bound. Control group Continue regular training.	The intervention group exhibited a substantial difference in dynamic balance and agility performance before and after four weeks of neuromuscular training.	Neuromuscular training is advisable for female athletes to improve dynamic balance and agility performance while preventing ACL injuries.
6.	(Sankarav el et al., 2016)	Effect Of Neuromuscular Training on Balance Among University Athletes	Non-contact sports,	n=20 Age 20.9± 0.85 Location Universiti Pendidikan Sultan Idris	Physical Performance Test: Balance error scoring system (BESS).	Intervention group Three sessions weekly for six weeks of progressive neuromuscular training. Progressive neuromuscular training is an ideal performance training strategy encompassing stability, strength, and power through a three-tiered progression from simple to more complex exercises. Control group Continue regular training.	The principal finding reveals a notable enhancement in static balance within the intervention group.	The early commencement of proprioceptive neuromuscular training may enhance balance and safeguard young athletes against potential reinjury.

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No	Author	Article title	Type of Sports	Participant (N, Age, Location)	Assessment Tools	Intervention Details	Outcomes	Recommendations
7.	(Ramalingam et al., 2020)	Effect of Neuro-Dynamic Technique on Repetitive Inward Ankle Rolls among Young Malaysian Athletes - A Randomized Controlled Trial	Not reported	n=18 Age 17-35 years old. Location National Sports Institute of Malaysia and Physiotherapy Centre, International University Malaysia (INTI)	Physical Performance Test: Dynamic equilibrium was assessed via the Y Balance Test, and the range of motion was evaluated using a dual-axis electrogoniometer. Neuromuscular activity: Peroneus longus and tibialis anterior muscle activation using wireless surface electromyography (sEMG). Pain rating scale: Visual analogue scale (VAS) Questionnaire: Functional Ankle Disability Index (FADI).	Intervention group Three sessions per week for six weeks of neurodynamic technique and Standard Physiotherapy (SP). Neurodynamic Technique (NDT): Technique that mobilise the peroneal nerve was carried out without producing pain symptoms. Control group Standard Physiotherapy (SP) Management.	The study's findings indicate enhancements in dynamic balance, pain scores, peroneal longus and tibialis anterior muscle activation responses, knee range of motion (ROM), and the functional ankle disability index (FADI) for both the intervention and control groups.	The neurodynamic approach and conventional physiotherapy intervention demonstrate comparable and safe outcomes across variables. The neurodynamic approach is also advised to prevent recurrent inversion ankle sprains.
8.	(Baharuddin, Mohd et al., 2020)	Effect of Plyometric Training on Anterior Cruciate Ligament Injury among Female Volleyball Players	Volleyball	n=20 Age Intervention: 21.9± 1.27 Control: 20.9± 1.9 Location Universiti Pendidikan Sultan Idris (UPSI)	Physical Performance Test: Standing Long Jump	Intervention group Twice a week for six weeks of plyometric training. Plyometric training: Bilateral two-foot ankle hops, unilateral jumps, and jump trucks. Control group Routine training.	The intervention group exhibited a notable difference between the pre-test and post-test results for the standing long jump, whereas the control group did not.	Plyometric training enhances lower limb strength and may mitigate the risk of anterior cruciate ligament (ACL) injuries in female athletes.
9	(Zulkarnain & Khairullina 2019)	The pilot study on Down to Earth (D2E) injury prevention program among varsity netball players	Netball	n=42 Age Intervention: 21.2± 1.8 Control: 20.9± 1.9 Location University Malaya Sports Centre, Kuala Lumpur	Questionnaire: Incidence of injuries on the lower extremity.	Intervention group Thrice a week for six weeks of <i>The Down to Earth</i> (D2E) training. Control group Routine training.	The results indicate a lower rate of lower extremity injuries in the intervention group than in the control group.	<i>Down to Earth</i> (D2E) training reduces netball players' risk of lower extremity injury. Increasing the training hours is also beneficial for athletes in minimising injury risk.

programs.^{15,17–21} In sport-specific injury prevention programs, one study conducted plyometric training²¹, one study conducted the Down to Earth training (D2E)³² and the remaining on football-specific training.¹⁶ General injury prevention programs indicate that three studies conducted neuromuscular training^{17–19} and the remaining studies conducted on progressive agility and trunk stabilisation (PATS),¹⁵ Neurodynamic Technique (NDT)²⁰ and Unexpected-Disturbance Program (UDP).¹⁴

The training frequency varies, and many studies were conducted about six weeks of intervention.^{14,17,19–21,32} The lowest frequency is about four weeks of intervention conducted in two studies^{15,18} and 12 weeks is the highest frequency of intervention indicated in a study among football players.¹⁶ There was primarily a twice-a-week intervention,^{17,18,21} three studies were conducted three times per week,^{19,20,32} and the remaining study is conducted once a week,¹⁵ five times per week¹⁶ and more

than eight times per week.¹⁴ Three studies reported that hours per training ranged from 15 to 30 minutes per session.^{16,17,32}

Outcomes and recommendations

The intervention group indicates positive and significant results in all studies for the physical performance test,^{14,15,17–21} questionnaire,^{14,16,20,32} neuromuscular activity,²⁰ pain rating scale²⁰ and lab test.¹⁵ A study suggested that an injury prevention program tailored to the characteristics of the competitive sport could reduce injury risk and enhance overall athletic performance.¹⁴ Injury prevention programs should be incorporated into training to mitigate injury risk.¹⁶ Besides that, incorporating platelet-rich plasma (PRP) treatment in injury prevention programs has been shown to hasten the time to return to play.¹⁵ Three studies recommended neuromuscular training in the injury prevention program for improving athletes' proprioception, dynamic balance, agility, and injury prevention.^{17–19} A study suggested a neurodynamic technique to prevent recurrent ankle sprain.²⁰ Besides that, plyometric training also helps to strengthen the lower extremities and prevents ligamentous injury.²¹

DISCUSSION

The main findings of the study on the characteristics of injury prevention programs in Malaysia shows that neuromuscular training programs are the most widely adopted.^{17–19} This is primarily because numerous studies have demonstrated that neuromuscular training is highly effective in reducing the risk of injuries among athletes.^{41–43} In neuromuscular training, athletes were subjected to multi-intervention programs involving several types of balance, weight training, plyometric exercises, agility drills, and sport-specific exercises.^{39,40} This comprehensive approach to injury prevention ensures that athletes are better equipped to maintain proper biomechanics during training or competition, thereby mitigating the risk of injuries. These findings underline the importance of neuromuscular training as a cornerstone of injury prevention strategies in Malaysian programs and support its inclusion as an evidence-based approach.

Alternative injury prevention strategies, such as Progressive Agility and Trunk Stabilization (PATS), have also effectively prevented re-injuries, especially in athletes recovering from previous injuries. However, it is worth noting that while PATS can help reduce the risk of re-injury, it may not significantly shorten recovery time. This limitation highlights the need for complementary strategies to optimise both prevention and rehabilitation processes.⁴⁶

In addition to PATS, the Unexpected-Disturbance Program (UDP) has shown promising results. UDP involves exposing athletes to more challenging stimuli that engage the sensorimotor, vestibular, and proprioceptive systems, enhancing their ability to respond to unpredictable situations. Compared to conventional rehabilitation methods, UDP has been found to improve balance and unilateral strength, which are crucial for injury prevention and recovery.⁴⁷ These alternative strategies provide a multifaceted approach to injury prevention, ensuring that athletes are equipped with the physical and neuromuscular capabilities to reduce injury risks and enhance overall performance.

Sport-specific injury prevention programs have demonstrated significant efficacy in reducing injury rates and enhancing athletic performance across various disciplines. In volleyball, targeted injury prevention initiatives have shown promise in minimising injury risks among athletes. These programs typically incorporate exercises to optimise jump mechanics, strength, and flexibility-key factors in mitigating injury risks in the sport.³⁵ The integration of plyometric training into injury prevention programs has demonstrated notable improvements in athletic performance and injury reduction. A systematic review highlighted the benefits of combining plyometric training with balance and strengthening exercises, making it a comprehensive approach to injury prevention.⁴⁴

In football, sport-specific interventions such as the FIFA 11+ program have been widely acknowledged for their effectiveness in injury prevention.²⁶ This program has been evaluated and shown to reduce injuries among

athletes, including semi-pros, amateurs, and professional athletes of both genders.^{37,38} Furthermore, a systematic review identified five core strategies for injury prevention in football: pre-activation exercises, foam rolling, strength training, the FIFA 11+ program, and core stability training.¹¹

Similarly, netball has benefited from tailored programs such as the Down to Earth (D2E) initiative, emphasising safe landing techniques during training. Safe landing mechanics are crucial in netball, as jumping and landing are frequent actions with a high risk of lower-limb injuries. This program has been particularly effective in reducing injury risks during both training and competition.⁴⁵ These sport-specific programs demonstrate the importance of tailored approaches to injury prevention. Addressing each sport's unique demands and movement patterns provides targeted strategies to reduce injuries and enhance athletic performance.

Injury prevention programs can be broadly categorised into general and sport-specific injury prevention strategies. Both approaches are essential for reducing the risk of injuries in athletes, but they differ in their scope, target population, and application. In Malaysia, these strategies are applied based on the population's needs, with general programs being more common in recreational and grassroots sports and sport-specific programs being implemented at the elite and competitive levels.^{30,36} The implementation of injury prevention programs faces various challenges, including perceived barriers such as the potential cost of implementation, coaches' lack of knowledge and confidence to implement, perceived time burden, lack of importance placed on the program, confusing exercises, lack of motivation and flexibility of the program especially among different skills level athletes.^{29,31,33,34} Addressing these issues by improving resource availability and enhancing coach training and awareness, Malaysia can further strengthen its approach to injury prevention, ensuring better safety and performance for its athletes.

In this review, one of the limitations identified was the small number of studies that met the inclusion criteria,

with only nine studies being selected. This limitation arose from the specific focus of the criteria, which only included studies with athlete participants and articles published in the last decade to ensure relevance to current practices in injury prevention programs in Malaysia. Additionally, prospective injury prevention studies face several challenges, such as high financial costs, the need for lengthy training durations, and the requirement for skilled and competent coaches to implement the programs effectively.^{22,23} These constraints can limit the feasibility and scalability of injury prevention programs, highlighting the need for further research to overcome these barriers while maintaining cost-effectiveness and broad applicability.

Another limitation of this review is that half of the relevant articles did not specify the type of sports in which the athletes participated. The lack of sport-specific information may hinder the ability to tailor injury prevention programs to match different sports' specific demands and risks. Research has shown that training programs designed to mirror the characteristics of competitive sports can effectively reduce injury risks while improving overall physical performance.^{14,48} Furthermore, many studies included in this review involved fewer than 20 participants, raising concerns about the results' statistical power. A small sample size may not provide enough power to detect meaningful differences between groups, potentially leading to false negative results and Type II errors, as noted in prior research on statistical validity.⁴⁹ Nonetheless, the prospective nature of the studies ensures a more accurate representation of how injury prevention programs influence athletes over time.⁵⁰

CONCLUSIONS

An injury prevention program has demonstrated promising results in minimising injuries and enhancing overall physical performance among athletes. Many of the studies adopted on neuromuscular training and general injury prevention programs, including the Unexpected Disturbance Program (UDP), Progressive Agility, Trunk Stabilisation (PATS), and sport-specific programs such as volleyball (plyometric training), football-specific training,

and netball (Down to Earth). These programs are typically conducted twice a week for six weeks, with 15–30 minutes per session, to improve strength, flexibility, balance, and neuromuscular control, which are critical factors in reducing injury risk. It is recommended that injury prevention programs be adopted in every sport, especially during warm-up periods of training sessions. Additionally, future research could focus on developing tailored exercise programs based on individual unique risk factors and incorporating technology to provide real-time feedback and enhance monitoring of injury prevention efforts. These advances could significantly improve the effectiveness of injury prevention strategies for athletes.

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CONFLICTS OF INTEREST

The authors certify no conflict of interest with any financial organisation regarding the material discussed in the manuscript.

Authors' contributions

M.I.S – Conceptualization, Methodology, Data Curation and Writing - Original Draft

H.A.Y – Validation, Writing - Review & Editing, Supervision and Project administration

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