THE INFLUENCE OF EXERGAMING ON WORKING MEMORY IN PREADOLESCENTS: AN EXPERIMENTAL STUDY

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Abstract

Introduction: Exergaming, which combines physical activity with video gaming, has gained popularity as a tool for promoting health and cognitive development, particularly in preadolescents. The influence of exergaming on working memory, a cognitive skill essential for tasks such as problem-solving, learning, and multitasking, has become a subject of research interest. Studies suggest that engaging in exergaming may enhance working memory in preadolescents by providing an interactive and enjoyable way to exercise both the body and brain. This introduction explores the potential benefits of exergaming on working memory development, examining how it might help improve cognitive functions while fostering physical activity in young children.

Aim: To determine the influence of exergaming on working memory in preadolescents.

Objective: to find the significance of exergaming on working memory in preadolescents.

Methodology: A 22-children study was conducted. Boys and Girls of 9-12 years were studied. Subjects received intervention of exergaming i.e. N-back and letter digit span. Study individuals received intervention for alternate days for 2 weeks. Backward digit span test was used as outcome measure.

Result: There is significant difference in pre and post score of backward digit span test

Conclusion: The study concludes that exergaming significantly improves working memory in pre-adolescents, highlighting its potential as an effective cognitive development tool.

Keywords: Exergaming, working memory, Backward digit span, Pre-adolescents.

Introduction

Young people today are often referred to as digital natives because they have grown up with and fully integrated new technologies into their lifestyles. In the 21st century, the widespread adoption of mobile phones, tablets, and digital tools like video games has made them central to daily life and learning strategies. [1-2] These devices inspire intrinsic motivation and have become the primary way young people communicate with each other, influencing both their social interactions and educational experiences.[3] Executive functions are higher order cognitive functions that are responsible for initiating, adapting, regulating, monitoring, and controlling information processes and behavior. These functions are oftenthought of as an important prerequisite for successful learning in preadolescent children. Inhibition, working memory and cognitive flexibility are identified as three core executive functions. [4-7] Exergaming serves as an innovative tool that effectively combines the benefits of highly controlled physical activity (PA) with the interactive and enjoyable elements of gaming. The term "exergaming" is derived from a fusion of the words "exercise" and "gaming," and it refers to a form of active video gaming where players engage in physical movement as part of the gameplay. This unique combination of exercise and entertainment has been shown to provide a physically challenging experience while also offering a strong motivational component, making it easier for participants to stay engaged and committed to physical activity. [8-10] Working memory refers to the cognitive system responsible for temporarily storing and managing information that is essential for completing tasks and making decisions during learning or performance. For instance, when a student is given instructions on how to solve a problem, they rely on their working memory to hold onto that information long enough to complete the task. It is a vital aspect of mental processing that allows individuals to retain and manipulate information actively as they engage in various activities. The letter digit span and N-back task are the most commonly used activities for working memory. [11,12]

Materials and methods

The ethical clearance was achieved from the ethical committee at Parul University institutional ethics committee for human research (PU-IECHR) and was registered with Clinical Trial Registry-India (CTRI) under reference number CTRI/2024/09/073691. An Experimental study was performed among total 30 subjects for 2 weeks. Prior to the commencement of the procedure, informed consent was taken from the subject's parents. The 22 participants were selected for the study. The purpose of the study was explained. The subjects were screened based on inclusion and exclusion criteria prior to the enrollment into the study. Both boys and girls with age group of 9-12 years were included in the study. Also, those subjects whose parents were willing to sign consent form, along with normal vision and healthy body were included.

Subjects with any neurological conditions, congenital disorders, cardiovascular diseases, any recent fractures or impaired upper limb and mentally retarded were excluded from the study. The demographic data such as age, gender, address, were collected through data collection sheet. Initial evaluation of baseline values for all the subjects in terms of backward digit span test were taken. The obtained pre-test and post-test scores were compared and analyzed statistically.

Before entering into the study each participant and their parent was given complete information about the study's protocols and supplied written informed consent. The experimental group received exergaming that was N-back and letter digit span through a software called PEBL Launcher version 2.1. The intervention was given alternatively in a week for 2 weeks. The session lasted between 30-45 mins.

Data analysis & results:

Data was entered in Microsoft excel and analyzed using IBM statistics SPSS version 27th. Mean and Standard Deviation (SD) was calculated for quantitative variables. Also, data was represented in form of visual impressions like bar diagram and table etc. For Quantitative data was represented in form of Mean an SD. Wilcoxon signed rank test was applied to check the difference of pre and post intervention. P-value was checked at 5% level of Significance.

Table 1:

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-Score	.244	20	.003	.929	20	.147
Post-Score	.279	20	.000	.830	20	.002

a. Lilliefors Significance Correction

These table denotes that the data is not normally distributed as p-value is <0.05 according to Shapiro-wilk test of normality.

Table 2:

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Pre-Score	22	4.64	1.217	2	7
Post-Score	20	6.75	1.251	4	8

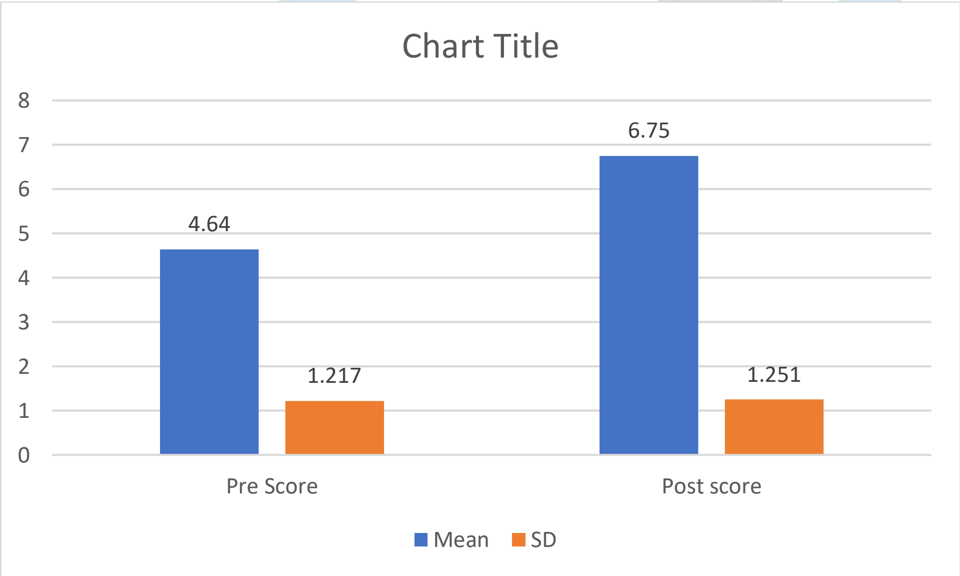
This table denotes the Mean and Standard Deviation of backward digit span test pre and post intervention.

Mean Difference: There is an increase in the average score from **4.64** in the pre-test to **6.75** in the post-test, suggesting a positive change or improvement.

Range Comparison: The range of scores has shifted upward in the post-test, with the lowest post-test score being 4 (higher than the pre-test minimum of 2) and the highest being 8 (higher than the pre-test maximum of 7).

Variability: The standard deviations (1.217 and 1.251) are similar, indicating that the spread or variability of scores is consistent across both tests.

Figure 1:



This bar graph indicates the Mean and Standard Deviation of backward digit span test pre and post intervention.

Table 3:

Test Statistics[a]

	Post-Score - Pre-Score
Z	-3.760[b]
Asymp. Sig. (2-tailed)	<.001

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

The **Wilcoxon Signed Ranks Test** results show:

- **Z = -3.760**: This indicates the magnitude of the difference between the Pre-Score and Post-Score.
- **Asymp. Sig. (2-tailed) = <0.001**: The p-value is less than 0.05, which means the difference between Pre-Score and Post-Score is statistically significant.

Interpretation:

There is a **significant improvement** in scores from Pre-Score to Post-Score, as the p-value (0.001) is below the threshold of 0.05.

Discussion

The study was performed with the intention to evaluate the impact of exergaming on working memory in preadolescent. When the study's outcome measure was examined, it was discovered that the working memory of experimental group was improved. With outcome measure backward digit span test, we evaluated the efficacy of exergame on working memory.

Working memory, the cognitive system responsible for holding and manipulating information over short periods, plays a crucial role in academic success, problem-solving, and daily activities. For preadolescents, a period of significant cognitive development, working memory is particularly vital for learning and adapting to new information. However, with the increasing prevalence of sedentary lifestyles among children, there is growing concern about the potential impact on cognitive functions, including working memory.

Exergaming, a form of active video gaming that combines physical exercise with interactive gameplay, has emerged as a promising tool to encourage physical activity while offering cognitive benefits. Research suggests that physical activity, especially exercises that engage both the body and mind, can enhance cognitive functions, including memory, attention, and executive functions. Exergames, by incorporating movement and strategic thinking, may offer a unique opportunity to support the development of working memory in children, particularly those in the preadolescent stage.

This study aims to explore the influence of exergaming on working memory in preadolescents, providing insight into the potential of this intervention to enhance cognitive abilities while promoting physical health. Through a series of experimental tasks and analyses, we seek to assess how engaging in exergaming activities might affect working memory performance, offering new perspectives on the intersection of physical activity, digital media, and cognitive development in young learners.

Conclusions:

Based on the research findings and the subsequent analysis of exergaming's impact on working memory, the results indicate a notable improvement in the working memory of pre-adolescents. The study concludes that exergaming significantly enhances working memory in this age group, suggesting its potential as an effective tool for cognitive development in children.

Limitations:

1. Sample Size: The study involved a small sample size (22 participants), which may limit the generalizability of the findings to a larger population of preadolescents.
2. Short Duration: The intervention period was only two weeks, which may not capture the long-term effects of exergaming on working memory.
3. Absence of a Control Group: The study lacked a control group, making it challenging to conclusively attribute the improvements in working memory solely to exergaming.
4. Selection Bias: Participants were self-selected based on parental consent, which could introduce bias and affect the results' applicability to other populations.

Future Recommendations:

1. Larger Sample Size: Future studies should involve a larger and more diverse sample of preadolescents to increase the generalizability of the findings.
2. Long-Term Studies: Research should investigate the long-term impact of exergaming on working memory to determine if the improvements are sustained over time.
3. Control Group: Incorporating a control group in future studies would strengthen the evidence for causality between exergaming and improvements in working memory.
4. Different Exergaming Programs: Exploring a variety of exergaming interventions with different types of cognitive challenges could help identify which aspects of exergaming most effectively improve working memory.

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Conflict of Interest:

The authors declare that there is no conflict of interest regarding the publication of this study. The research was conducted impartially, and no financial or personal relationships influenced the outcomes of the study.

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