Research Article

Association of age, BMI and physical activity with the risk of musculoskeletal injuries among school going children

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ABSTRACT

Background: Understanding the factors that predict risk of musculoskeletal injuries among school going children is necessary for developing timely intervention before accidents occur.

Objective: To analyse the relationship between age, BMI, physical activity and MSK injuries among school going children.

Methodology: A cross sectional analytical study was carried out on children of schools of Islamabad and Rawalpindi having sample size n=127. Male students of age between 8-12 years were included in the study. Data was collected including age, BMI and physical activity level on Physical Activity Questionnaire for Children (PAQ-C) and risk of injury with Functional Movement Screen (FMS). Data was analysed using Hierarchical Regression Analysis.

Result: A multiple regression results showed that variables were statistically non-significant and showed low explanatory power. $F(9, 90)=0.936$, $p=0.497$. in model 1 Age and BMI explain 3.7% of total variance in injury risk. And in model 2 adding physical activity increased the variance to 6.7%.

Conclusion: Only considering how old, what sex or what BMI a school-age child has does not accurately show injury risk. It did not appear that exercise was greatly protective, even though obesity seemed to lower the chance of muscle and bone injuries. Therefore, it appears that factors such as what exercise is done, someone's general health and the environment are more important in predicting injury risk.

Keywords: age; BMI; musculoskeletal injuries; physical activity.

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INTRODUCTION

Globally, musculoskeletal injuries are a significant public health issue that contribute significantly to the burden of pain and disability[1,2]. In children and adolescents, musculoskeletal complaints are prevalent. Children's physical and mental health suffers as a result of these symptoms. but little is known about their underlying causes and risk factors[3]. The most significant cause of MSK injuries on children is musculoskeletal discomfort, which restrict the mobility and result in MSK pain, psychological, and physical issues[4, 5].

In children increased body weight cause joint and spinal stress, while poor fitness, inadequate training, or postural misalignment can heighten vulnerability[6]. The overuse injuries also caused by early specialization and weight training[7]. The prolonged sitting, improper ergonomics, family history of musculoskeletal pain, and psychosocial stress may also contribute[8, 9]. Sports-related injuries in children are also common because their bodies are still growing[10]. During growth spurts, flexibility decreases and changes in bone and muscle development make them more vulnerable to strain[11].

Although children generally heal faster, the period of rapid growth creates an imbalance between strength and flexibility, increasing the risk of injury. Children with low fitness levels or limited mobility may also experience more pain and difficulty participating in physical activities, which can lead to chronic problems[12]. Body Mass Index (BMI) and physical activity are strongly linked. While BMI is often used to define weight categories, it does not reflect muscle mass or fat distribution. Regular physical activity helps maintain a healthy BMI by improving metabolism, burning calories, and supporting overall health[13,14,15].

Previous research on musculoskeletal injuries in school-age children identified a number of important gaps in the body of knowledge. Children who were not athletes in school settings did not received enough attention in the literature since most of it has been on adult or athletic groups. Furthermore, there was a dearth of thorough information on kids from particular areas, especially in low- and middle-income nations where environmental and educational circumstances differed widely. Although there is a wealth of research on paediatric MSKI worldwide, there is comparatively little thorough, region-specific data available in Pakistan, especially when it comes to school-age children and a wide range of risk factors other than merely large school bags. Thus the objective of this study was to examine associations of age, BMI, and physical activity with musculoskeletal injury risk among school-going children.

METHODOLOGY

Study Design: This study employed a cross-sectional design to conduct in private schools located in Rawalpindi and Islamabad, with data collection taking place between August and October 2024.

Participants Selection: A total of n=200 participants meeting the eligibility criteria were approached, of whom n=127 were included in the study. The study included male school-going children aged between 8 and 12 years. Participants were not actively engaged in any form of competitive sports during the study period. Children were excluded from participation if they had any mental or physical disability, a recent history of acute illness or fracture, active inflammation or infection, or any physical deformity that could interfere with the assessment or performance of physical activity.

Variables: The age, BMI and physical activity level on Physical Activity Questionnaire for Older Children (PAQ-C) were used to collect the data. The Low PAQ-C score means low physical activity and vice versa. The Functional Movement Screen (FMS) is standardise screening tool to assess the movement efficiency, including limitations, asymmetries, and dysfunctional movement patterns. In FMS, there are seven fundamental exercise tasks including deep squat, hurdle step, in-line lunge, shoulder mobility, active straight-leg raise, trunk stability push-up, and rotary stability. A three-point Liker scale ranged from 0-3 was used to assess the movement efficiency. The zero indicate low movement quality and three mean high. The total score is 21, while ≤14 means have greater odd for sustaining an injury.

Data collection process: The data was collected during break time to ensure standard conditions for all assessments. All assessments were taken on all tools under the supervision of sports physical therapist to ensure consistent scoring. The systematic sampling technique was used to recruit the sample from n=779 students, evaluated for eligibility and out of which n=127 student full filled the criteria.

Sample Size: The sample size was calculated by G*Power 3.1.9.7, with an effect size of 0.25, a significance level (α) of 0.05, and a power (β) of 0.80. So the total sample size was n=127 participants, needed to find association between variables.

Statistical method: The demographic variables were presented as mean±SD, including age, height, weight, and BMI. While the categorical variables were presented as frequency distribution in graphs,

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such as grades/classes, BMI categories, and PAQ-C items. The assumption of the model based hierarchical regression was met, allowing further analysis. The Model 1 was included Age and BMI category to predict the ability of demographic characteristics. While in the Model 2 Physical Activity Variables the PAQ-C items from Q2-Q8, representing school-based, leisure, and organized physical activities, to assess whether physical activity contributed additional explanatory power beyond demographics. For each model, Coefficient of determination (R^2) to explained variance, F-test for overall model significance, and Unstandardized (β) coefficients with corresponding p-values to determine the significance and direction of individual predictors. Forest plot was used to visually present effect sizes and confidence intervals. A $p<0.05$ was considered statistically significant. The analysis was done by using SPSS ver 26.

Ethical consideration: Ethical approval was obtained from the research and ethical committee of Riphah College of Rehabilitation and Allied Health Sciences (Riphah/RCRAHS-ISB/REC/MS-PT/01926) and permission was granted by Principals Allied school, Islamabad. Informed consent from parents and assent from students were obtained, ensuring confidentiality and anonymity throughout the study.

RESULTS

The mean age of the n=127 participants was 10.89±1.43 years, with average height 133.54±10.55 cm, ranging from 101.0 cm to 154.2 cm. The mean Body Mass Index (BMI, was 17.60±0.62, with range from 15.98 to 19.99. The n=90(70%) of the students were from middle grades (3, 4, and 5) contributing in the study. (Figure 1-3)

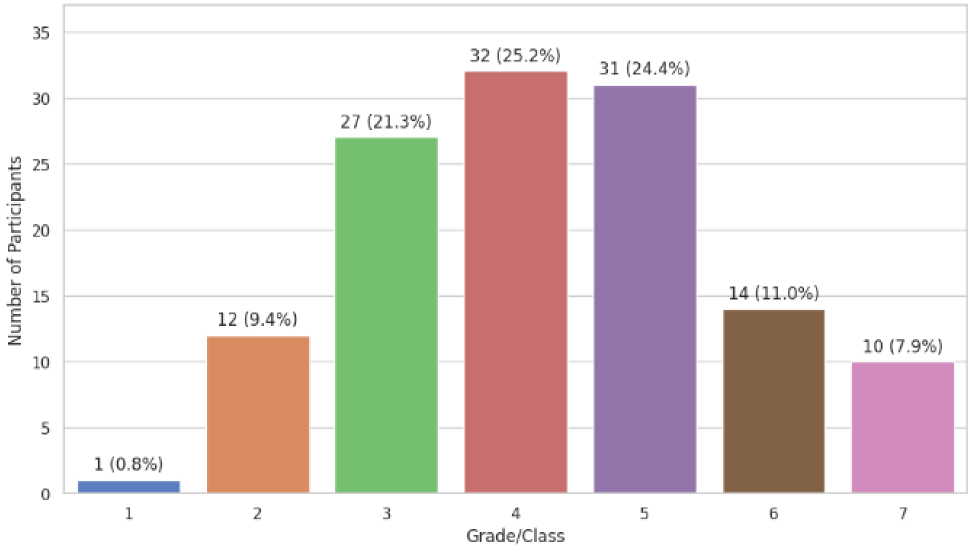

Figure 1: Frequency distribution (Grades/Classes)

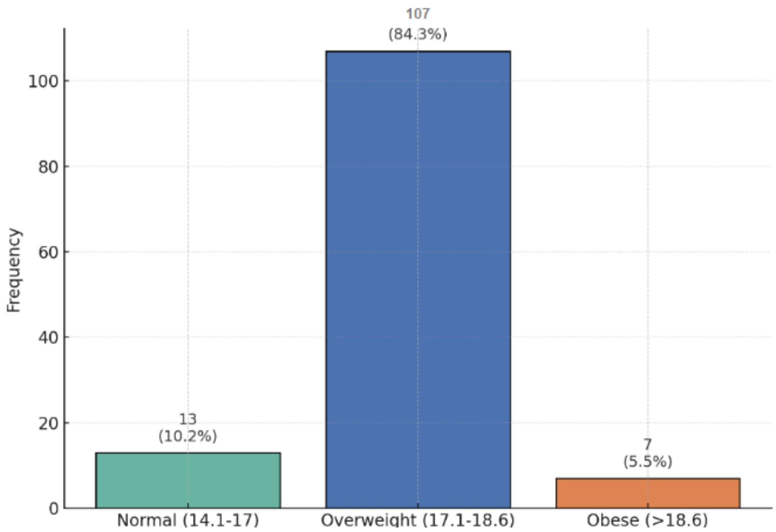

Figure 2: Frequency distribution (BMI)

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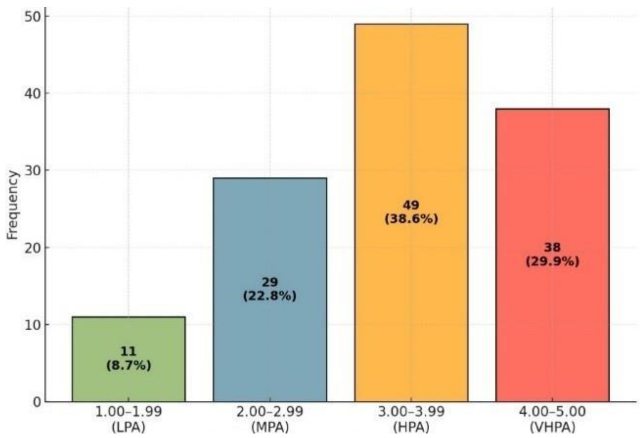

Figure 3: Frequency distribution (PAQ-C)

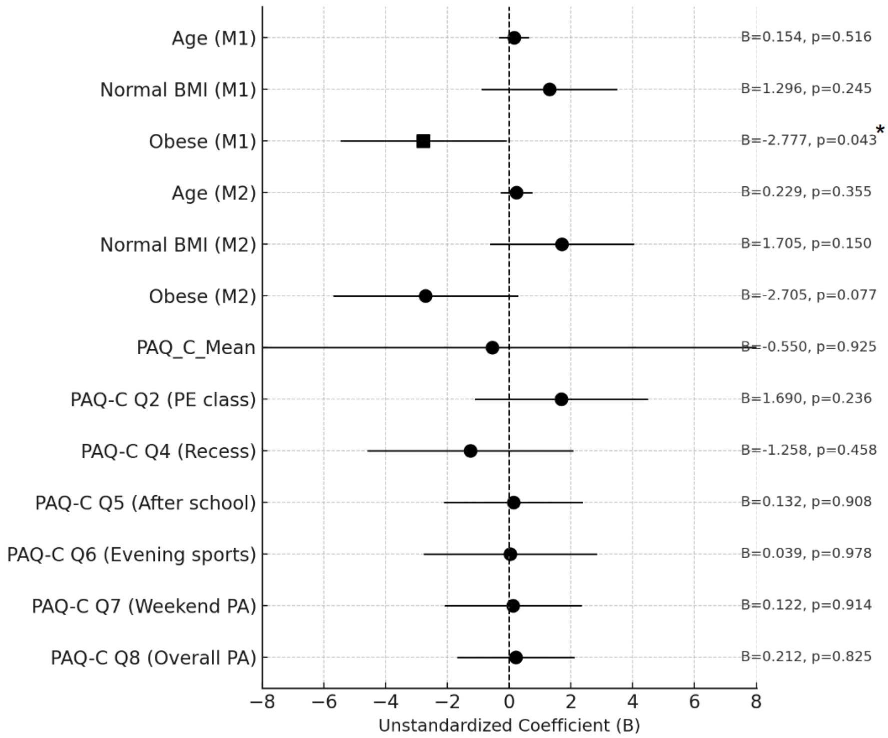

Figure 4: Forest plot of hierarchical regression analysis

The hierarchical regression analysis was structured in two sequential models: the first included demographic variables (Age and BMI), while the second introduced physical activity-related variables (PAQ-C Q2 to Q8) to assess their additional predictive power. Despite meeting assumptions, these models showed low and non-significant explanatory power and overall fit, limiting their practical predictive value.

The first model, which included only Age and BMI category, accounted for 3.7% of the variance in musculoskeletal injury risk (R^2=0.037). However, this model was not statistically significant {F(2, 97)=2.363, p=0.098}, indicating limited predictive value. In the second model, the inclusion of physical activity variables from the PAQ-C (Q2–Q8) slightly increased the explained variance to 6.7% (R^2=0.067), but the Adj. R^2 dropped to -0.005, suggesting over fitting. The overall model remained non-significant {F(9, 90)=0.936, p=0.497}, indicating that the additional predictors did not improve model performance.

The results showed that age was not a significant ($p \geq 0.05$) predictor in either model. In Model 1, being obese was associated with a significant decrease (p=0.043) in injury risk compared to the overweight reference group. In Model 2, this effect became non-significant (p=0.077), suggesting that the inclusion of PAQ-C variables diluted the BMI effect. None of the PAQ-C items were also not statistically significant ($p \geq 0.05$), but PAQ-C Q2 showed a positive trend and PAQ-C Q4 displayed a negative trend. (Figure 4)

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DISCUSSION

The objective of this study was to examine associations of age, BMI, and physical activity with musculoskeletal injury risk among school-going children. The result suggested that the age did not significantly predict injury risk in either model (p=0.221 in Model 1; p=0.194 in Model 2), though it showed a weak positive association.

According to a study on injuries connected to teenage physical activity, the incidence of injuries varied by age group, with older kids showing a reduced chance of getting hurt when engaging in leisure-time physical activities than their younger counterparts[16]. In order to promote musculoskeletal health in school-age children, research highlights the dynamic link between age and MSK injury risk and the necessity of age-appropriate preventative strategies, such as strength training, movement instruction, and safe play spaces[17].

Children's musculoskeletal systems change as they mature, resulting in changes in muscular strength, coordination, and bone density that may affect their susceptibility to injuries[18]. While physical development may play a part in injury risk, posture, habits of physical activity, and environmental variables are more important[19]. These results provide confidence to the idea that, although age may have a positive associated with the incidence of MSK injuries. Other characteristics including physical development, movement efficiency, and exposure to activities that are prone to injuries are probably more important. The body of research highlights the necessity of a multifaceted strategy for injury prevention that takes age into account in addition to physiological, biomechanical, and environmental factors[20].

The studies showed that the FMS identify asymmetries and functional movement deficits, which are frequently associated with musculoskeletal injuries. Those with higher BMIs especially those who are overweight or obese generally have lower FMS scores, which may indicate movement injuries and a higher risk of injury[21, 22]. Research has demonstrated that changes in FMS performance can forecast changes in BMI over time, supporting the notion that movement competence is essential for preserving a healthy weight[23].

Furthermore, kids with lower FMS scores typically do less exercise, which increases sedentary behaviour and may have long-term health effects [24]. The relationship between schoolchildren's BMI and levels of physical activity was examined in a research published in BMC Public Health. Children who are overweight or obese were shown to be less active, which may lead to inefficient mobility and a higher risk of injury[25]. Being overweight may increase the strain on the musculoskeletal system, leading to discomfort and potential long-term health issues[4]. In current study, the BMI is statistically significant, but it is unlikely to be the only factor influencing injury risk. The low sample size may be the reason for insignificant results.

Because BMI primarily assesses weight in relation to height rather than body composition or functional movement patterns, it may not be a good indication of injury risk on its own. Muscle mass, fat distribution, and other biomechanical characteristics that affect movement efficiency and injury risk are not taken into consideration by BMI. These findings could potentially be the consequence of methodological variances, population-specific changes, or the requirement for a multifactorial strategy that integrates screening techniques other than BMI. A more thorough knowledge of children's injury risk may be possible by taking into account different metrics such body fat percentage, mobility evaluations, and levels of physical activity[26].

This result suggests that the model's accuracy in determining the risk of musculoskeletal injuries was not significantly improved by adding PAQ-C items. The results show that, despite to improve the model by adding more variables, did not offer significant explanatory power. Numerous studies have examined the connection between children's injury risk and physical activity, with varying degrees of predictive validity[27, 28]. Although physical activity has many health advantages, there is an inherent risk of injury, especially for school-aged children, according to research published in the British Journal of Sports Medicine[29].

The school-age children's are naturally at risk for injuries when participating in physical activities. Organized sports have a higher injury incidence rate than disorganized leisure activities[30]. The significance of progressive adaptation to exercise by showing that children who have lower regular levels of physical activity are more likely to sustain injuries during physical activities[31]. Predicting injuries is difficult since physical activity isn't always a reliable indicator on its own. Injury risk is influenced by a number of factors, including individual differences, environmental factors, prior injuries, and biomechanics[32]. It shows that injury prediction models are variable and occasionally incorrect due to the lack of strong, evidence-based criteria in school sports injury prevention strategies. Given that injury patterns vary according to a child's developmental stage and degree of sports engagement, age and maturity play a significant role as well[33]. Biomechanical, physiological, environmental, and psychological factors all play a part in injuries. biomechanical, physiological, psychological and environmental factors collectively influence injury occurrence[34, 35].

This study has several limitations. Future studies should have a more varied sample size to increase the findings' relevance because gender and sex affect BMI, exercise levels, and injury patterns. The use of self-reported measures, such as the PAQ-C, may have introduced recall and social desirability bias. As the sample size was smaller and limited to students from selected private schools, the findings may not be generalizable to all schoolchildren.

CONCLUSION

The results of this study indicate that school-age children's injury risk cannot be accurately predicted by age, or physical activity levels alone. Consequently, methods for preventing injuries shouldn't be limited to these specific traits. Instead, to create successful preventative measures, a more thorough strategy that considers a variety of physiological and environmental aspects is required. The findings also show that the regression model's ability to adequately explain injury risk is limited, highlighting the need for more study.

DECLARATIONS & STATEMENTS

Author's Contribution

SN, MJ and AI: substantial contributions to the conception and design of the study.
RF and AT: acquisition of data for the study.
AT, MJ and AI: interpretation of data for the study.
SN, RF and AT: analysis of the data for the study.
SN, RF, AT, MJ and AI: drafted the work.
SN, RF, AT, MJ and AI: revised it critically for important intellectual content.
SN, RF, AT, MJ and AI : final approval of the version to be published and agreement to be accountable for all aspects.
of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed to the article and approved the submitted version.

Ethical Statement

Ethical approval was obtained from the research and ethical committee of Riphah College of Rehabilitation and Allied Health Sciences (Riphah/RCRAHS-ISB/REC/MS-PT/01926) and permission was granted by Principals Allied school, Islamabad. Informed consent from parents and assent from students were obtained, ensuring confidentiality and anonymity throughout the study.

AI Use Statement

The authors used Grammarly to improve language clarity during manuscript preparation. Generative AI tools such as ScisSpace and Semantic Scholar were used to assist with literature summarization and refinement of the research rationale. All interpretations, conclusions, and original ideas remain solely those of the authors and approved by the authors.

Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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Funding Sources

None to declare.

Conflicts of Interest

None to declare.

REFERENCES

1. Hauret KG, Jones BH, Bullock SH, Canham-Chervak M, Canada SJAjopm. Musculoskeletal injuries: description of an under-recognized injury problem among military personnel. Am J Prev Med. 2010;38(1):S61-S70. [CrossRef] [PubMed]
2. Mock C, Cherian MNJCo, research r. The global burden of musculoskeletal injuries: challenges and solutions Clin Orthop Relat Res. 2008;466(10):2306-16. [CrossRef] [PubMed]
3. El-Metwally A, Salminen JJ, Auvinen A, Macfarlane G, Mikkelsson MJBmd. Risk factors for development of non-specific musculoskeletal pain in preteens and early adolescents: a prospective 1-year follow-up study. BMC Musculoskelet Disord .2007;8:1-8. [CrossRef] [PubMed]
4. Viester L, Verhagen EA, Hengel KMO, Koppes LL, van der Beek AJ, Bongers PMJBmd. The relation between body mass index and musculoskeletal symptoms in the working population. 2013;14:1-9. BMC Musculoskelet Disord. [CrossRef] [PubMed]
5. Amani F, Zakeri A, Abbasi V, Bahadoram M, Davoodi M, Dorestan NJJPE. The prevalence of musculoskeletal pains among students. J Prev Epidemiol 2018;3(1):e06.. [CrossRef]
6. Warda DG, Nwakibu U, Nourbakhsh A. Neck and upper extremity musculoskeletal symptoms secondary to maladaptive postures caused by cell phones and backpacks in school-aged children and adolescents. Healthcare (Basel). 2023;11(6). [CrossRef] [PubMed]
7. Cristian Manescu, D. Training and Testing Strategies in Young Athletes: A Critical Review Across Sports Specialization Pathways. Preprints 2025, 2025061785. [CrossRef]
8. Ozyemisci Taskiran O, Topaloglu M, Giray E, Turan Z, Yilmaz Yalcinkaya E, Sakarya S. Musculoskeletal complaints and associated factors in school children aged between 6 and 13 years in Istanbul during the COVID-19 pandemic: A cross-sectional study. Work. 2023;74(3):811-21. [CrossRef] [PubMed]
9. Fabricant PD, Lakomkin N, Sugimoto D, Tepolt FA, Stracciolini A, Kocher MSJTP, et al. Youth sports specialization and musculoskeletal injury: a systematic review of the literature. Phys Sportsmed .2016;44(3):257-62. [CrossRef] [PubMed]
10. Shanmugam C, Maffulli NJBmb. Sports injuries in children. Br Med Bull. 2008;86(1):33-57. [CrossRef] [PubMed]
11. Zoellner A, Whatman C. "The association between biological maturity and injury in young females

https://doi.org/10.52567/trehabj.v9i04.118

participating in sport: A systematic review". Phys Ther Sport. 2025. [CrossRef]

12. BAXTER-JONES AGJSm. Common skeletal injuries in young athletes. Sports Med. 1995;19(2):137-49. [CrossRef] [PubMed]
13. De la Corte-Rodriguez H, Roman-Belmonte JM, Resino-Luis C, Madrid-Gonzalez J, Rodriguez-Merchan EC. The Role of physical exercise in chronic musculoskeletal pain: best medicine-a narrative review. Healthcare (Basel). 2024;12(2). [CrossRef] [PubMed]
14. Bradbury KE, Guo W, Cairns BJ, Armstrong ME, Key TJJBo. Association between physical activity and body fat percentage, with adjustment for BMI: a large cross-sectional analysis of UK Biobank. BMJ Open .2017;7(3):e011843. [CrossRef] [PubMed]
15. Alangari AA, Almutairi MM, Alrrajeh AM, Aleidi MA, Alqarni MA, Almeneif HA, et al. The Relation Between Body Mass Index and Musculoskeletal Injury. Cureus. 2022;14(9):e28965. [CrossRef] [PubMed]
16. Räisänen AM, Kokko S, Pasanen K, Leppänen M, Rimpelä A, Villberg J, et al. Prevalence of adolescent physical activity-related injuries in sports, leisure time, and school: the National Physical Activity Behaviour Study for children and Adolescents. BMC Musculoskelet Disord. [2018;19:1-8. CrossRef] [PubMed]
17. Fritz J, Cöster ME, Stenevi-Lundgren S, Nilsson J-Å, Dencker M, Rosengren BE, et al. A 5-year exercise program in children improves muscle strength without affecting fracture risk. Eur J Appl Physiol. 2016;116:707-15. [CrossRef] [PubMed]
18. Wik EH, Chamari K, Tabben M, Di Salvo V, Gregson W, Bahr R. Exploring growth, maturity, and age as injury risk factors in high-level youth football. Sports Med Int Open. 2024;8:a21804594. [CrossRef] [PubMed]
19. Johnson DM, Cumming SP, Bradley B, Williams S. The influence of exposure, growth and maturation on injury risk in male academy football players. J Sports Sci. 2022;40(10):1127-36. [CrossRef] [PubMed]
20. Faienza MF, Urbano F, Chiarito M, Lassandro G, Giordano PJFiP. Musculoskeletal health in children and adolescents. Front Pediatr .2023;11:1226524. [CrossRef] [PubMed]
21. Nicolozakes CP, Schneider DK, Roewer BD, Borchers JR, Hewett TEJJosr. Influence of body composition on functional movement Screen™ scores in college football players. Front Pediatr. 2018;27(5):431-7. [CrossRef] [PubMed]
22. Duncan MJ, Stanley M, Leddington Wright S. The association between functional movement and overweight and obesity in British primary school children. BMC Sports Sci Med Rehabil. 2013;5:11. [CrossRef] [PubMed]
23. Duncan MJ, Stanley M. Functional movement is negatively associated with weight status and positively associated with physical activity in british primary school children. J Obes. 2012;2012:697563. [CrossRef] [PubMed]
24. Bardenett SM, Micca JJ, DeNoyelles JT, Miller SD, Jenk DT, Brooks GSJIjospt. Functional movement screen normative values and validity in high school athletes: can the FMS™ be used as a predictor of injury? Int J Sports Phys Ther. 2015;10(3):303. [PubMed]
25. Schwarzfischer P, Weber M, Gruszfeld D, Socha P, Luque V, Escribano J, et al. BMI and recommended levels of physical activity in school children. BMC Public Health. 2017;17:1-9. [CrossRef] [PubMed]
26. Pollack KM, Xie D, Arbogast KB, Durbin DRJIp. Body mass index and injury risk among US children 9–15 years old in motor vehicle crashes. Inj Prev. 2008;14(6):366-71. [CrossRef] [PubMed]
27. Wang C, Stokes T, Vargas JT, Steele R, Wedderkopp N, Shrier I. Predicting injury risk over changes in physical activity in children using the acute:chronic workload ratio. Am J Epidemiol. 2022;191(4):665-73. [CrossRef] [PubMed]
28. Costa e Silva L, Silva AL, Teles J, Fragoso I. Study on the influence of physical activity intensity and maturation on sports injuries in children and adolescents. Appl. Sci. 2024;14(22):10632. [CrossRef] [PubMed]
29. Bloemers F, Collard D, Paw MCA, Van Mechelen W, Twisk J, Verhagen EJBjosm. Physical inactivity is a risk factor for physical activity-related injuries in children. Br J Sports Med.2012;46(9):669-74. [CrossRef] [PubMed]
30. Nauta J, Martin-Diener E, Martin BW, Van Mechelen W, Verhagen EJSm. Injury risk during different physical activity behaviours in children: a systematic review with bias assessment. Sports Med. 2015;45:327-36. [CrossRef] [PubMed]
31. Myer GD, Faigenbaum AD, Stracciolini A, Hewett TE, Micheli LJ, Best TM. Comprehensive management strategies for physical inactivity in youth. Curr Sports Med Rep. 2013;12(4):248. [CrossRef] [PubMed]
32. Dos'Santos T, Thomas C, McBurnie A, Comfort P, Jones PA. Biomechanical determinants of performance and injury risk during cutting: a performance-injury conflict? Sports Medicine. 2021;51(9):1983-98. [CrossRef] [PubMed]
33. Costa e Silva L, Silva AL, Teles J, Fragoso IJAS. Study on the influence of physical activity intensity and maturation on sports injuries in children and adolescents. *Appl. Sci.* 2024;14(22):10632. [CrossRef] [PubMed]
34. Morrongiello BA, Lasenby-Lessard JJIp. Psychological determinants of risk taking by children: an integrative model and implications for interventions. Inj Prev. 2007;13(1):20-5. [CrossRef] [PubMed]
35. Salminen S, Kurenniemi M, Råback M, Markkula J, Lounamaa AJFiph. School environment and school injuries. Front Public Health. 2014;1:76. [CrossRef] [PubMed]

https://doi.org/10.52567/trehabj.v9i04.118