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Research Article

Sports Injuries in University Physical Education Teacher Education Students: A Prospective Epidemiological Investigation

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Abstract

The university physical education (PE) program is rigorous and exposes the students to increased risks of sports injuries. The higher risk of injuries in the university PE students is a concern as it can adversely affect their teacher training and also interfere with their professional career in the long term. This study was a prospective epidemiological investigation of sports injuries in university physical education teacher education (PETE) students.

Participants were year-1 PETE students (n=124). Sports-related injuries sustained during intracurricular and extramural sports participation were reported once every three weeks using an injury registration form. A total of 107 injuries were documented during the year-1 of the PE programs. 53% of the injuries were sustained during the intracurricular activities. Males and females sustained 77 % and 24% of the injuries respectively. 72% were new and 24% were recurrent injuries. Ankle was overall the commonest body part to be injured (18%) while fingers were the most commonly injured part during the curriculum (21%). Sprain was the commonest type of injury (31%) followed by contusion (20%) and muscle-tendon strain (14%). With regard to medical attention, 84% injuries were classified as mild and 15% were moderate injuries. In terms of time-loss, 88% injuries were mild, 9% moderate and 2% were severe injury.

Injury prevention programs are critical for safety in training and safeguarding professional careers of university PE students. This study provides useful information on epidemiology of sports injuries in university PETE students. Evidence from the present study can be used to identify the modifiable risk factors to develop and implement injury prevention strategies to minimize the risk of injuries in university PE students. Future studies on elucidation of intrinsic and extrinsic risk factors and implications of intervention programs in this population are desired.

Keywords: University PETE Students; Sports Injuries; Epidemiology; Prospective; Injury Prevention.

Introduction

The benefit of participation in sports and physical activity is unequivocal. However, it is also apparent that sports participation presents an added risk of injuries. While the magnitude, risk, pattern and severity of injuries vary between sports, populations, gender, age and competitive levels, prevention of sports injuries continues to be a topic of interest and concern. The university physical education (PE) program is rigorous and requires the trainee teachers to undergo intense training on the pedagogical aspects, techniques and skills, assessment and officiating aspects of different sports. This exposes the physical education teacher education (PETE) students to increased loading of different body parts often with insufficient recovery thus increasing the risk of sports and physical activity-related injuries during the program. The higher risk of injuries in this population is a matter of serious concern as it has the potential to adversely affect their academic commitment and sports training during the program. While previous studies on PETE students have reported an injury risk of 1.1-2.1 injuries/student/year and an incidence rate of 1.4-4.7 injuries/1000 h of sports participation [1-4] a recent study reported an injury risk of 0.85 injuries/student/year and an incidence of 1.91 injuries/1000 h of sports participation [5].

Injuries in PETE students can lead to short or long-term absence from lessons and sports training which can adversely affect their performance in examinations leading to lowering of grades. We have observed PETE students sustaining stress fractures, shoulder and elbow dislocations, recurrent ankle sprains and cruciate ligament and meniscal injuries in the knee during the program. Such injuries have direct financial implications in terms of expenses related to medical consultation, investigations, hospitalization, surgery and aftercare as well as indirect economic implications in the form of the PETE student missing a semester leading to extended academic program and delays in the start of professional career. Moreover, many of the injuries can have a high likelihood of recurrence as the PETE students will continue to be involved in sports and physical activities especially with students in schools. This notion is substantiated by previous studies reporting higher physical workloads, high energy expenditure, high incidence of chronic musculoskeletal conditions and greater absenteeism from work amongst the PE teachers in schools [6-8]. Therefore, it is of paramount importance to prevent sports injuries in the PETE students during the university program.

Identification of modifiable risk factors and development of injury prevention strategies for different sports have led to reduction of injury rates [9-16]. However, the PETE students are exposed to the physical demands and loading patterns of multiple sports during the course of the PE training program. Moreover, many of the PETE students may not have been exposed to certain sports prior to enrolling in the PE program.

Therefore, the prevention strategies for individual sports may not be entirely applicable and effective to prevent sports injuries in the PETE student population.

While prevention is the most effective approach to minimize occurrence of sports injuries, the measures to prevent sports injuries do not exist in isolation. They form a part of the sequence in the chain of injury prevention [17] with the first step being obtaining epidemiological information and insights on injury characteristics and patterns in the specific population. It has been suggested that if the program organizers have information about injury amongst university PE students, they can reduce the risk of injuries during the physical activity-based part of the curriculum [18]. Such information can be effectively used to develop intervention strategies, curriculum restructuring, enhancing the 'participation safety' of the students and preserve their professional careers in the long-term. Consequently the primary objective of the study was to determine the incidence, rate, severity and distribution pattern of curriculum-related sports injuries in the university PETE students using a prospective design. The additional aims were to determine the gender and age predisposition for injuries in the participants.

Materials and Methods

The entire cohort of the first year university PETE students ($n=124$; male: 95; female:29) across three different PE programs at the National Institute of Education (NIE), Nanyang Technological University (NTU), Singapore volunteered to participate in the study. Ethical clearance for non-interventional human research was obtained from the NTU IRB prior to the start of the study. Whilst the university had its general workplace health and safety program in existence, there was no sports injury prevention program or protocol in effect at the commencement of this study. The mean age of the participants was 25.94 ± 4.50 years and the range was 21.8 – 44.2 years. Depending on the program the PETE students were exposed to a weekly 6-8 hours of curricular sports lessons including rugby, basketball, soccer, field hockey, volleyball, principles of games, curriculum gymnastics, badminton, swimming and track and field.

The injury definition included the following criteria:

- Injury occurred as a result of the PE curriculum sports participation
- Injury occurred as a result of training/practice related to the PE curriculum
- Injury occurred as a result of participation in the other forms of organized sport (e.g. leisure, inter-hall games, varsity sports etc.)
- The injury may or may not affect academic commitment in any form for any length of time
- The injury may or may not require medical attention

- Any dental injury regardless of time loss

An injury registration questionnaire adapted from the NCAA injury surveillance system [19] was used to document the injuries at a three weekly interval. The PETE students were followed prospectively for two consecutive semesters during July 2012 to May 2013. The injury registration form was physically handed over to the PETE students by the Researcher during the classroom lessons. Any student who missed the session was contacted on telephone for obtaining the injury information. The injury documentation essentially included demographic information (PE program, age, gender, height, weight, date of injury), circumstance (during PE lessons, extramurals, training etc.), mechanism in terms of contact or non-contact, location and type of injury and information on time loss and the type of medical attention, if any required for the injury.

The injury severity was classified based on both medical attention and time loss. In terms of medical attention, a mild injury was one that required basic first aid like ice and compression and/or consultation with a Traditional Chinese Medicine physician. A moderate injury was one that required consultation with a physiotherapist, and/or a general practitioner and/or required prescription drugs and/or basic investigations like x-ray and blood count. An injury was categorized as severe if it required a specialist consultation, advanced investigations like CT scan and MRI, and/or required surgery and/or required hospitalization for any length of time.

In terms of time loss, an injury was considered mild if it did not lead to any time loss. A moderate injury was classified as one that led to missing up to six days of the curriculum lessons and an injury was categorized as severe if it led to the PETE student missing seven or more days consecutively during a semester. The reliability of the questionnaire was ascertained using a sub-sample of 28 post-graduate diploma students who answered the injury registration form twice within a week interval with reference to a recent injury (within last two weeks) sustained. The average kappa coefficient was 0.7835 ± 0.192 ; $p < 0.01$ suggesting a high degree of reliability of the questionnaire. However the kappa coefficient was low for the question related to whether the injury was a recurrent of overuse type (kappa coefficient- 0.4244 ± 0.166 ; $p = 0.16$).

The validity of the injury registration system was determined by comparing the responses of the PETE students with the sports physician's report. While the information related to the location of injury (Cramer's V = 0.958; $p < 0.01$) and the type of injury (Cramer's V = 0.902; $p < 0.01$) were found to be valid, the information on type of tissue involved was not found to be valid (Cramer's V = 0.586; $p = 0.56$). Therefore, the data related to the type of tissue involved is not included in the analysis.

In terms of the exposure, while the curricular exposure time was 6-8 hour per week depending on the PE program, the re-

call was rather poor for the extracurricular sports exposure time (training, practice, leisure, competition etc.).

Results

A total of 107 injuries were documented during the two semesters (one year) of the PE programmes. Of these, 57 injuries (53.27%) were incurred during PE curricular sports activities while 50 injuries were sustained during extracurricular activities (Table 1). Of the 57 curriculum-related injuries, 31 (54.4%) and 26 (45.6%) injuries were sustained in the first and the second semester respectively.

Table 1. Total Injuries documented and injury risk in the university PETE students.

	Total injuries	Curricular	Extracurricular	Injury risk overall	Injury risk during PE curriculum
Combined n=124	107	57	50	0.86	0.53
Males n=95	82	38	44	0.86	0.46
Females n=29	25	19	6	0.86	0.65

Injury risk: injuries/student/year

For curricular injuries, the risk difference between males and females was 19% and the risk ratio was 1.41 [20].

The average curricular exposure time was 6.77 hours/student/week. This amounted to a total of 20147.52 hours for the entire cohort and 15435.60 and 4711.92 for males and females respectively. Based on the total exposure time the combined injury incidence rate (IR) was 2.83 injuries/1000 hours (95% CI: 2.14-3.66) of curricular exposure time. The IR for male and females participants were 2.46 (95% CI: 1.74-3.37) and 4.03 (95% CI: 2.42-6.29) respectively. Owing to the poor recall of extracurricular exposure time the injury incidence rates are not presented in this report.

Injury distribution

The lower limb was the most commonly affected region followed by the upper limb for both overall (Figure 1) and curriculum-related sports injuries (Figure 2).

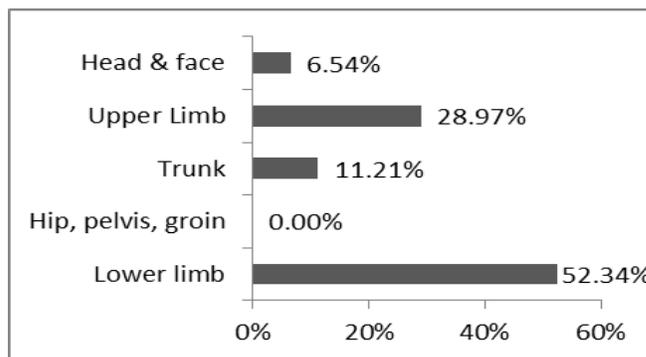


Figure 1. Overall injury distribution.

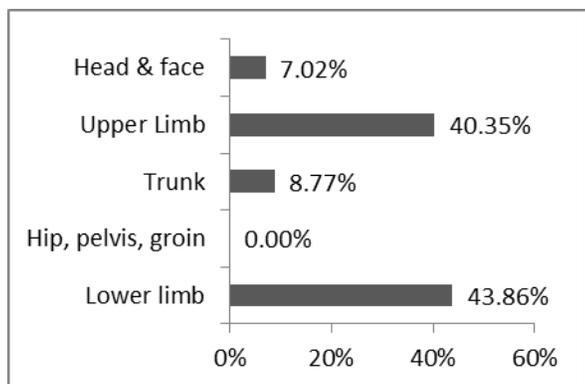


Figure 2. Curricular injury distribution.

In terms of specific body parts, ankle was overall (Figure 3) the most commonly affected part (17.7%) followed by the knee (16.8%) and fingers (12.1%). However, fingers were the most commonly affected part (21%) during the curriculum (Figure 4) followed by the ankle (17.5%), knee (12.2%) and the shoulder (12.2%).

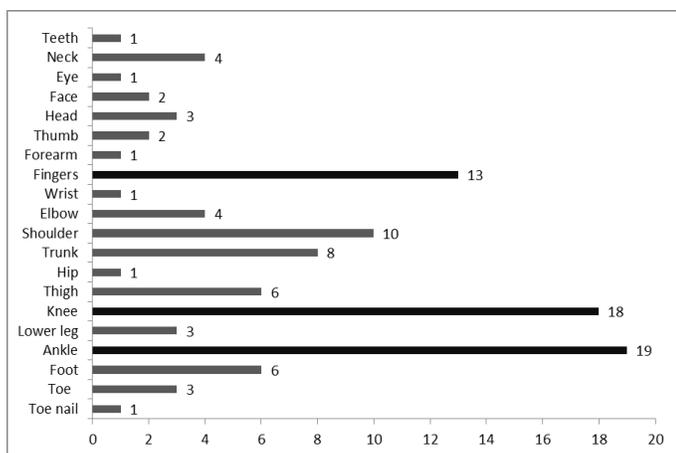


Figure 3. Injury distribution including both curricular and extracurricular injuries.

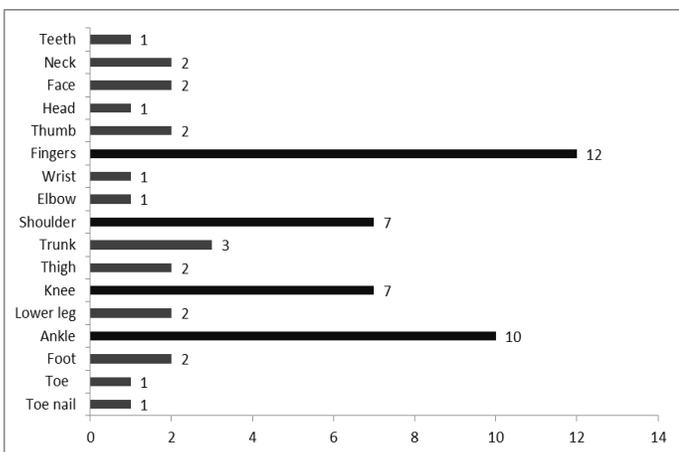


Figure 4. Injury distribution for PE curriculum-related injuries.

Gender differences

Amongst the sports injuries sustained during the curriculum, males had a higher incidence of lower limb injuries compared to the females ($\chi^2 = 0.136$, $p = 0.713$) while females had a higher incidence of upper limb ($\chi^2 = 2.702$, $p = 0.10$) and head and face injuries compared to the male PETE students (Figure 5).

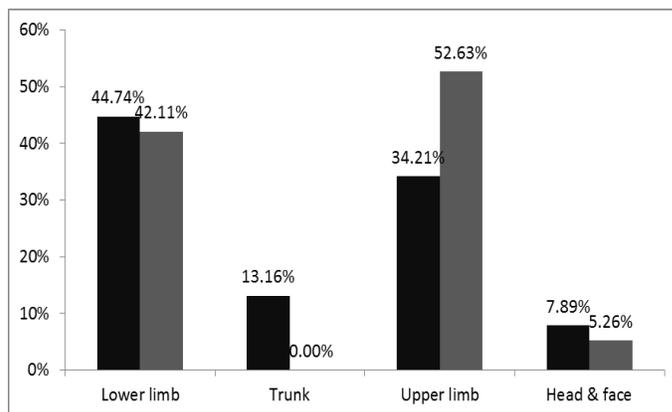


Figure 5. Gender difference in injury distribution amongst the PETE students.

Age predisposition

Results showed that the injury incidence decreased with age and this trend was consistent in both male and female participants (Figure 6).

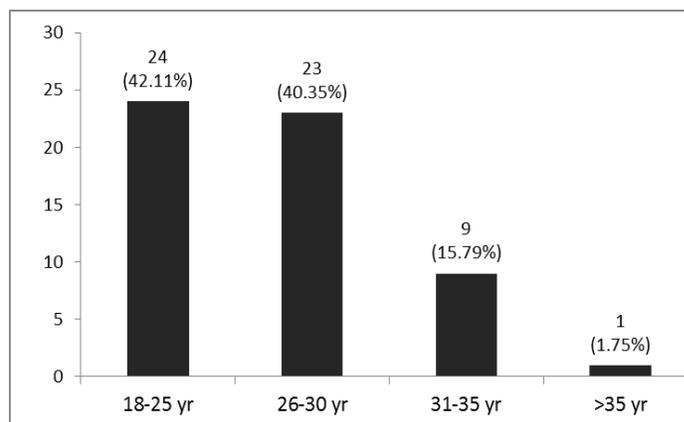


Figure 6. Age predisposition of sports injuries amongst the PETE students.

Injury type

Incomplete ligament sprain was the commonest type of injury (Figure 7) amongst both overall (30.84%) and curriculum-related injuries (42.1%). This was followed by contusion and incomplete muscle-tendon strain. However, there was no significant difference between the type of injuries sustained by males and females (Fisher's exact = 9.846; $p = 0.548$).

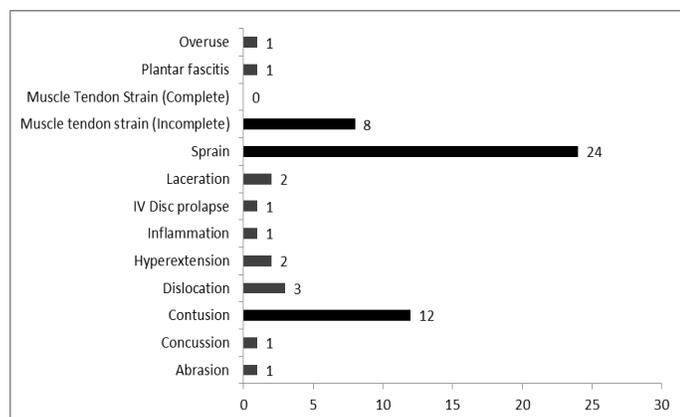


Figure 7. Types of sports injuries sustained during the PE curriculum.

Nature of injuries

The majority of injuries incurred during the PE curriculum were new/acute injuries (73.7%) followed by recurrent (21.5%), aggravation of previous injury (3.5%) and overuse injury (1.75%). In terms of gender, females sustained significantly more number of new injuries compared to the male PETE students (88.2% vs 64.3%; $\chi^2 = 5.387$, $p = 0.020$) while the males suffered a higher proportion of recurrent injuries compared to the females (29% vs 5.3%; $\chi^2 = 1.680$, $p = 0.195$).

Injury mechanism

Majority of the sports injuries sustained were due to contact with the implement while non-contact mechanisms accounted for the least number of injuries during the PE curricular sports lessons (Figure 8).

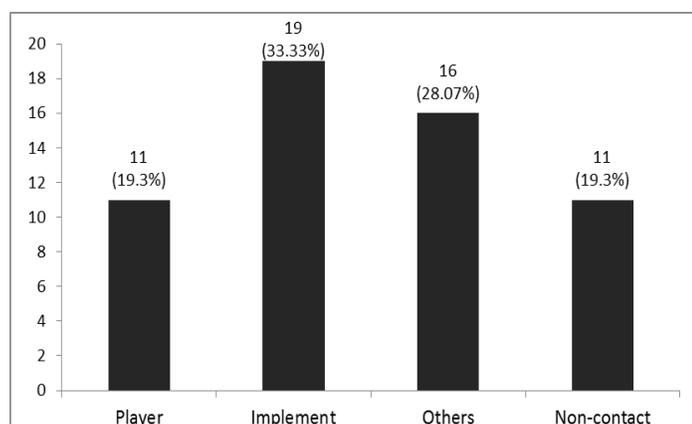


Figure 8. Distribution of injury mechanisms during the PE curriculum sports lessons.

Interestingly, a greater proportion of curricular injuries in males were due non-contact mechanisms (23.7% vs 10.5%) compared to the female PETE students.

Injury severity

In terms of medical attention, the majority of the injuries were mild (84.2%) while medical or physiotherapist consultation was sought for 15.8 % of the curriculum-related injuries. None of the injuries documented were of severe nature. This trend was similar for both male and female PETE students.

In terms of curriculum time loss, 87.7% of injuries were mild not causing any time loss while 8.8% and 3.5% injuries were classified as moderate and severe respectively. 24.5% of injuries led to the students missing sports lessons for up to six days while 5.3% of injuries caused the students to miss sports lessons for seven or more days. There was no significant difference in terms of the severity of injuries based on time loss between male and female PETE students (Fisher's exact = 6.86; $p=0.517$).

Discussion

The university PETE students undergo a rigorous program of training in multiple sports and physical activities during the curriculum making them susceptible to sports injuries. 53.2% of the injuries were sustained during the PE curriculum-related sports lessons and training suggesting that the content and the characteristics of the program exposes the PETE students to a high degree of sports injury risk during the university PE program.

The results showed that the students had an overall injury risk of 0.86 and a curriculum-related injury risk of 0.53. The females had a 19% higher curricular sports injury risk compared to the male PETE students. While the overall injury risk is comparable to that reported by Goosens et al [5] (0.86 vs 0.85), the curricular injury risk in the present study was higher than the above cited study (0.53 vs 0.29) as well as that reported by van Mechelen et al [21] (0.53 vs 0.36) on a generally sports active adult population. However, the overall injury risk of 0.86 and the curricular injury risk of 0.53 in the present study were lower than other previous sports injury reports on PETE students [1-4]. A plausible explanation for the differences in the injury risk between the present study and the previous reports might be based on the exposure time. While van Mechelen et al [21] reported an exposure time of 13665 h and a lower injury risk (0.36), the study by Twellar et al [4] had a higher exposure time of 150286 h (over 4 years) and a higher curricular sports injury risk of 2.25. However, despite the comparable exposure time (20147 vs 22515 h), common duration (one year) and similarity of sports in the curriculum in the Goosens et al [5] study, our study had a higher curricular sports injury risk. This was most likely due to the differences in the injury definition adopted by the two studies. While the injury definition in our study was more inclusive and irrespective of medical attention and time loss, the Goosens et al study included only those injuries which led to the student stopping

activity and/or causing pain during sports and/or inability to fully participate in sports lessons. However, the similar overall injury risk in the present and the cited study (0.86 & 0.85) does suggest that the university PETE students are at a higher risk of sports injuries compared to the general sports active population [21].

The combined injury IR was 2.83 injuries/1000 hours of curricular exposure time. The IR for males and females were 2.46 and 4.03 respectively [5]. While this was higher than that reported in few of the previous studies on PETE populations [4,5], the IR was lower than in another study [3]. While it might be logical to assume that the IR would be a function of the exposure time, it was not necessarily the case [21]. The exposure time per student per year in our study was 162.5 h (IR: 2.83) and that in other studies were 175.9 h (IR: 1.69) [5], 276.3 h (IR: 2.04) [4] and 420 h (IR: 4.72) [3]. This might be due to the differences in the injury definition, severity criteria, study duration reporting criterion (weeks vs calendar year) and the nature of sports in the PE curriculum. While Twellar et al included all injuries reported by the participants, which was similar to our study, Goosens et al adopted an injury definition different from our study and Lysens et al. [3] included only those injuries causing at least a time loss of three days. In terms of duration while the present study and Goosens et al reported the number of weeks, other studies have reported the duration as number of years [1-4]. In addition, while some of the sports were common, one of the studies reported skiing causing about 16% of the injuries [1].

A particularly noteworthy finding was a curricular injury IR of 4.03 amongst the female PETE students which was higher than in previous studies [4,5]. Furthermore, this IR was comparable to that reported in elite and high-level female footballers and team sports athletes [22-24] suggesting that the female participants seem to be at a much higher risk.

The lower limb was the most commonly affected part accounting for 52.3% of the overall injuries and 43.8% of the curricular injuries. This was in agreement with the previous studies [1,2,4,5] suggesting that the lower limb is the highest risk body part in the PETE students. This might be explained by the high-intensity intermittent and impact loading nature of sports like rugby, soccer, field hockey and basketball in the curriculum. This notion is substantiated with the finding that the ankle and the knee being maximally loaded in such sports were the most commonly injured parts of the lower limb.

An interesting finding was that the upper limb injuries accounted for greater proportion of curricular injuries (40.3%) compared to the overall (29%) injuries. This was higher than the Goosens et al study that reported the upper limb to account for 21.1% of the overall injuries. Moreover, fingers were the most commonly affected body part (21%) during the curriculum

followed by the ankle and knee. Apparently none of the previous studies have reported such findings making it improbable to provide a comparative elucidation. A plausible explanation of the high incidence of finger injuries might be based on the sports in the curriculum. Ball handling sports like basketball, volleyball, and rugby involve a higher risk of finger injuries [25]. Fingers have also been reported to be at a high risk in field hockey [26]. Moreover, many of the PETE students may not have played these sports prior to being exposed during the PE program and hence may lack the necessary motor skills for the sport. The high incidence of finger injuries is a concern as fingers take time to heal and a history of finger injury increases the risk of new injuries [25]. Moreover in the PETE students it might affect sports involvement as well as academic activities like writing and typing. This makes it imperative to take necessary preventive actions like using protective wear and training to develop the required motor skills for the sport.

It is noteworthy that the male students sustained 46.3% of the total injuries during the PE curriculum compared to 76% of injuries in the females. This trend was similar to the previous reports [5]. The male participants incurred a marginally higher proportion of lower limb injuries compared to the females while the female students sustained relatively greater number of upper limb injuries than males during the PE curriculum. This finding was contrary to the previous studies [2,5] that reported women sustaining more knee and lower leg injuries. Based on similar injury distribution patterns and comparable IR it has been suggested that no separate injury prevention programs should be developed for women and men [5]. However, the results of our study show that the females had a higher injury risk and IR during the PE curriculum and specific patterns in injury distribution compared to the male students. This finding might be reflective of the population-specific characteristics of the female participants in our study. The results showed that the male participants sustained the majority of injuries during extracurricular sports and activities suggesting that they had higher overall sports exposure and hence probably better training status compared to the females. This speculation is supported by a previous study reporting that the differences in the amount of training could explain the gender differences in the sports injuries [27]. Therefore it is likely that the higher injury risk, IR and upper extremity predominance of injuries in the female PETE students might be due to the relative lack of training rather than due to risk elements in the PE curriculum. However, this assumption merits further investigation.

Age is a potential factor that increases the risk of injury due to structural and functional alterations in the body [28]. A recent trend at the NIE Singapore has been an increasing number of students opting for the PE teaching profession as a mid-career change option. The number of PETE students in the fourth decade of life at the time of admission has increased from 7 to 24

in the last five years. While no previous studies have reported similar trends, it is critical to investigate the age-related risk of sports injuries in the PETE students. Remarkably the results showed a clear trend of decrease in the injury incidence with increase in age. While it is improbable to conclusively explain this phenomenon, it is likely to be a reflection of individual behavior with the older participants deliberately avoiding high-risk situations and adhering to safe practices.

Sprain was the commonest type of injury sustained during the PE curriculum followed by contusion and incomplete muscle-tendon strain. While this is in agreement with a previous study [4] it represents a concern for the PETE students. It has been reported in follow-up studies that recurrent injuries most commonly are ligament sprains and incomplete muscle strains [29]. The same study also reported that recurrent injuries caused more athletes to end sports participation than new injuries. Therefore injuries like sprain and strain have a high likelihood of recurrence with the potential of adversely affecting sports training during the PE program as well as have a long-term effect during their professional careers. This makes it critical to further investigate the specific risk factors for these injury types and distributions so that targeted preventive measures can be implemented during the PE program. The incidence of new/acute injuries sustained during the PE curriculum was almost 3.5 times greater than recurrent injuries. While this might suggest that the loading patterns of sports training in PE program exposes the students to a higher risk of sports injuries, relative lack of training and past exposure to certain sports is also a plausible explanation. This notion is supported by the finding that the female PETE students sustained significantly higher proportion of new injuries compared to the male students thus corroborating our previous explanation that the females have relatively lower sports exposure and training adequacy compared to the male students. It may therefore be worthwhile for the female PETE students to increase their sports exposure and undergo additional training and conditioning both prior to and following the start of the PE program.

Contrary to the previous reports [5] our results showed that most injuries during the PE curriculum were due to contact mechanism with contact with the implement accounting for the majority of injuries. Moreover, a greater proportion of injuries in female students were due to contact mechanisms. Collectively, this finding implies a lack of motor skills necessary for implement-based sports like basketball, soccer, field hockey and volleyball. Therefore, it is vital that the students are exposed to a wide range of sports during their pre-university years.

The majority of injuries sustained did not require medical or physiotherapy consultation. This was contrary to the recent study [5] reporting that medial and physiotherapeutic aid was

sought for majority of the injuries. While it is difficult to elaborate this difference, accessibility of medical and physiotherapy facilities might be a probable factor. There was no medical or physiotherapy facility in the vicinity of our institute and hence the students might have chosen the wait and watch option rather than making time to seek medical help. However, 15% of injuries were of moderate severity requiring medical/physiotherapy aid and/or basic investigations implying that the sports injuries incurred during the PE curriculum does have some direct economic implications on the PETE students.

In terms of time loss, the majority of the injuries sustained did not lead to the students missing classroom lessons. However, almost a quarter of the injuries caused inability to attend sports lessons for up to six days and about 5% of injuries affected sports participation for seven or more days. This is again not in accord with the previous studies [4,5] reporting more than 50% of injuries affecting sports participation for more than a week. While the overall injury severity was comparatively lower in our study, about 30% of injuries led to some degree of time loss thus adversely interrupting the learning of techniques and skills, training and practice during the program which might eventually be detrimental to the performance of the affected students in the program.

Limitations of the study

While this study was a comprehensive and prospective epidemiological investigation of sports injuries in the university PETE students, there were a few limitations. Firstly, as a part of the Ethical Board's advice, the participants were given the option if they wanted to provide their names and other personal details. However, the majority chose not to reveal their names. This prevented us from following them up and estimating the odds ratio and relative risk of sustaining a re-injury or aggravation in those with previous history of injuries. Secondly, the questionnaire did not require the students to specify the sport during which the injury was sustained. Therefore, it is improbable to determine specific sport in the PE curriculum with a higher risk of injuries.

While the study had the aforementioned limitations, the prospective design, an inclusive injury definition, the duration of study and direct proximity to the participants constitute a strongly representative data on sports injuries in the university PETE student population.

Conclusion

Sports injuries in the university PETE students can adversely affect their teacher training and also interfere with their professional career in the long-term. The results showed that the PETE students were at a high risk of sports injuries with female students being at a much higher risk compared to males.

While lower limb was the overall most commonly affected part, the upper limb accounted for a significant number of curriculum-related injuries with fingers incurring the maximum injuries. This finding together with the higher incidence of new injuries suggest a relative lack of sports exposure, necessary motor proficiency and training adequacy especially amongst the female students which may be a specific focus of the injury prevention strategy in this population. Sprains and partial muscle tendon strains being the commonest injuries increase the risk of recurrent injuries in the students thus providing further insights for injury prevention strategies. While the overall severity of the injuries was low, the findings do reflect some medical cost-related direct economic implications and time loss-related repercussions on training and career thus further emphasizing the significance of injury prevention in the university PETE students.

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