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Original Article

Physical Medicine and Rehabilitation Section

Relationship between Physical Activity Status and Physiological Parameters among Adolescents and Young Children

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ABSTRACT

Introduction: Childhood obesity is strongly associated with elevated Blood Pressure (BP) and elevated cholesterol levels, progressing over time to adult premature Cardiovascular Disease (CVD). Physical Activity (PA) is protective against various diseases like hypertension and CVD.

Aim: To assess the relationship between PA status and physiological parameters among adolescents and young children.

Materials and Methods: An interventional study was conducted in the Department of Physiology at Siddhartha Medical College, Vijayawada, Andhra Pradesh, India from October 2019 to December 2019. A PA intervention was given to 30 participants in the study group (one hour of PA, three times a week for three months) and compared with 30 participants in the control group. The anthropometric and physiological parameters were compared between the groups. The coGuide statistical software was used for data analysis.

Results: A total of 30 participants in each group were studied. The mean age was 14.28±3.1 years in the study group and 13.6±2.8 years in the control group. The mean duration of PA was 47.8±6.3 minutes. No statistical significance was observed between groups for Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and body temperature postintervention. There was a statistically significant difference between the two groups in heart rate (beats/min) and respiratory rate (breaths/min) postintervention (p-value <0.05).

Conclusion: The findings shed light on the need of different PA intervention programs for school going children to improve their physiological parameters.

Keywords: Children, Cardiovascular disorders, Heart rate, Lifestyle disorder, Non communicable disease, Risk, School

INTRODUCTION

Globally, there is a rise in the prevalence of obesity and body fat accumulation. Worldwide, there are 350 million obese (Body Mass Index, BMI ≥30 kg/m^2) and one billion overweight people (BMI ≥25), and approximately 2.5 million deaths are caused due to overweight and obesity [1]. Overweight and obesity in childhood can increase the risk of developing the same in adult life; hence, childhood obesity is considered a public health problem [2]. The worldwide increase in body fat among adolescents and children is caused due to insufficient PA and unhealthy lifestyles among them [3]. Childhood obesity has a strong association with elevated Blood Pressure (BP) and elevated cholesterol levels, progressing over time to adult premature CVD [4].

A study done in Bahraini school children shows significant differences in mean SBP and DBP between obese and non obese children. Children with high BP had a greater risk of developing hypertension in adult life [5]. Since high BP contributes significantly to coronary heart disease among adults [6], it becomes essential that an association between PA and BP and other health parameters in adolescents and children should be examined [7]. Available literature suggests that school based PA interventions might help improve the health parameters and result in lifestyle behaviour changes among children and adolescents, ultimately leading to a reduction in cardiovascular risk in adulthood [8] and World Health Organisation (WHO) recommends that 5 to 17-year-olds should engage in atleast 60 minutes of moderate or vigorous PA per day [9]. Improvement in objective health outcome was reported in adolescent population with increased PA levels, but the evidence is conflicting about the level of PA and self reported health status [10]. Ansari W El et al., showed that in Egyptian adolescents, a school based PA intervention improved physiological parameters and reduced overweight in 12.5% of the intervention group [11]. A systematic review by Granger E et al., supports the need for PA initiatives among adolescents in order to improve their physical health [12]. This study was planned as there are no studies available in this study area and with increase in the prevalence of non communicable diseases among children, it is ideal to plan an intervention that can improve their physical health.

Hence, this study was planned to find the association between PA and physiological factors among adolescents and young children.

MATERIALS AND METHODS

An interventional study was conducted in the Department of Physiology at Siddhartha Medical College, Vijayawada, Andhra Pradesh, India, from October 2019 to December 2019 after taking clearance from the Institutional Ethical Committee. A non randomised convenient sampling technique was followed. A secondary school in Vijayawada, Andhra Pradesh, India, was selected to conduct the study since they had indoor and outdoor sports and sports kits. This criterion was considered so that the PA program can continue without interruption in all weathers to ensure the children's safety. Children were given an introductory session and explained the aim of the study, and participation was encouraged. Informed written consents were signed by both the participants and their parents/guardians. Boys and girls were randomnly distributed among the study groups.

Sample size calculation: The expected mean and standard deviation of the heart rate in control group was 93.21±6 and in the intervention group it was 89.11±5 as per the previous study by Omoniyi MM et al., [13]. The other parameters considered for sample size calculation included were 80% power of study and 5% two sided alpha error [14]. The required sample size as per the above mentioned data was 30 (29 with 5% lost to follow-up therefore, one case added) in each group. In our study, we considered 30 subjects in each group.

Inclusion criteria: All children aged 5-19 years with no history of intake of medicines and no history of chronic illness were included in the study.

Exclusion criteria: Children with contraindication for PA, chronic medical illness and under chronic medication were excluded from the study.

Study Procedure

Medical fitness was ensured for all participants, and a PA readiness questionnaire was used for assessing the medication and chronic disease status. The PA readiness questionnaire contains total of seven step questionnaire that screens for evidence of risk factors during moderate PA [15]. Based on the completed PA readiness questionnaires and consent forms, 30 subjects were included in the intervention and control group (aged 5-19 years), respectively. A PA intervention program was implemented for the study group with one hour of moderate PA three times a week for three months. The control group children followed the routine physical activity conducted in school (optional and not standardised).

For the 60 pupils, anthropometric (weight, height, BMI) and physiological (pulse rate, respiratory rate, body temperature, SBP, DBP, heart rate) measurements were taken twice, once at baseline during the first school term (preintervention); and after three months during the second school term (postintervention). The measurements were obtained three times the same day, and an average of the value was taken as the final measurement. Participants were instructed not to take any caffeine or tobacco on the day of measurement. The anthropometric evaluation comprised three parameters:

Weight (and height) were measured using digital scales. Height measurement was done to the nearest 0.1 cm when participants stood barefoot, and body weight measurement was done to the nearest 0.1 kg in light clothing and no footwear.

The Body Mass Index (BMI) Status was calculated using Metric BMI Formula {BMI (kg/m^2)=weight in kilograms/the squared height (m^2)} [9,16,17]. The BP and heart rate measurements were done using a digital BP monitor. The BP documentation was done based on international guidelines [18]. The measurements were repeated three times in a day, and the average values were taken as final.

The values were measured in a quiet, peaceful room after allowing the participant to sit there for 10 minutes. These measurements were taken at a sitting position in the right arm at the level of the heart. After the intervention period, the participant's measurements were taken after a two day rest period.

STATISTICAL ANALYSIS

Physiological parameters like heart rate, respiratory rate, BP etc., were included as study outcomes, and the study group intervention was considered explanatory variable. Continuous variables were analysed by independent samples t-tests and expressed as the mean and standard deviation. The count variables were analysed by the Chi-square, expressing as the number. Baseline to follow-up time differences in continuous parameters was defined using paired t-test. A statistically significant difference was set at p<0.05. Data was analysed by using Statistical Package for the Social Sciences (SPSS) software, version 22 [19].

RESULTS

A total of 30 participants were considered in intervention (PA) and control group (no PA) each. In intervention group the mean age of study participants was 14.28±3.1 years, 23 (76.67%) were boys and 7 (23.33%) were girls and in control groups mean age was 13.6±2.8 years, 20 (66.67%) were boys and 10 (33.33%) were girls. The difference in age and gender between study group was statistically not significant (p-value >0.05). The mean duration of PA was 47.8±6.3 minutes.

No statistical significance was observed between groups in baseline parameters like weight, BMI (p-value >0.05); weight and BMI were higher in controls than in the study that is 48.6±12.7 kg and 25.1±4.9 kg/m^2, respectively. There was a statistically significant difference between the two groups in baseline parameter of height (p-value <0.05). Height was more in intervention group children as 1.8±0.2 meters [Table/Fig-1].

Parameters	Study group		p-value
	Intervention (n=30)	Control (n=30)	
Age (years), (mean±SD)	14.28±3.1	13.6±2.8	0.37*
Age group n (%)			
5-10 years	11 (36.67%)	8 (26.67%)	0.41†
11-19 years	19 (63.33%)	22 (73.33%)	
Gender n (%)			
Boys	23 (76.67%)	20 (66.67%)	0.39†
Girls	7 (23.33%)	10 (33.33%)	
Weight (kg)	47.1±12.3	48.6±12.7	0.65*
Height (meters)	1.8±0.2	1.4±0.1	<0.001*
BMI (Kg/m^2)	23.6±4.5	25.1±4.9	0.22*

[Table/Fig-1]: Comparison of baseline parameter between study group (N=60). p-value calculated as *Independent sample t-test; †Chi-square test; p-value <0.05 was considered statistically significant

The difference in family income/per year between the study groups was insignificant, with a p-value of 0.26. The majority of 14 (46.67%) participant's parents earned one to five lacs in the intervention group. The difference in family type between the study groups was insignificant with a p-value of 0.42. The difference in parent's education status between the study groups was significant with a p-value of 0.01[Table/Fig-2].

Parameters	Study group, n (%)		p-value*
	Intervention (n=30)	Control (n=30)	
Family income/year			
<1 lac	7 (23.33%)	13 (43.33%)	0.26
1-5 lacs	14 (46.67%)	10 (33.33%)	
>5 lacs	9 (30%)	7 (23.33%)	
Family type			
Nuclear	18 (60%)	21 (70%)	0.42
Joint	12 (40%)	9 (30%)	
Location			
Urban	22 (73.33%)	16 (53.33%)	0.11
Rural	8 (26.67%)	14 (46.67%)	
Parent's education status			
Both educated	14 (46.67%)	6 (20%)	0.01
Single parent educated	11 (36.67%)	9 (30%)	
Illiterate	5 (16.66%)	15 (50%)	

[Table/Fig-2]: Comparison of family related parameters between study groups (N=60). *Chi-square test; p-value <0.05 was considered statistically significant

There was no statistically significant difference between the two groups in physiological parameters like SBP (mm/Hg), DBP (mm/Hg), body temperature (degrees Celsius), peak VO_2 (at rest) (p-value >0.05) at baseline. However, there was a statistically significant difference between the two groups in physiological parameters like heart rate (beats/min), pulse rate (beats/min), respiratory rate (breaths/min) and SpO_2 (%) (at rest) (p-value <0.05). Postintervention, there was no statistically significant difference in follow-up physiological parameters like, SBP (mm/Hg), DBP (mm/Hg), body temperature (degrees celsius), pulse rate (beats/minute) and peak VO_2 between study groups (p-value >0.05). There was a statistically significant difference in follow-up physiological parameters like heart rate (beats/min), respiratory rate (breaths/mints), SpO_2% between study groups (p-value <0.05) [Table/Fig-3].

Parameter	Study group		p-value*
	Intervention (N=30)	Control (N=30)	
Baseline			
Heart rate (beats/min)	73±14	65±12.4	0.02
SBP (mm/Hg)	124.1±18.7	126.2±20.4	0.67
DBP (mm/Hg)	67.3±5.9	69.2±6.7	0.24
Body temperature (degrees Celsius)	37.6±4.5	37.4±4.1	0.86
Pulse rate (beats/min)	71±15	67±12.8	<0.001
Respiratory rate (breaths/min)	14±5	12±2	0.04
SpO_2% (at rest)	95.3±1.2	96.7±1.9	0.001
Peak VO_2 (at rest)	36.2±8.3	34.9±7.5	0.53
Follow-up			
Heart rate (beats/min)	72.3±12.1	63.7±11.5	0.007
SBP (mm/Hg)	123.4±16.7	123.6±18.9	0.97
DBP (mm/Hg)	65.2±4.9	66.4±5.2	0.36
Body temperature (degrees Celsius)	37.1±3.5	36.8±3.2	0.73
Pulse rate (beats/min)	68±13	65±12.3	0.36
Respiratory rate (breaths/min)	12.6±4	11±1.7	0.04
SpO_2%	91.7±0.9	95.6±1.2	<0.001
Peak VO_2	37.1±8.5	34.1±6.9	0.14

[Table/Fig-3]: Comparison of physiological parameters between study groups (N=60).
*Independent sample t-test; p-value <0.05 was considered statistically significant

Groups	Preintervention	Postintervention	p-value*
Intervention group (N=30)			
Heart rate (beats/min)	73±14	72.3±12.1	0.83
SBP (mm/Hg)	124.1±18.7	123.4±16.7	0.88
DBP (mm/Hg)	67.3±5.9	65.2±4.9	0.14
Body temperature (degrees Celsius)	37.6±4.5	37.1±3.5	0.63
Pulse rate (beats/min)	71±15	68±13	0.41
Respiratory rate (breaths/min)	14±5	12.6±4	0.24
SpO_2%	95.3±1.2	91.7±0.9	<0.001
Peak VO_2	36.2±8.3	37.1±8.5	0.14
Control group (N=30)			
Heart rate (beats/min)	65±12.4	63.7±11.5	0.67
SBP (mm/Hg)	126. 2±20.4	123.6±18.9	0.61
DBP (mm/Hg)	69.2±6.7	66.4±5.2	0.07
Body temperature (degrees Celsius)	37.4±4.1	36.8±3.2	0.53
Pulse rate (beats/min)	67±12.8	65±12.3	0.54
Respiratory rate (breaths/min)	12±2	11±1.7	0.04
SpO_2%	96.7±1.9	95.6±1.2	0.009
Peak VO_2	34.9±7.5	34.1±6.9	0.69

[Table/Fig-4]: Comparison of physiological parameters between time periods in Intervention and control group individually.
*Paired t-test; p-value <0.05 was considered statistically significant

Respiratory rate (breaths/min) in controls showed statistically significant difference (p-value=0.04), from baseline to follow-up period. In both intervention and control groups SpO_2% reported statistically significant difference in follow-up compared to baseline (p-value <0.05) where peak VO_2 reported no statistically significant difference from pre to post in both the groups individually (p-value >0.05) [Table/Fig-4].

DISCUSSION

Based on the study findings, it was clear that the physiological variables were slightly improved among the intervention group compared to the control group. This might be attributed to the PA. Risk factors of CVD in childhood can project into adult life leading to morbidity and mortality [20,21]. Children and adolescents do insufficient PA that puts their health at risk of obesity [22], due to this overweight and obesity epidemic has been spreading globally with negative health impact [23].

As per the study's objective, a description of a range of anthropometric and physiological parameters was studied for a sample of secondary school children. School based BMI measurement acts as a potential approach to address the increase in obesity among youth [24]. Objective measurement of various parameters is preferred over reported values, as self reported values might be underestimated [10,25]. Since, BMI classification based on self reported values in previous studies was inaccurate, we followed the objective measurement method [26-29].

With reference to baseline mean SBP, the sample values in present study were (124.1±18.7 mmHg in the intervention group and 126.2±20.4 mmHg in the control group) were slightly higher than the 107.1 mmHg reported in 2,156 Argentinean adolescents (15 to <18-year-old) but close to those of 676 adolescents in Norway (119.9 mmHg). Similarly, our baseline means DBP (67.3±5.9 in the study group and 69.2±6.7 in the control group) were slightly higher than Norway and Argentina (64 and 67 mmHg, respectively) [30]. A physically active child will have a good basal metabolic rate that can help in maintaining the physiological parameters [31].

The study findings suggest a positive relationship between a moderate PA intervention and prevention of obesity and becoming fit. This finding was supported by study that indicated that PA could reduce weight gain by increasing energy expenditure [31]. Similar results were seen in previous studies that suggest that atleast one hour three times per week, PA will have a beneficial effect on the physiological parameters[Table/Fig-5] [6,30]. PA can improve the physiological parameters by ensuring a balanced state. Physically active work results in maintaining the body's metabolism and enables in maintaining a normal BMI range [30].

S. No.	Authors name and year	Place of study	Number of subjects	Intervention done	Parameters compared	Conclusion
1	Present study	India	30 subjects in each group	Physical activity-three months of physical activity one hour three times a week	Physiological parameters (SBP (mm/Hg), DBP (mm/Hg), body temperature (degrees Celsius) heart rate (beats/min), pulse rate (beats /min), and respiratory rate (breaths/mins)	Significant difference observed in the physiological parameters lke SpO_2, respiratory rate and heart rate between experimental group and control group.
2	Stray-Pedersen M et al., 2009 [30]	Argentina and Norway	2,156 adolescent girls from Norway evaluated between 1995 and 1997, and 669 from Argentina evaluated between 2004 and 2005	No intervention	anthropometric and blood pressure measurements	Obesity is associated with systolic hypertension. High prevalence of obesity among adolescents
3	Nielsen GA and Andersen LB [6] 2003	Denmark	13557 adolescents	Shuttle run test	BMI, physical activity and blood pressure	Low physical fitness level and high BMI were associated with a high BP and risk of having hypertension in both girls and boys.

[Table/Fig-5]: Comparison of physiological parameters between time periods in Intervention and control group individually [6,30].
*Paired t-test

Limitation(s)

The limitations of the current study are the short duration of a three month follow-up period. One school in Vijayawada was selected for the study. Hence, generalisation to the whole population is not possible. Therefore, in the future, multicentric studies with large sample sizes and long term follow-up are recommended.

CONCLUSION(S)

The study findings showed that physiological parameters improved in those doing PA. A PA program for three months can help maintain and enhance the anthropometric and physiological parameters in children compared to those not physically active. Education and healthcare policymakers should include school based PA as a part of the school curriculum, thus ensuring a healthy child can become healthy adult.

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