

A Comparative Study on the Impact of Flooring Types on the Occurrence of Sports Injuries in Elementary Schools

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Abstract

This study investigated the impact of different flooring types on the incidence of sports injuries during physical education sessions in primary schools. Employing a comparative approach, the study analyzed four groups of schools, each using a distinct surface type: artificial grass, asphalt, cement, and dirt. Injury rates, severity, and types were compared using data from existing administrative registers of 46 intentionally selected schools.

The results revealed statistically significant differences in injury rates depending on the surface type, with asphalt surfaces showing the highest injury rates. Additionally, asphalt surfaces were associated with higher rates of severe and moderate injuries. However, no significant differences were observed for mild injuries across the different surfaces. The study also found that bone and joint injuries were more prevalent on asphalt surfaces, while muscle and skin injuries were more common on cement surfaces.

These findings underscore the importance of selecting appropriate flooring to minimize injury risks, offering evidence-based recommendations for creating safer physical education environments. The study suggests that future research should include longitudinal studies and consider broader contextual factors to enhance injury prevention strategies in schools.

1. Introduction

Despite the well-documented benefits of physical education (PE) on the physical, cognitive, and social development of young children, injuries resulting from its practice, especially in the absence of appropriate conditions, can have consequences that extend beyond immediate physical harm. These injuries can impact a child's physical development, academic performance, and emotional well-being while also imposing a financial burden on families. Additionally, such injuries can increase administrative tasks and potential legal liabilities for schools unable to ensure a safe environment. Various studies have highlighted that different types of flooring surfaces influence injury rates among young children, leading to a growing interest in identifying the safest options for school settings. Understanding the relationship between flooring types and sports injuries is crucial for developing safer PE programs and preventing injuries in elementary school students. For example, McKay et al. (2001) found that hard surfaces like asphalt are associated with a high incidence of injuries in recreational basketball, underscoring the need to explore safer alternatives (BJSM).

Although the importance of safe flooring in preventing sports injuries is recognized, comprehensive research directly comparing the impact of different flooring types on injury rates in elementary schools remains limited. Some previous studies have produced conflicting results regarding which surfaces are most hazardous, highlighting the need for systematic comparative analysis. McKay et al. (2001) noted a high incidence of injuries on hard surfaces such as asphalt, while other research has suggested that softer surfaces might reduce the severity but not necessarily the frequency of injuries (BJSM). The lack of consensus among researchers poses a significant challenge in making informed decisions about the most appropriate flooring for elementary school PE activities. Additionally, a longitudinal study by Backx et al. (1991) on high-risk sports in schoolchildren emphasized the critical need for injury prevention strategies, including suitable flooring types, to reduce injury rates in school environments (BJSM).

Despite the available information, there remains a gap in the literature concerning a detailed comparison of common school flooring types,

particularly in Algeria. This gap is notable due to the scarcity of studies in this area, alongside the nature of sports floor coverings used in the local environment—specifically artificial turf, asphalt, cement, and dirt—and their specific effects on the occurrence of sports injuries during physical education classes in primary school children. This study aims to fill this gap by systematically examining how different types of floor coverings in primary schools affect the incidence and nature of sports injuries. By analyzing the rates, severity, and types of injuries on various surfaces, this research seeks to provide evidence-based recommendations for teachers, school administrators, and policymakers.

The main question of this research is: Does the nature of the terrain contribute to the occurrence of sports injuries in primary schools? From this question, several sub-questions emerge:

- Is there a statistically significant difference in the average number of injuries according to the nature of the ground (artificial grass, asphalt, cement, dirt)?
- Are there statistically significant differences in the average number of injuries (in terms of their severity) in light of the nature of the ground (artificial grass, asphalt, cement, dirt)?
- Are there statistically significant differences in the average number of sports injuries (in terms of type) in light of the nature of the ground (artificial turf, asphalt, cement, dirt)?

To answer these questions, the following hypotheses were proposed:

- There is a statistically significant difference in the average number of injuries among primary school children based on the type of ground surface (artificial grass, asphalt, cement, dirt), with a higher incidence of injuries on asphalt floors.
- There are statistically significant differences in the average severity of injuries (severe, moderate, mild) among primary school children based on the type of ground surface (artificial grass, asphalt, cement, dirt), with more severe injuries occurring on asphalt floors.
- There are statistically significant differences in the average number of sports injuries (according to their type: fractures, joint injuries,

muscle damage, skin injuries) based on the nature of the ground (artificial grass, asphalt, cement, dirt), in favor of cement floors.

2. Method and Materials

2.1. Participants

Refers "to group of individuals or elements sharing specific characteristics or attributes that make them the focus of research or investigation" (Fowler, 2013). On this basis, the available population was determined include primary schools located in the city of Al-Wadi, totaling 66 primary schools. To achieve the research aims, purposive sampling was employed. This technique relies on the researcher's judgment in selecting participants from the population (Morgan, 1997). Consequently, 46 schools in Al-Wadi were chosen for the study, representing 69.70% of the total population, as illustrated in Figure 01.

Twenty-nine (29) schools were excluded for various reasons, such as the administration's unwillingness to participate, ongoing renovation work on sports facilities, or the absence of an administrative register necessary to identify student injuries during the current year.

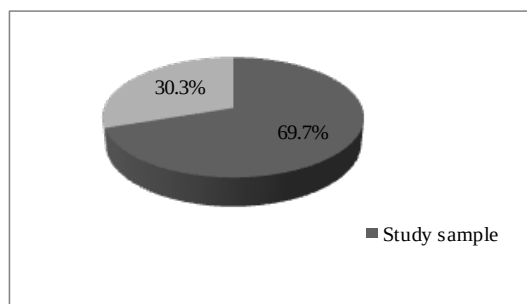


Figure (1). Representation of the sample in relation to the population

The sample of schools was then distributed into groups based on the nature of the ground on which physical education and sports activities are practiced in each institution, as shown in the table (1).

Table (1). Distribution of the sample among the study groups

Floor type	frequency
Artificial grass	11
Asphalt	14
Cement,	12
Dirt	9
Total	46

To ensure the study's integrity and minimize the impact of confounding variables, the homogeneity of the four groups was assessed based on chronological age, gender, physical condition, previous injury history, supervision levels, environmental conditions, and duration and intensity of activity.

2.2. Design and Procedure

- Study Design

This study employs a comparative research design to investigate the impact of different types of flooring on the incidence of sports injuries during physical education sessions in elementary schools. The design allows for the comparison of injury rates, severity, and types across four groups of schools, each using a different flooring type: artificial grass, asphalt, cement, and dirt.

- Variables

Independent Variable: Type of flooring (artificial grass, asphalt, cement, dirt)

Dependent Variable: Number, severity, and type of sports injuries

Confounding Variables: Age, gender, physical condition of students, previous injury history, supervision levels, environmental conditions, duration, and intensity of physical activities.

- Data Collection

Data were collected from the existing administrative registers of the selected schools. These registers included detailed records of sports injuries, categorized by number, type, and severity. The data collection period spanned from April 2 to April 23, 2024.

- Procedure

Grouping: Schools were grouped based on the type of flooring used for physical education and sports sessions.

Data Extraction: Injury data were extracted from the administrative registers of each school, ensuring that data were accurate and comprehensive.

Classification: Injuries were classified according to their number, type (bone and joint injuries, muscle and skin injuries), and severity (mild, moderate, severe).

Homogeneity Check: A homogeneity check was conducted to ensure comparability among the groups in terms of age, gender, physical condition, previous injury history, supervision levels, environmental conditions, duration, and intensity of activity.

- Ethical Considerations

The study adhered to ethical guidelines, ensuring confidentiality and anonymity of the participating schools and students.

2.3. Statistical Analysis

The data were transcribed and analyzed using the statistical analysis program SPSS and an Excel sheet. The following statistical approaches were employed:

Mean, Median, Mode: To summarize the central tendency of injury rates.

Standard Deviation, Variance: To measure the dispersion of injury rates.

Frequency Distributions: To show how injuries are distributed across different types of flooring.

ANOVA (Analysis of Variance): To compare the mean injury rates among the four different flooring types (artificial grass, asphalt, cement, and dirt). fo determine if there are statistically significant differences between groups.

3. Results

a) Presentation and analysis of the results of the first hypothesis

There is a statistically significant difference in the average number of injuries according to the nature of the ground (artificial grass, asphalt, cement, dirt) in favor of asphalt floors. To verify the validity of the hypothesis, the (F) test was used after ensuring the moderation of the distribution of the data (within each group) to identify the significance of the differences. Among four groups of unequal numbers, the results were as shown in Table (2).

Table (2). shows the significance of differences between research groups in the number of injuries.

Variable	Group 1 (Mean ± SD)	Group 2 (Mean ± SD)	Group 3 (Mean ± SD)	Group 4 (Mean ± SD)	Calculated F-Value	Significance of Differences
Number of Injuries	3.45 ± 1.74	11.21 ± 2.75	10.08 ± 4.17	3.89 ± 2.13	4.65	Significant

The tabulated F-value is 2.82 at an error rate of ≤ 0.05 with degrees of freedom $df_b = 3$ and $df_w = 42$.

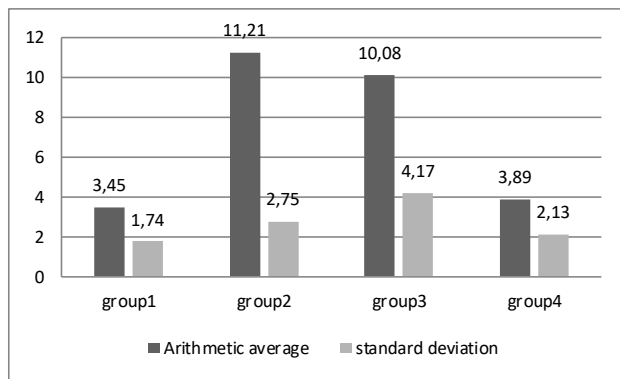


Figure (2). Results according to the arithmetic mean and standard deviation for the research groups in the number of sports injuries

Significance of Differences:

The F-test results in Table 2 indicate that there are significant differences in the number of injuries among the four groups based on the type of ground surface. The calculated F-value of 4.65 exceeds the critical value of 2.82 at the 0.05 significance level, confirming that the differences in injury rates across the different surfaces are statistically significant.

Comparison of Groups:

A closer examination of the means and standard deviations reveals notable differences between the groups:

Group 1 (Artificial Grass): 3.45 ± 1.74 injuries

Group 2 (Asphalt): 11.21 ± 2.75 injuries

Group 3 (Cement): 10.08 ± 4.17 injuries

Group 4 (Dirt): 3.89 ± 2.13 injuries

Among these, Group 2 (asphalt) shows the highest average number of injuries, followed closely by Group 3 (cement). Groups 1 (artificial grass) and 4 (dirt) have significantly lower injury rates. This confirms the hypothesis that asphalt surfaces are associated with a higher incidence of injuries.

Implications for School Settings:

The results have several important implications for the design and management of sport flooring. The high incidence of injuries on asphalt and cement surfaces suggests that these materials are not ideal for children's play areas. Schools should consider using safer alternatives such as artificial grass or dirt, which were associated with significantly lower injury rates. Regulatory bodies should establish and enforce safety standards for playground surfaces in schools, prioritizing materials that minimize injury risks and ensure the well-being of students during physical activities. Schools may need to invest in upgrading their playground surfaces to safer materials. While this may involve initial costs, the long-term benefits in terms of reduced injuries and associated healthcare costs can justify the investment. Additionally, educators and school staff should be trained to recognize and mitigate risks associated with different playground surfaces. They should be aware of the potential hazards of harder surfaces like asphalt and cement and take preventive measures during physical activities. Policymakers should develop comprehensive guidelines that address the construction and maintenance of school play areas.

b) Presentation and analysis of the results of the second hypothesis

There are statistically significant differences in the average number of injuries (according to their severity) depending on the type of ground (artificial grass, asphalt, cement, dirt) in favor of cement floors. To verify this hypothesis, the F test was used after ensuring the evenness of the data distribution within each group to determine the significance of differences between four groups that were unequal in number. The results are shown in Table (3).

Table (3). shows the significance of differences between research groups in terms of injury severity.

Variable	Group 1 (Mean $\pm$ SD)	Group 2 (Mean $\pm$ SD)	Group 3 (Mean $\pm$ SD)	Group 4 (Mean $\pm$ SD)	Calculated F-Value	Significance of Differences
Severe injuries	0.09 $\pm$ 0.29	2.93 $\pm$ 1.64	1.25 $\pm$ 1.04	0 $\pm$ 0	9.34	Significant
Moderate	0.27 $\pm$ 0.73	4.79 $\pm$ 1.98	4.25 $\pm$ 3.09	0.44 $\pm$ 0.73	4.273	Significant
Mild injuries	3.09 $\pm$ 1.91	3.50 $\pm$ 2.50	4.58 $\pm$ 2.46	3.44 $\pm$ 3.12	2.086	Not significant

The tabulated F-value is 2.82 at an error rate of ≤ 0.05 with degrees of freedom $df_b = 3$ and $df_w = 42$.

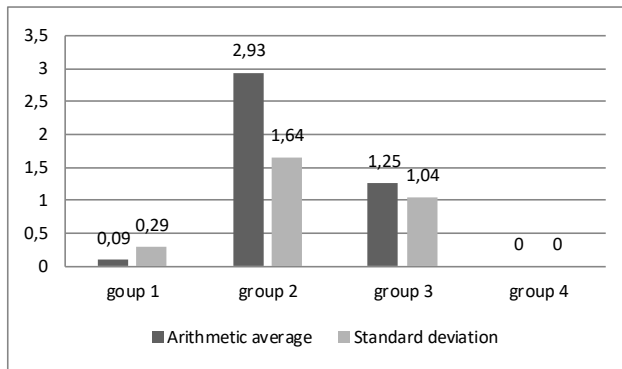


Figure (3). Results according to the arithmetic mean and standard deviation of the research groups in the number of severe injuries

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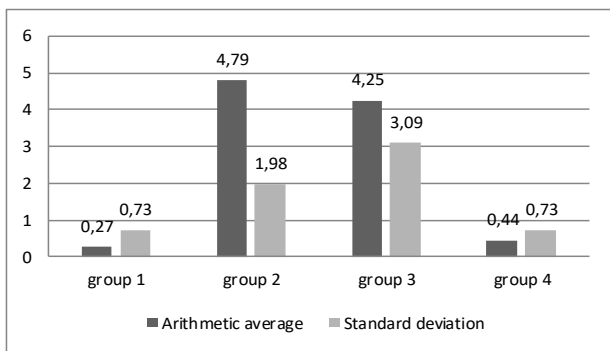


Figure (4). Results according to the arithmetic mean and standard deviation for the research groups in number of moderate injuries

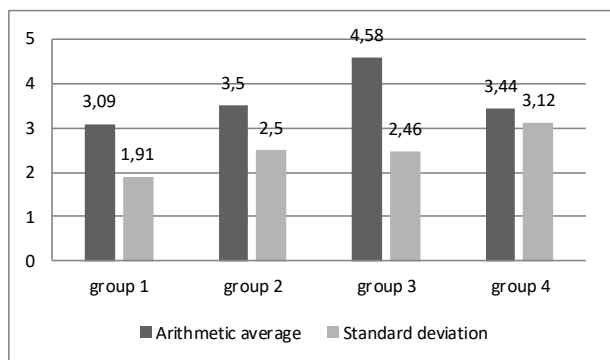


Figure (5). Results according to the arithmetic mean and standard deviation for the research groups in the number of mild injuries

Significance of Differences:

For severe injuries, the calculated F-value of 9.34 indicates a highly significant difference among the groups, with asphalt surfaces (Group 2) showing the highest mean number of severe injuries (2.93 ± 1.64), followed by cement surfaces (Group 3) (1.25 ± 1.04). The absence of severe injuries on dirt surfaces (Group 4) suggests that softer surfaces pose less risk for severe injuries.

For moderate injuries, the calculated F-value of 4.273 also indicates significant differences. Asphalt surfaces again show the highest mean

number of moderate injuries (4.79 ± 1.98), followed closely by cement surfaces (4.25 ± 3.09), while artificial grass and dirt surfaces have much lower averages.

For mild injuries, the F-value of 2.086 is not significant, indicating no statistically significant difference in the number of mild injuries among the four flooring types.

Comparison of Groups:

Severe and Moderate Injuries: Asphalt surfaces have the highest rates of severe and moderate injuries, underscoring their risk for more serious harm. Cement surfaces also show relatively high injury severity but to a lesser extent than asphalt. These findings align with previous research indicating that harder surfaces contribute to more severe injuries (McKay et al., 2001; BJSM).

Mild Injuries: The lack of significant differences in mild injuries suggests that the type of flooring does not notably affect the incidence of less severe injuries, which could be due to the nature of these injuries being less dependent on surface hardness.

Implications for School Settings:

The significant differences in injury severity based on flooring type highlight the need for safer flooring solutions in elementary schools to mitigate the risk of severe and moderate injuries. Schools should consider replacing high-risk surfaces like asphalt and cement with softer alternatives such as artificial grass or dirt, or implement additional safety measures to protect students during PE activities.

These findings support the development of comprehensive injury prevention strategies in schools, including the selection of appropriate flooring materials that reduce the risk of severe and moderate injuries. Such strategies are crucial for ensuring a safe environment for young students, aligning with injury prevention guidelines from previous studies (Backx et al., 1991; Shalaj et al., 2016; BJSM).

c) Presentation and Analysis of the Results of the Third Hypothesis

The third hypothesis states that there are statistically significant differences in the average number of sports injuries (according to their type) based on the nature of the ground (artificial grass, asphalt, cement, dirt), in favor of cement floors. To test this hypothesis, an F-test was employed after ensuring the moderate distribution of data distribution within each group to determine the significance of differences among four groups, which vary in number. The results are presented in Table (4).

Table (4). Shows the significance of the differences between the research groups In terms of nature of injury

Variable	Group 1 (Mean $\pm$ SD)	Group 2 (Mean $\pm$ SD)	Group 3 (Mean $\pm$ SD)	Group 4 (Mean $\pm$ SD)	Calculated F-Value	Significance of Differences
Bone Injury	0.18 $\pm$ 0.57	2.86 $\pm$ 1.46	1.25 $\pm$ 0.94	0.56 $\pm$ 1.57	11.112	Significant
Muscle Injury	0.45 $\pm$ 0.50	0.5 $\pm$ 0.88	1.58 $\pm$ 1.66	0.56 $\pm$ 0.73	3.134	Significant
Joint Injury	0.64 $\pm$ 0.74	2.28 $\pm$ 2	1.08 $\pm$ 1.08	1.89 $\pm$ 1.36	4.144	Significant
Skin Injury	2.18 $\pm$ 2	5.57 $\pm$ 3	6.17 $\pm$ 2.8	0.89 $\pm$ 0.78	13.06	Significant

The tabulated F-value is 2.82 at an error rate of ≤ 0.05 with degrees of freedom $df_b = 3$ and $df_w = 42$.

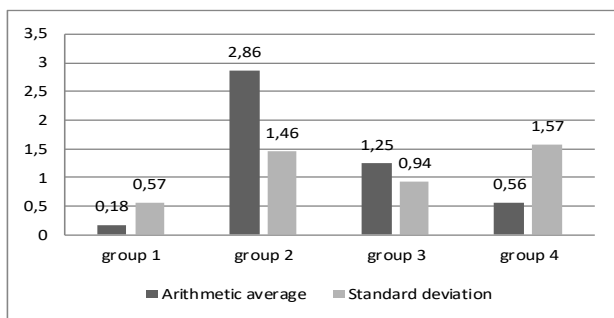


Figure (6). Results according to the arithmetic mean and standard deviation of the research groups in number of bone injury

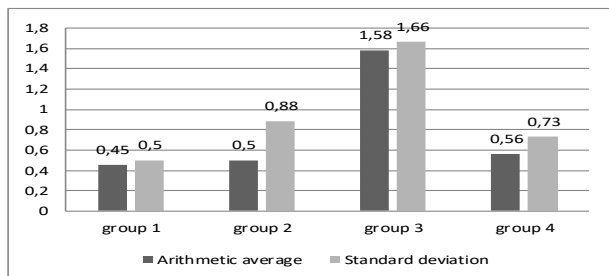


Figure (7). Results according to the arithmetic mean and standard deviation for the research groups in the number of muscle injuries

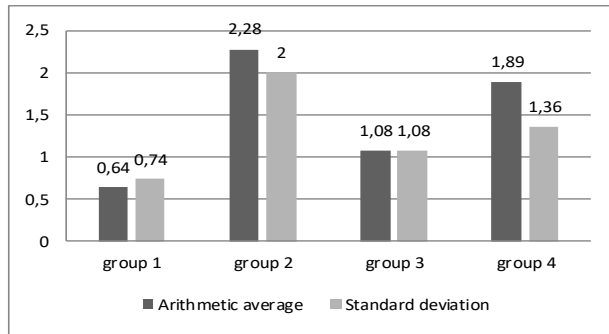


Figure (8). Results according to the arithmetic mean and standard deviation for the research groups in the number of joint injuries

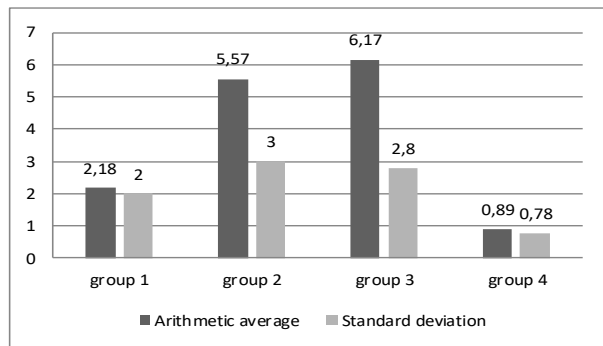


Figure (9). Results according to the arithmetic mean and standard deviation for the research groups in the number of skin injuries

Significance of Differences:

Bone Injuries: The calculated F-value of 11.112 indicates a highly significant difference among the groups, with asphalt surfaces (Group 2) showing the highest mean number of bone injuries (2.86 ± 1.46), followed by cement surfaces (Group 3) (1.25 ± 0.94). This suggests that harder surfaces contribute more to bone injuries.

Muscle Injuries: The calculated F-value of 3.134 also indicates significant differences. Cement surfaces show the highest mean number of

muscle injuries (1.58 ± 1.66), suggesting that these surfaces may cause more muscle-related injuries compared to others.

Joint Injuries: The F-value of 4.144 highlights significant differences, with asphalt surfaces again having the highest mean number of joint injuries (2.28 ± 2.00). Cement and dirt surfaces also show notable joint injury rates.

Skin Injuries: With an F-value of 13.06, skin injuries show significant differences among groups, with cement and asphalt surfaces having the highest mean numbers of skin injuries (6.17 ± 2.80 and 5.57 ± 3.00 , respectively).

Comparison of Groups:

Bone Injuries: Hard surfaces like asphalt are significantly more prone to causing bone injuries, possibly due to the greater impact force during falls.

Muscle Injuries: Cement surfaces, being less yielding than dirt or artificial grass, seem to result in more muscle injuries, which could be due to the higher strain on muscles during activities.

Joint Injuries: Asphalt surfaces show the highest joint injury rates, which may be due to the increased stress on joints from the hard surface.

Skin Injuries: Both cement and asphalt have high rates of skin injuries, likely due to the abrasive nature of these surfaces causing more scrapes and cuts.

Implications for School Settings:

These findings underscore the necessity of choosing safer flooring options in elementary schools to minimize different types of sports injuries. Schools should prioritize installing softer surfaces like artificial grass or well-maintained dirt to reduce the risk of bone, muscle, joint, and skin injuries.

The analysis confirms the third hypothesis, demonstrating significant differences in the types of sports injuries based on flooring type, it also shows that asphalt and cement surfaces present a higher risk of various injuries. These results highlight the importance of selecting safer flooring

options in elementary schools to reduce the incidence of sports injuries. This evidence supports the development of injury prevention strategies tailored to the specific risks associated with different flooring materials, aligning with previous studies on injury prevention in school environments.

4. Discussion

The results of this study highlight significant differences in Injury rates, severity, and types depending on the type of flooring in elementary schools. These findings align with and extend previous research on the topic, providing valuable insights into the specific risks associated with different surfaces.

Comparison with Previous Studies

Asphalt Surfaces:

High Injury Rates: Consistent with McKay et al. (2001), the present study found that asphalt surfaces are associated with the highest rates of injuries, particularly severe and joint injuries. McKay et al. observed a high incidence of injuries in recreational basketball on hard surfaces, emphasizing the increased risk posed by such surfaces.

Injury Severity: The significant number of severe injuries on asphalt aligns with studies that suggest hard surfaces increase the impact force during falls, leading to more serious injuries (McKay et al., 2001).

Cement Surfaces:

Muscle and Skin Injuries: The study found a higher occurrence of muscle and skin injuries on cement surfaces. This finding is in line with Backx et al. (1991), who noted the importance of injury prevention strategies in high-risk sports environments, highlighting that harder surfaces could lead to more abrasions and muscle strains due to their less yielding nature.

Contradictory Results: While some studies have indicated that softer surfaces might reduce injury severity, the present study shows that cement surfaces, though harder, still result in significant injuries, suggesting the complexity of factors influencing injury risks (Backx et al., 1991).

Artificial Grass and Dirt Surfaces:

Lower Injury Rates: These surfaces were associated with lower injury rates overall, which supports findings by Drago & Braun (2012) that softer and more forgiving surfaces tend to result in fewer injuries.

Variety of Injuries: However, the specific types of injuries differed, with artificial grass showing fewer severe injuries compared to dirt,

indicating that while both surfaces are safer, the exact nature of safety may vary.

Implications for School Settings

The study's findings underscore the critical need for schools to carefully consider the type of flooring used in physical education settings:

Policy Recommendations: Schools should prioritize installing softer surfaces like artificial grass or well-maintained dirt to minimize severe injuries, aligning with the recommendations from studies on injury prevention (Dragoo & Braun., 2012).

Comprehensive Approach: Developing a comprehensive approach to injury prevention should include not only choosing appropriate flooring but also implementing regular maintenance and considering other environmental and activity-related factors that contribute to safety.

Limitations and Future Research

While the study provides valuable insights, it also highlights the need for further research:

Longitudinal Studies: Future studies should consider longitudinal designs to better understand the long-term effects of different flooring types on injury rates and severity.

Broader Context: Examining a broader range of environmental and individual factors, including student behavior and activity types, would provide a more comprehensive understanding of injury risks in school settings.

5. Conclusion

The results of this study, in conjunction with previous research, clearly indicate that the type of flooring significantly influences the rate and severity of sports injuries in elementary schools. Asphalt surfaces pose the highest risk, while artificial grass and dirt are associated with lower injury rates. These findings should guide policy and decision-making in schools to enhance the safety and well-being of students during physical education activities.

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