Original Article

Effect of Outdoor Activities on Physical fitness of Adolescent Children

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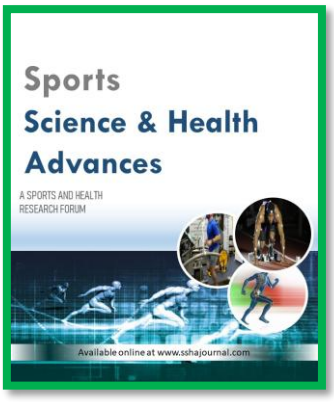

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Abstract

Purpose: this study aimed to examine the impact of school-based sports activities on the physical fitness of adolescents over a 12-week period. **Methods:** total no. of 33 students (17 boys and 16 girls) participated in regular sports sessions integrated into their school outdoor activities. Physical fitness was assessed before and after the intervention using standardized tests to measure endurance, speed, shoulder strength, and flexibility. **Results:** significant improvements were observed across all measured fitness components. Statistical analysis confirmed meaningful progress ($p < 0.05$), and effect size calculations indicated substantial practical significance, especially in speed and flexibility. **Conclusion:** Regular participation in school sports activities positively influences the physical fitness of adolescents. These findings support the integration of structured physical activity into school programs to promote health and fitness among students.

Keywords: Adolescents, physical fitness, school-based sports, endurance, speed, strength, flexibility, exercise benefits

Introduction

Physical activity is essential for the physical, mental, and social development of adolescents. Regular exercise has been associated with improved cardiovascular fitness, muscular strength, flexibility, and mental well-being. Despite these well-established benefits, physical inactivity is on the rise among teenagers globally, particularly in developing countries like India, due to increased screen time, academic pressures, and limited access to structured sports facilities. Schools are uniquely positioned to address this issue by offering regular, structured physical activity sessions within the curriculum.

Most previous research has focused either on single-sport interventions or general, unstructured outdoor activities, lacking comprehensive multi-activity, school-based programs that integrate both traditional and modern sports. Additionally, there is a scarcity of studies investigating the differential effects of such structured interventions across genders within the Indian adolescent population. This represents a notable gap in the literature regarding the effectiveness of diverse, supervised sports interventions in simultaneously improving multiple fitness components such as endurance, speed, strength, and flexibility.

To address this gap, the present study implemented 12-week outdoor activities, school-based sports intervention program to

evaluate its effects on various components of physical fitness among adolescents.

The specific research questions guiding this study were:

1. *Do outdoor school-based sports activities lead to significant improvements in endurance, speed, shoulder strength, and flexibility among adolescents?*
2. *Are there gender differences in the magnitude of improvement in these physical fitness components following the intervention?*

Material and Methods

This study aims to evaluate the effects of various sports activities on the fitness levels of school-aged adolescents. The activities include general warm-up exercises, running (600m–800m), sprints (30m–50m), flexibility exercises, and sports such as Kho-Kho, badminton, and volleyball. Conducted over a twelve-week period, the activities were implemented three days per week on alternate days. The participants were students from the eleventh class at a school in Dharuhera, Rewari, Haryana. A total of 33 students (17 boys and 16 girls) aged 15 to 17 years participated in this study. The students were selected based on their willingness to participate and were actively engaged in the program. No prior specialized sports training was required for participation.

Outdoor Activities:

The outdoor activities program was implemented over a twelve-week period, comprising three sessions per week on alternate days, with each session lasting 40 minutes. The sessions generally began with warm-up exercises such as dynamic stretching and jogging to prepare the body for physical exertion. Depending on the day's schedule, students participated in various activities including running exercises (600m–800m) to improve endurance, sprints (30m–50m) to enhance speed and agility, and flexibility exercises involving static and dynamic stretching. In addition, on different days, traditional and modern sports such as Kho-Kho, badminton, and volleyball were organized to promote skill development and overall physical fitness. Each session concluded with cool-down exercises designed to aid recovery and prevent injuries. All activities were part of the school's outdoor sports activities and were conducted under the supervision of instructor.

Variables and Measurements

To evaluate the impact of the outdoor sports activities program, four fitness components were assessed. Endurance was measured using the 600-meter run test, with the time taken by each participant recorded in minutes to assess aerobic capacity. Speed was evaluated through the 30-meter sprint test, recorded in seconds, reflecting the participant's short-distance running ability. Shoulder strength was determined by the 2 kg medicine ball throw, with the distance thrown measured in meters to assess upper body strength. Flexibility was assessed using the sit-and-reach test, recorded in centimeters, to evaluate the flexibility of the lower back and hamstrings. These measurements provided an overall assessment of the participants' physical fitness.

Data Collection

Pre- and post-test data were collected to assess improvements in the physical fitness levels of the participants. Endurance was evaluated by recording the running time for distances of 600 to 800 meters. Speed was measured through sprint performance over 30 to 50 meters. Flexibility was assessed using the sit-and-reach test, while shoulder strength was determined by the distance achieved in the medicine ball throw. Additionally, observations were made regarding the participants' overall engagement and performance during the outdoor sports activities to gain qualitative insights into their physical activity levels.

Statistical Tools and Techniques

To analyze the collected data, included the Descriptive Paired Samples Statistics to summarize the means, standard deviations, and variations in pre- and post-test scores, providing an overview of changes in endurance, speed, strength, and flexibility. A Comparative Paired Samples T-Test was conducted to assess the statistical significance of the differences observed between the pre- and post-test results, determining whether the

changes were meaningful beyond chance. Additionally, Paired Samples Effect Sizes were calculated to measure the magnitude of these changes, offering insight into the practical importance and impact of the intervention on the assessed physical performance variables.

Table 1 Statistics Analysis of Physical Fitness Variables of School Boys

Variables	Measurement	Mean	N	SD	SEM	Pooled SD	SEM	(t)	(df)	Sig.
Endurance	Pretest	2.62	16	0.36	0.09	0.35	0.09	2.98	15.00	0.01
	Posttest	2.37	16	0.54	0.14					
Speed	Pretest	5.73	16	0.62	0.15	0.38	0.10	5.18	15.00	0.00
	Posttest	5.23	16	0.68	0.17					
Shoulder Strength	Pretest	4.77	16	1.14	0.29	0.75	0.19	-3.08	15.00	0.01
	Posttest	5.35	16	1.32	0.33					
Flexibility	Pretest	26.25	16	7.56	1.89	2.68	0.67	-7.65	15.00	0.00
	Posttest	31.38	16	8.22	2.06					

The descriptive statistics indicate notable improvements in all physical fitness variables among schoolboys after the 12-week sports activity program. Endurance improved as the mean time for the 600m run decreased from 2.62 to 2.37 minutes, suggesting enhanced stamina. Speed increased, with the 30m sprint time reducing from 5.73 to 5.23 seconds. Shoulder strength showed improvement, as the medicine ball throw distance increased from 4.77 to 5.35 meters. Flexibility also improved, with sit-and-reach test scores rising from 26.25 to 31.38 cm. The increased post-test means in strength and flexibility, along with reduced times in endurance and speed, indicate the positive impact of regular structured physical activities on overall fitness levels.

The paired samples t-test results indicate statistically significant improvements across all physical fitness variables among schoolboys. Endurance showed a significant reduction in time ($M = 0.25$, $t = 2.98$, $p = 0.01$), suggesting enhanced stamina. Speed improved notably ($M = 0.50$, $t = 5.18$, $p = 0.00$), reflecting better sprinting ability. Shoulder strength increased significantly ($M = -0.58$, $t = -3.08$, $p = 0.01$), demonstrating greater upper-body power. Flexibility exhibited the most substantial improvement ($M = -5.13$, $t = -7.65$, $p = 0.00$), confirming enhanced joint mobility. The statistically significant results ($p < 0.05$) highlight the effectiveness of the sports activity program in enhancing overall physical fitness.

The paired samples effect size analysis using Cohen's d and Hedges' correction indicates meaningful improvements in physical fitness variables among schoolboys. Endurance (Cohen's $d = 0.75$) and speed (Cohen's $d = 1.30$) showed moderate to large effects, suggesting notable gains in stamina and sprinting ability. Shoulder strength (Cohen's $d = -0.77$) demonstrated a moderate effect, indicating increased upper-body strength. Flexibility exhibited the most substantial effect (Cohen's $d = -1.91$), highlighting a remarkable improvement in joint mobility. The large effect sizes confirm that the sports activity program had a significant positive impact on overall fitness.

Table 2 Statistics Analysis of Physical Fitness Variables of School Girls

Variables	Measurements	Mean	N	SD	SEM	Pooled SD	(t)	(df)	Sig.
Endurance	Pretest	4.04	17	0.60	0.15	0.35	3.53	16	.003
	Posttest	3.74	17	0.56	0.14				
Speed	Pretest	7.09	17	0.78	0.19	0.60	4.82	16	.000
	Posttest	6.39	17	0.65	0.16				
Shoulder Strength	Pretest	3.32	17	0.51	0.12	0.37	-3.90	16	.001
	Posttest	3.66	17	0.49	0.12				
Flexibility	Pretest	24.71	17	8.33	2.02	1.97	-9.13	16	.000
	post test	29.06	17	8.03	1.95				

The descriptive paired samples statistics for schoolgirls indicate improvements across all measured physical fitness variables after the intervention. The mean endurance decreased from 4.04 to 3.74 minutes, suggesting improved stamina. Speed performance improved as the mean sprint time decreased from 7.09 to 6.39 seconds, indicating faster running ability. Shoulder strength increased from 3.32 to 3.66 meters, reflecting enhanced upper-body power. Flexibility showed a significant improvement, with the mean increasing from 24.71 to 29.06 cm, highlighting better joint mobility. These findings suggest that the structured sports activity program positively influenced the girls' overall fitness.

The paired samples t-test results for schoolgirls indicate statistically significant improvements across all physical fitness variables. Endurance showed a mean difference of 0.30 ($t = 3.53$, $p = .003$), suggesting a notable improvement in running performance. Speed improved significantly, with a mean difference of 0.70 ($t = 4.82$, $p = .000$), reflecting enhanced sprinting ability. Shoulder strength exhibited a decrease in pre-to-post test scores (-0.35, $t = -3.90$, $p = .001$), indicating a potential shift in muscle engagement or technique. Flexibility demonstrated the most significant improvement, with a mean difference of -4.35 ($t = -9.13$, $p = .000$), showing considerable gains in joint mobility. The low p-values across all variables confirm that the improvements were statistically significant, reinforcing the positive impact of the intervention.

The paired samples effect size analysis for schoolgirls demonstrates varying magnitudes of improvement across physical fitness variables. Endurance showed a moderate effect size (Cohen's $d = 0.86$), indicating a meaningful improvement in running performance. Speed exhibited a large effect size (Cohen's $d = 1.17$), reflecting a significant enhancement in sprinting ability. Shoulder strength presented a negative effect size (Cohen's $d = -0.95$), suggesting a decline, possibly due to variations in training adaptation. Flexibility had the most substantial effect (Cohen's $d = -2.21$), indicating a major improvement in joint mobility. The effect sizes, particularly in speed and flexibility, highlight the effectiveness of the intervention in improving key aspects of physical fitness among schoolgirls.

Results

The findings of this study indicate significant improvements in the physical fitness variables of both boys and girls after participating in a structured 12-week school-based sports activity program. The results demonstrate positive changes in endurance, speed, shoulder strength, and flexibility, with notable variations between boys and girls.

Descriptive Statistics and Performance Improvements

For schoolboys, endurance improved as the mean 600m run time decreased from 2.62 minutes to 2.37 minutes. Sprint speed also increased, with the 30m sprint time reducing from 5.73 seconds to 5.23 seconds. Shoulder strength, measured by the medicine ball throw, increased from 4.77m to 5.35m. Flexibility showed the most significant improvement, with sit-and-reach scores increasing from 26.25 cm to 31.38 cm.

Similarly, for schoolgirls, endurance improved as the 600m run time decreased from 4.04 minutes to 3.74 minutes. Speed performance improved, with the 30m sprint time reducing from 7.09 seconds to 6.39 seconds. Shoulder strength increased from 3.32m to 3.66m, while flexibility improved significantly, with sit-and-reach scores increasing from 24.71 cm to 29.06 cm.

The paired samples t-test confirmed significant differences between pre- and post-test scores across all fitness components for both boys and girls. In boys, the t-test values for endurance ($t = 2.98$, $p = 0.01$), speed ($t = 5.18$, $p = 0.00$), shoulder strength ($t = -3.08$, $p = 0.01$), and flexibility ($t = -7.65$, $p = 0.00$) were all statistically significant. Similar trends were observed in girls, with endurance ($t = 3.53$, $p = .003$), speed ($t = 4.82$, $p = .000$), shoulder strength ($t = -3.90$, $p = .001$), and flexibility ($t = -9.13$, $p = .000$) showing significant improvements.

The effect size analysis (Cohen's d) further supported the effectiveness of the intervention. For boys, the effect sizes were moderate to large for endurance (0.75), speed (1.30), and flexibility (-1.91). Similarly, for girls, speed (1.17) and flexibility (-2.21) demonstrated large effect sizes, emphasizing the program's significant impact.

Discussion

The findings of the present study align with previous research suggesting that structured school-based sports programs contribute significantly to enhanced physical fitness among adolescents (Singh et al., 2021; Bailey et al., 2019). Regular engagement in running and sprint activities explains the observed improvement in endurance and speed, while the increase in flexibility among both boys and girls underscores the importance of dynamic and static stretching in training routines.

The observed enhancement in various fitness components corroborates the conclusions drawn by Kparev et al. (2022), who demonstrated that recreational physical activities improve body composition, cardiovascular fitness, muscular strength, endurance, and flexibility among secondary school students. Furthermore, Sun et al. (2024) reported that structured exercise regimens, combining aerobic and anaerobic activities, positively impact running performance and vital capacity outcomes similar to those in the current study.

Interestingly, the effect size for shoulder strength showed a negative value, particularly in girls. This may be due to gender-related differences in neuromuscular adaptation or the specificity of the medicine ball throw test. Prior research suggests that girls may exhibit lower upper-body strength gains compared to boys due to differences in muscle mass and hormonal influences (Faigenbaum et al., 2018). This is supported by Wu et al. (2021), whose meta-analysis revealed that high-intensity, low-frequency resistance training improves muscular fitness, although girls may respond differently based on training volume and intensity. Thus, future interventions could include tailored upper-body resistance programs to address this gap, especially in female adolescents.

The larger effect sizes observed in flexibility and speed improvements among girls may also reflect their superior adaptability to stretching routines and neuromuscular efficiency during sprinting, consistent with previous findings (Buchan et al., 2019). In addition, studies by Fromel et al. (2017) emphasized that preference-driven outdoor physical activity enhances both physical and mental well-being in adolescents, suggesting that incorporating preferred activity types may further optimize fitness outcomes.

A broader perspective on environmental influences indicates that outdoor spaces such as parks and playgrounds play a critical role in promoting moderate-to-vigorous physical activity (Oreskovic et al., 2015). Gray et al. (2015) also highlighted that greater outdoor time is linked with higher physical activity levels and reduced sedentary behavior among youth. These findings imply that the training effects observed in this study could be amplified by promoting outdoor play and environmental access.

Furthermore, Sampasa-Kanyinga et al. (2020) and Nugraha et al. (2024) reported that outdoor physical activity not only improves physical fitness but also reduces overweight/obesity rates and enhances mental health outcomes such as life satisfaction and reduced anxiety. The importance of psychosocial and environmental factors such as parental and peer support, enjoyment, and connection with nature as emphasized by Christiana et al. (2014), suggests that noncompetitive, enjoyable outdoor activities can foster long-term engagement and health benefits in adolescents.

Lastly, Feil Pinho et al. (2024) underlined that sex, BMI, and type of exercise significantly affect physical fitness trainability, reinforcing the need for individualized and gender-sensitive training approaches in school-based programs. This perspective aligns with the observed differences in fitness improvements between boys and girls in the present study.

In conclusion, the collective evidence supports the notion that structured, enjoyable, and preference-oriented outdoor physical activity programs can substantially enhance adolescents' physical fitness while addressing gender differences and broader health outcomes. Future studies should explore the interplay between environmental factors, personal preferences, and specific training modalities to optimize school-based interventions.

Conclusion

This study demonstrates that a 12-week program of regular school-based sports activities significantly improves adolescents' physical fitness. Both boys and girls showed measurable gains in endurance, speed, shoulder strength, and flexibility, with the greatest improvements in speed and flexibility, especially among girls. Statistical analysis confirmed these changes were significant ($p < 0.05$), with strong correlations between pre- and post-test results ($r = 0.67–0.97$). Effect size analysis highlighted the practical relevance of these improvements. These findings underscore the positive impact of general school-based sports activities on adolescent fitness, even without structured training programs.

Implications and Future Research

These findings highlight the value of integrating sports activities into school schedules to promote physical fitness and overall health in adolescents. Future research could explore how different types of sports activities contribute to specific fitness improvements, examine long-term effects, and assess additional benefits such as psychological well-being and social development.

Conflict of interest:

The authors declare that there is no conflict of interest regarding the publication of this paper.

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References

Bailey, R., Hillman, C., Arent, S., & Petitpas, A. (2019). Physical activity: An underestimated investment in human capital? Journal of Science and Medicine in Sport, 22(12), 1233-1240. https://doi.org/10.1016/j.jsams.2019.05.013

Barbosa, J., Vieira, F., & Sousa, M. (2019). Effectsof Extracurricular Physical Activity on the Physical Fitness Levels of Youngsters in School Environments. Journal of Sports Sciences, 7(2). https://doi.org/10.17265/2332-7839/2019.02.002

Buchan, D. S., Ollis, S., Young, J. D., Cooper, S. M., Shield, J. P., & Baker, J. S. (2019). High-intensity interval running enhances measures of physical fitness but not metabolic measures in healthy adolescents. Journal of Sports Sciences, 37(3), 225-232. https://doi.org/10.1080/02640414.2018.1493577

Christiana, R. W., Davis, M., & Freeman, M. (2014). I'd Rather Dance Outside: A Phenomenological Examination of Youth Experiences in Outdoor, Noncompetitive Physical Activity. The Qualitative Report, 19(46), 1–16. https://doi.org/10.46743/2160-3715/2014.1132

Faigenbaum, A. D., Lloyd, R. S., MacDonald, J., & Myer, G. D. (2018). Citius, Altius, Fortius: Beneficial effects of resistance training for young athletes: Narrative review. British Journal of Sports Medicine, 50(1), 3-7. https://doi.org/10.1136/bjsports-2015-094621

Feil Pinho, C. D., Bagatini, N. C., Chedid Lisboa, S. D., Mello, J. B., & Cunha, G. dos S. (2024). Effects of different supervised and structured physical exercise on the physical fitness trainability of children and adolescents: a meta-analysis and meta-regression. BMC Pediatrics, 24(1). https://doi.org/10.1186/s12887-024-04929-2

Fromel, K., Kudláček, M., Groffik, D., Svozil, Z., Simunek, A., & Garbaciak, W. (2017). Promoting Healthy Lifestyle and Well-Being in Adolescents through Outdoor Physical Activity. International Journal of Environmental Research and Public Health, 14(5), 533. https://doi.org/10.3390/IJERPH14050533

Gray, C. E., Gibbons, R., Larouche, R., Sandseter, E. B. H., Bienenstock, A., Brussoni, M., Chabot, G., Herrington, S., Janssen, I., Pickett, W., Power, M., Stanger, N. R. G., Sampson, M., Tremblay, M. S., & Tremblay, M. S. (2015). What Is the Relationship between Outdoor Time and Physical Activity, Sedentary Behaviour, and Physical Fitness in Children? A Systematic Review. International Journal of Environmental Research and

Public Health, 12(6), 6455–6474. https://doi.org/10.3390/IJERPH120606455

Kparev, T., Umar, D., Ikpato, T. V., Agba, S. D., Duenya, J., Ihum, J. T., & Tyoakaa, A. A. (2022). Effect of recreational physical activities on health-related components of physical fitness of adolescents in secondary schools in Gboko local government area of Benue state, Nigeria. Journal of Educational Research in Developing Areas, 3(1), 49–64. https://doi.org/10.47434/jereda.3.1.2022.49

Kumar, D., Nara, K., & Dhull, S. (2023). The advantage and disadvantage of body composition on athletic success: A kabaddi player perspective. Methods, 1, 19. https://doi.org/10.22271/yogic.2023.v8.i2c.1448

Kumar, D., Kumar, S., Kumar, N., & Sagre, S. (2023). Effects of circuit training on selected physical fitness components of kabaddi players. Sports Science & Health Advances, 1(2), 143-148. https://doi.org/10.60081/ssha.1.2.2023.143-148

Kumar, S., & Ahlawat, R. P. (2025). The Impact of Physiological Parameters on Defense Aspirant's Performance: Exploring Key Factors and Implications. International Journal of Social Science Research (IJSSR), 2, 133–120. https://www.ijssr.com/wp-content/uploads/journal/published_paper/volume-2/issue-1/IJSSR30264.pdf https://doi.org/10.70558/ijssr.2025.v2.i1.30264

Kumar, S., Ahlawat, R. P., & Kumar, D. (2023). Training Adaptations and Seasonal Health: Their Cumulative Effect on the Physical Fitness Profile of All India Inter-University Athletes. Sports Science & Health Advances, 1(2), 156–161. https://doi.org/10.60081/ssha.1.2.2023.156-161

Larouche, R., Garriguet, D., Gunnell, K. E., Goldfield, G. S., & Tremblay, M. S. (2016). Outdoor time, physical activity, sedentary time, and health indicators at ages 7 to 14: 2012/2013 Canadian Health Measures Survey. Health Reports, 27(9), 3–13. https://pubmed.ncbi.nlm.nih.gov/27655167/ https://doi.org/10.17269/cjph.107.5700

Nugraha, H., Hernawan, H., Ali, M., Rahmat, A., Septianto, I., Aryati, A., & Suryadi, D. (2024). Outdoor activities and outdoor environments for fitness and mental health: a systematic review. Retos: Nuevas Tendencias En Educación Física, Deportes y Recreación, 59, 642–648. https://doi.org/10.47197/retos.v59.108730

Oreskovic, N. M., Perrin, J. M., Robinson, A. I., Locascio, J. J., Blossom, J., Chen, M. L., Winickoff, J. P., Field, A. E., Field, A. E., Green, C., & Goodman, E. (2015). Adolescents' use of the built environment for physical activity. BMC Public Health, 15(1), 251. https://doi.org/10.1186/S12889-015-1596-6

Ortega, F. B., Ruiz, J. R., & Castillo, M. J. (2013). Physical activity, physical fitness, and overweight in children and adolescents: evidence from epidemiologic studies. Endocrinología y Nutrición : Órgano de La Sociedad Española de Endocrinología y Nutrición, 60(8), 458–469. https://doi.org/10.1016/J.ENDOEN.2013.10.007

Pagels, P. (2017). Impact of school outdoor environment upon pupils' physical activity and sun exposure across ages and seasons. https://openarchive.ki.se/xmlui/handle/10616/46040

Preeti, Kumar, S., Ahalawat, R. P., & Chaudhary, S. (2025). Effect of six-week physical training on telic and paratelic judo players: A comparative analysis of speed, agility, and explosive power. International Journal of Physical Education Sports and Health, 12(3), 107–111. https://doi.org/10.22271/kheljournal.2025.v12.i3b.3784

Sampasa-Kanyinga, H., Colman, I., Hamilton, H., & Chaput, J.-P. (2020). Outdoor physical activity, compliance with the physical activity, screen time, and sleep duration recommendations, and excess weight among adolescents. Obesity Science & Practice, 6(2), 196–206. https://doi.org/10.1002/OSP4.389

Singh, A., Uijtdewilligen, L., Twisk, J. W. R., van Mechelen, W., & Chinapaw, M. J. M. (2021). Physical activity and performance at school: A systematic review of the literature including a methodological quality assessment. Archives of Pediatrics & Adolescent Medicine, 166(1), 49-55. https://doi.org/10.1001/archpediatrics.2021.990

Sun, J., Kong, J., Tian, X., Wang, L., Wang, Q., & Xu, J. (2024). Regular meta-analysis of the impact of sports activities intervention on some items of the national student physical health standards for adolescents. Frontiers in Physiology. https://doi.org/10.3389/fphys.2024.1419441

Wu, C., Xu, Y., Chen, Z., Cao, Y., Yu, K., Huang, C., & Huang, C. (2021). The Effect of Intensity, Frequency, Duration and Volume of Physical Activity in Children and Adolescents on Skeletal Muscle Fitness: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. International Journal of Environmental Research and Public Health, 18(18), 9640. https://doi.org/10.3390/IJERPH18189640