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Research article

Impact of Aerobic Activity on Reaction Time in School-Going Children: A Randomized Controlled Trial

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ABSTRACT

To determine whether reaction time (RT) was immediately influenced by aerobic activity in the form of running in school-aged children. 208 participants, aged 6–12 years, were included in the study after excluding missed follow-up participants which was documented as 6 participants. They were divided into 2 groups, namely the experimental (n=102) and the control group (n=106) using the block randomization method. Afterward, the RT was determined through visual stimuli, via a ruler drop test (RDT). The participants from the experimental group underwent a 20-meter shuttle run test (20-m SRT) whereas the participants of the control group were assigned no task. Each participant's total RDT duration was documented before, immediately following and after 30 seconds of intervention.The obtained results show that there was a statistically significant difference in the value of the RT of children who performed the 20-meter shuttle run test and those who were sitting (p=<0.001 for both groups), While there was no statistically significant difference in RT between children in the two groups for comparisons between prior to and immediately after the intervention (mean= 0.25±0.49 and p=0.30), soon after the intervention and after 30 seconds (mean= 0.28±0.43 and p=0.46), and between before and right soon after 30 seconds of the intervention (mean= 0.53±0.46 and p=0.10), respectively keeping <0.05 as statistically significant. According to the findings of the current investigation, there was no discernible immediate distinction between the RT of individuals who underwent a 20-meter shuttle run test and those who were at rest throughout the intervention period.

Keywords: Child; Follow-Up studies; Humans; Running.

INTRODUCTION

The 20-m SRT is a simple and cost-effective test to assess aerobic capacity. In adolescents and kids, the 20-m SRT has been shown to have a strong correlation (R = 0.91) with VO2 max. Additionally, the 20-m SRT for kids has a test-retest reliability rate of 0.89. As a result, it is acknowledged as a useful field-based CRF measurement for children and adolescents and has been deployed across the world [1].

RT can be used to calculate the amount of time the brain needs to process various external stimuli. It takes time to recognize a stimulus is present, identify an appropriate response, organize the response, executing it all take time [2]. Previous study indicates that healthy children between the ages of 6 and 12 have an average reaction time of 230.01 ms [3].

For the age groups of 6 to 12 years, another investigation provided normative results ranging from 214.2 to 248.8 milliseconds [4]. An earlier study conducted on intellectually disabled Caucasians explored that, prolonged aerobic exercise routines might impact their reaction times [5].

There are many tools available to determine reaction time, but they are expensive and time-consuming. The RDT is a valid and reliable test battery to quickly evaluate a person's RT [6]. As far as we are aware, no research has yet been done on how aerobic activity impacts school-age children's RT. Therefore, the primary objective of this study is to investigate how running affects RT immediately using a 20-m SRT and an RDT [9].

In this study, we hypothesized that either aerobic activity may have any significant effect on reaction time among school-going children or it may have no significant effect on reaction time among school-going children [10].

MATERIAL AND METHODS

Ethical Statement

This study employed a single-blinded RCT with a two-group pretest-posttest design. The Institutional Ethical Committee (IEC) of Maharishi Markandeshwar (Deemed to be) University, Student Project Committee of the Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, have granted their approval (IEC-2219). The study was conducted in accordance with the ethical standards outlined by the Helsinki Declaration (Revised 2013) (http://www.wma.net/en/20activities/10 ethics/10helsinki/DoH-Oct2013-JAMA.pdf) and the Indian Council of Medical Research (ICMR2006) (http://www.icmr.nic.in/ ethical guidelines.pdf). The trial has been listed on ClinicalTrials.gov as CTRI/2023/05/052237, before commencing the study; the principal investigator obtained written consent from the medical director of the schools to perform it in the school students. Stratified random sampling was used to screen participants. Students who consented to participate in this study were selected for the study.

Methods

G*power analysis was used to estimate the sample size with keeping the effect size at 0.51, α at 0.05, and power at 0.90. The sample size came to 86 participants per group. After keeping the dropout as 10%, the sample size per group was 95 participants. Therefore, the total sample size was 190 participants. In our study, we included 214 participants of which 6 participants were documented as missed to follow-up.

A total of 208 students (142 males and 66 females) who were of either gender from 6 to 12 years of age were included and randomized into experimental and control groups through the block randomization method. Children who were medically unstable, undergoing treatment of any kind, or who have had surgery or any other problem which can hinder their performance were all excluded. Prior to the commencement of the study, Anthropometric measurements include Age, sex, weight, and height. were obtained. The 20-m SRT and RDT were performed by the students every day between 10:30 and 2:00 pm during their physical education class hours. For each participant, the entire process took approximately two and five minutes [7, 8].

20-Meter Shuttle Run Test

At the school playground, the principal investigator measured a straight line of 20 meters. Two shuttles were placed to indicate the "Start point" and "Endpoint" respectively for clear visualization. The pulse oximeter was worn on the index finger of the non-dominant hand of the participant, the participants were instructed to stand at the starting point with their faces pointed towards the endpoint and their arms at each side. The principal investigators were standing at the terminal end, which had a table and seats set up. Upon the Principal investigator's "GO" command, the participants had to run the required distance and then were instructed to sit on the chair along with their dominant hand on the table as shown in Figure 1.

Figure 1: Showing the 20-m SRT on a participant

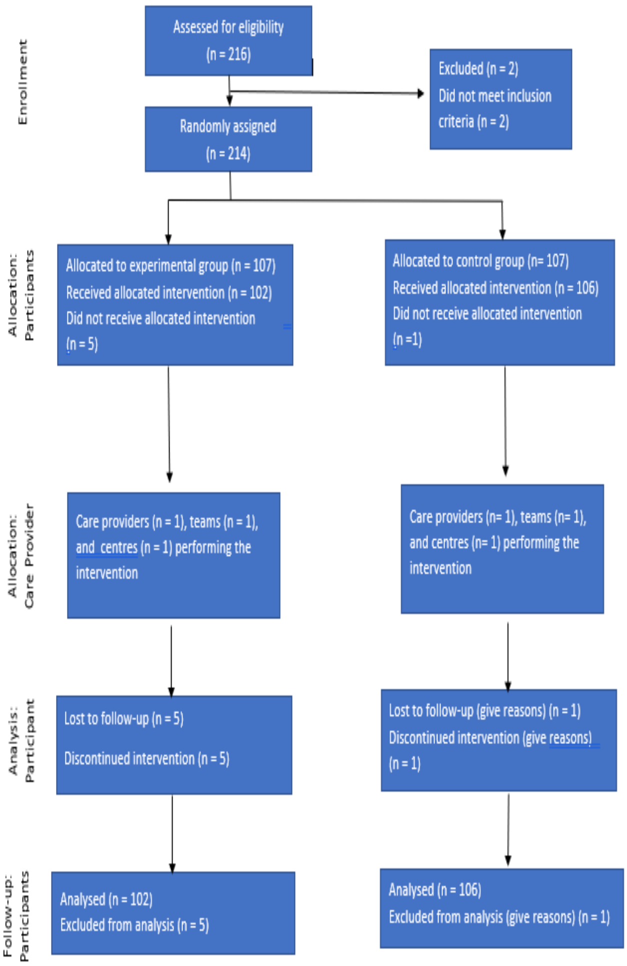
Ruler drop test

A 60cm long wooden ruler was used to determine the RT. The participants were asked to sit on the chair comfortably with the dominant hand over the table placed beside the chair. The participants had to keep their arm relaxed on the table with their elbow at 90 degrees of flexion. The hand complex should be placed on the table edge point. The distance of the web space (between the thumb and the index finger) was limited to a maximum of approximately 4 cm where the marked 0 cm point of the ruler was placed. The investigator was holding the ruler from the 60 cm point. The ruler was dropped by the principal investigator and the participant had to hold it through a prehension grip as quickly as possible. Visualization is shown in figure-2. The distance of holding the ruler from the 0 cm mark was documented and RT was calculated through the following formula: -

t= √2s/g (where, s= distance, t= time, and g= acceleration due to gravity I.e., 9.8)

Figure 2: Showing the RDT on a participant

Figure 3: The modified consort diagram 2017 for this randomized controlled trial was shown in



RESULTS

The Kolmogorov-Smirnov test was used to evaluate whether or not the data follows a normal distribution. Due to the not normal distribution, data were expressed in geometric mean, median (IQR 25,75), skewness and kurtosis, and range. The Friedman test and Mann-Whitney U test were employed for within-group and between-group analyses, respectively, p-values of 0.05 or less were regarded as statistically.

Table 1: descriptive statistics of the demographic dimensions of all the recruited participants

Demographic dimensions	Geometric mean	Mean (upper-lower) 95% CI	skewness	kurtosis	Median (25,75) IQR	range
Age (years)	10.46	10.52 (10.69-10.36)	-0.22	-1.08	11 (10, 12)	8 to 12
Height (cm)	139.39	139.72 (141.03-138.41)	-0.09	-0.42	140 (132, 147)	115 to 163
Weight (kg)	38.132	39.79 (41.40-38.18)	0.61	-0.30	37 (30.5, 47.6)	18.8 to 75
BMI (kg/m^2)	19.694	20.12 (20.71-19.53)	0.71	0.02	19.3 (16.9, 22.6)	11.5 to 33.1

The experiments reveal that the interventions, such as sitting and the 20-m SRT, had a substantial impact on the RDT both immediately after the intervention and after 30 seconds. However, there are no discernible differences between the two groups.

D1 (RT pre-intervention - RT post-intervention), D2 (RT post-intervention - RT post 30 seconds intervention), and D3 (RT pre-intervention - RT post 30 seconds intervention) were used to calculate the time differences.

Table 2 shows the within-group analysis of the time differences between D1, D2, and D3 whereas Table 3 shows the comparable difference between both the groups for the time differences of D1, D2, and D3.

Table 2: Within the group comparison among difference1, difference2, and difference 3 for both groups.

Measure	Group	Measures	p-value#
Reaction time	Experimental group	D1	<0.001
		D2	
		D3	
	Control group	D1	<0.001
		D2	
		D3	

Note- #Friedman test

Table 3: Between the group comparison among difference1, difference2, and difference 3 for both groups.

Variable	Groups		Measures	p-value#
Reaction time	Experimental group	Control group	D1	0.30
			D2	0.46
			D3	0.10

Note- #Mann-Whitney U test

DISCUSSION

To the best of our knowledge, this was the first study that explore the immediate impact of aerobic activity on RT in school-aged children. RTs are accurate measures of how quickly sensory input is processed and converted into motor responses.[7] In our study, RT was significantly influenced by both the experimental and control groups with and without aerobic activity, although between-group analyses were not significant.

In a study conducted on Indonesian students from a primary school in 2018, aged 6 to 8, it was discovered that participants who trained in various aerobic gymnastics three times per week for eight weeks exhibited a substantial increase in their RTs through RDT with a p-value of 0.43.[8] In this study, we discover differences in RT between pre-intervention and immediately after the intervention (mean±SD,0.25±0.49 s, p=0.30), immediately after the intervention, and post 30 seconds of the intervention (mean±SD, 0.28±0.43 s, p=0.46), and pre-intervention and after 30 seconds of the intervention (mean±SD, 0.53±0.46 s, p=0.10).

According to the findings of a previous study online published in 2020, research finds that there was no statistically significant difference in RT between children who equally participated in physical activity and video games (0.386±0.134 s) and shows a significant difference in those who regularly indulge in physical activity compared to those who play video games[(0.327±0.081 s) vs. (0.403±0.137 s), p = 0.013] when compared to those who regularly practice physical activity (p=0.156) and who only played video games.

(p=0.610).[9] The RT may have improved as a result of prolonged physical activity, The brief duration of physical activity at the time of the procedure may be the reason why we did not find any comparable differences across the groups in our study.

A study was conducted at Urbana-Champaign to explore the relationship between age, aerobic fitness, and cognitive function by comparing high- and low-fit preadolescent children and adults, which showed children who are more active have more effective neuro-electric profiles than children with sedentary lifestyles, studies reveal that increased aerobic capacity is linked to changes in neurocognitive functioning. This study in adult populations confirms the finding that children with higher aerobic capacity also do better in tests of reaction speed and response accuracy, which may be due to greater resource allocation to working memory.[10] Hence, this could be another factor responsible for the non-significant relation seen in the present study between the RT immediately after the 20-meter shuttle run test and sitting.

The reliability and cost-effectiveness of the RDT and 20-m SRT are one of the strengths of this study. Also, RDT can be performed as an on-field and off-field test battery. Unavoidable human errors and heterogeneity of the participant may be a limitation for this present study.

CONCLUSION

This study concludes that physical activity has immediate benefits at the time of reaction but showed no comparable relationship between the RT immediately after aerobic activity and sitting. It has been observed that children with an active lifestyle have better neuro-electrical profiles than do children who lead sedentary lives. As a result, regular aerobic activity stimulation should be included as a learning stimulation in the curriculum. There may be a need for curriculum revision in educational institutions so that regular physical activity is included as an intra-curriculum activity.

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