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Impact of Aerobic Physical Exercise on Cardiovascular Health of In-school Adolescents of Nepalgunj, Nepal

Article by Manita Pyakurel[1], Archana Shrestha[2], Nnodimele Onuigbo Atulomah[3]
[1]*Texila American Uiversity, Guyana*
[2]*Kathmandu University, Nepal*
[3]*Babcock University, Ogun State, Nigeria*
E-mail: bhattamanita@gmail.com[1], deararchana@gmail.com[2], atulomahn@babcock.edu.ng[3]

Abstract

Background*: Physical activities and exercise play supportive role in preventing cardiovascular morbidity. Long-term exercise provides more health benefits. Contemporary society are plagued with increasing inactivity and obesity particularly among children and adolescents. Studies demonstrate benefits of moderate but consistent aerobic exercise on cardiovascular health, however roles of physical exercise on components of cardiovascular health CVH)-related parameters still remain unclear. This study investigated the effect of aerobic physical exercise on (CVH-related) parameters among in-school adolescents in Nepalgunj municipality, Banke, Nepal.*

Methodology: *This was an eight-week quasi-experimental design conducted by systematic random selection of consenting 8th and 9th graders assigned into intervention and control groups by odd and even number randomization, respectively. Measures of CVH-related parameters were anthropometry while demographic characteristics were collected using validated questionnaire. Data analysis was conducted, and results displayed as frequency, means and standard deviation with paired-sample t-test for test of significance at 5% level.*

Results: *At baseline, physical education and physical exercise groups showed no significant difference in most CVH-related parameters, except resting-Heart Rate that was significantly different ($p<0.01$). Impact of physical exercise on CVH-related parameters was significant for three CVH-related parameters of resting-HR (ES=0.56; $p<0.001$), BMI (ES=0.474; $p<0.05$), DBP (ES=0.355; $p<0.05$), but physical education only impacted on CVH-related parameters of resting-HR (ES=0.64; $p<0.001$).*

Conclusion: *Aerobic physical exercise implemented among in-school adolescents produced marginal but important changes in CVH-related parameters among in-school adolescents in the study despite the short duration of the intervention. The study recommends that physical exercise should be made part of school curriculum activities.*

Keywords: *Cardiovascular health, Physical activity, Aerobic exercise, Nepalgunj, in-school adolescents.*

Introduction

There is a global growing health problem associated with increasing physical inactivity among children and adolescents [1, 2, 3]. Early detection programmes facilitates prevention and control of morbidity from chronic diseases such as cardiovascular (CVD) and metabolic-related diseases involving obesity and diabetes mellitus, among others. It has been observed that several risk factors are clearly associated with emergence of chronic illnesses which can be prevented during childhood by strategically blending such preventive measure into the school curriculum. Sedentary lifestyle and lack of physical activity among growing children accounts for current rise in morbidity due to obesity, diabetes mellitus and cardiovascular diseases (CVD) observed in young adults [4]. Health education is known to play significant role in closing knowledge gaps created due to disparities in social opportunities [5], however,

engaging students at an early age in active physical exercises appear most effective in preventing chronic illnesses, especially CVD, obesity and consequently metabolic syndrome that may emerge later in life as they grow older [6]. Role of physical activities and exercise has been accepted as supportive method of decreasing cardiovascular morbidity[7].

This modality of introducing physical exercise in school is an important primary prevention strategy to reduce inactivity which has become prevalent among young children with consequent emerging morbidity. Exercise training and physical activity intervention programs longer than 6 months have been reported to be associated with a better reduction in cardiovascular risk factor profile in children, notably blood pressure and triglycerides reduction as compared to less intensive interventions[8]. Although long term exercise could potentially provide insight toward a useful method of health benefit, short term results are helpful to alleviate the increasing inactive and aging society. Although benefits elicited by a single exercise are considered to be transient, such improvements are still of high practical relevance due to being independent of the fitness level and can be elicited quickly [9]. When these activities are blended strategically into the school curriculum would facilitate behaviour change that would become part of life-long skills the student would acquire that would protect them from likelihood of morbidity later in life.

The three main types of exercise are aerobic, anaerobic and flexibility. Aerobic exercise involving exercise which requires the use of oxygen to drive body metabolic activities as demanded during the exercise. Despite direct effect on cardiovascular health, aerobic exercise also has indirect cardiovascular benefits in optimization of body weight, improvement in neurocognitive function [9-11] cerebrovascular function [10, 12].

Schools can serve as the community resource for programs to increase physical activity in children and adolescents, particularly given the urgent need for the development of strategies that would encourage at-risk adolescents to become more active. This constitute the best avenue to implement effective physical exercise programme for the growing child.

Although many studies have investigated acute effects of moderate aerobic exercise on cardiovascular health, the roles of age, fitness, and the component of cardiovascular health in this relationship still remains unclear [13]. The present study was undertaken to investigate the effects of aerobic physical exercise on cardiovascular health-related parameters among in-school adolescents with specific objectives to determine their pre and post intervention cardiovascular health parameters and similarly, to determine the impact of physical exercise intervention on CVD health parameters of the intervention group.

Materials and methods

Study design, subjects and settings

This study was a quasi-experimental design. List of higher secondary schools in Nepalgunj municipality served as the sampling frame with a total number of 7 schools consisting of 4 private schools and 3 government schools. The study was conducted for a duration of eight weeks and enrolled 178 consenting eighth and ninth Graders in Nepalgunj municipality, Banke, Nepal through systematic random selection of names in the register associated with odd and even number identifiers into intervention and control groups. The groups were designated as control and intervention groups by simple balloting. Sample size was computed for the study using the formula adopted by Kish (1995) which gave 96 per group. Since this is an intervention study subject to replication, the 89 consenting participants that enrolled has no effect on external validity of the study outcome. Students from grade 8 and 9 with age between 10 to 19 years were included in the study. Measures of cardiovascular health (CVH) parameters used included blood pressure, heart rate and anthropometry while demographic characteristics were collected using validated questionnaire. Data analysis was conducted, and results displayed as frequency distribution, means and standard deviation with paired-sample t-test for test of significance at 5% level.

Exclusion criteria

Student not willing to be part of study or unable to carry out prescribed aerobic exercise during study period due to underlying health conditions**,** subjects on planned aerobic exercise prior to the study and adolescents with morbidity

affecting exercise and outcome such as prior stroke, heart attack, heart failure and surgery, bypass, cardiac dysrhythmia, acute flu or cold, spinal-, joint and head pain, diabetes mellitus, untreated hypertension (>160/>100), acute and chronic inflammatory condition, severe arthrosis, endoprosthesis, trauma (within the last 6 month) were excluded from the study.

Data collection

Data for the study was collected using a questionnaire validated by test and retest. Data collection was performed at pre-intervention or baseline, and post-intervention at the close of the eight weeks of the intervention to measure changes that may have occurred for CVH-related parameters at endline. Clinical assessment of indicators of cardiovascular health was measured by anthropometry and included body mass index (BMI), resting heart rate, blood pressures, physical activity level, smoking, alcohol habit and dietary pattern by a qualified nurse-practitioner who served as research assistant. At study entry, participants were counselled and required to report information on history of hypertension (blood pressure≥140/90) and diabetes, and family history of CVD. Control group went through regular physical education as required at school. Physical education included physical therapy once a week for 20 to 30 minutes for 2 months.

Intervention group received the programmed vigorous aerobic exercise (running) for 25 minutes per day for 3 days in week lasting 2 months. Adherence to prescribed exercise was encouraged and reinforced through counselling of benefits to be derived for participants in the intervention group. Caffeine intake was not allowed 5 hours prior to measurements and commencing exercise routine. Global physical activity questionnaire was used to collect necessary information on present physical activity level at baseline and repeated after 2 months of exercise session as endline. Measurement of height was done with a calibrated pole, and weight was measured with a digital weighing scale. Blood pressure was measured using Mercury sphygmomanometer after 5 minutes of rest in sitting position in both arms. The arm with highest reading was recorded in a data sheet. Resting heart rate was assessed using auscultation of heart. All the parameters measured were carried out by the same researcher.

Data analysis

Data collected was initially entered in windows excel 2010 programme then imported to SPSS 26 version for data analysis. Descriptive statistics was computed with mean and standard deviation for continuous variable and percentage and proportion was calculated for categorical variables.

Ethical consideration

Consent was sought from all participants that met the inclusion criteria a day before study commenced and each participant was counselled concerning the purpose of the study, assured of confidentiality and the likely risk that may occur. Similarly, consent from schoolteachers, or their parents were obtained in simple written form, with all implications of the study explained in clear language that conveyed meaning as required by the health research ethics committee and approval received from all relevant research Ethics Boards.

Results

The results showed that 186 participants were enrolled for the study. Among them, 5(2.6%) refused to participate and 3(1.6%) were not eligible. Thereafter, 178 students were finally selected for the study which were further divided into physical education group (89) and physical exercise group (89). *(See Table 1).*

At baseline, the physical education and physical exercise groups showed no significant difference in BMI, (21.66±2.01 and 22.34±2.21; $p>0.05$), DBP (65.17±6.58 and 65.07±6.08; $p>0.05$) and SBP (99.31±5.83 and 98.94±5.94; $p>0.05$), except for resting HR that was significantly different ($p<0.01$) *(See Table 2).*

Similarly, at post-intervention endline assessment, there was no significant difference between physical education and physical exercise groups in regards to BMI, (21.72±1.99 and 22.21±2.21; $p>0.05$), DBP (65.43±6.44 and 64.47±5.62; $p>0.05$) and SBP (99.39±5.79 and 98.53±5.10; $p>0.05$), except for resting HR that was significantly different (73.20±5.31 and 71.19±5.07; $p<0.01$). *(See Table 3).*

Computing changes in CVH-related parameters defined by Cohen's d effect size (ES) for the various groups comparing before and after

the interventions in the control group showed that impact of physical education on CVH-related parameters of resting-HR (ES=0.64; p<0.001) was the only variable that was significant. The impact of the physical education on all other CVH-related parameters were not statistically significant *(See Table 4)*.

Interestingly, at post-intervention evaluation, changes in mean scores of CVH-related parameters for physical exercise showed that impact of the intervention on CVH-related parameters of resting HR (ES=0.56; p<0.001), BMI (ES=0.474; p<0.05), DBP (ES=0.355; p<0.05), were statistically significant, except SBP (ES=0.073; p>0.05) which was not statistically significant *(See Table 5)*. The observed reduction in mean blood pressure was not statistically significant. *(See Table 3).*

Discussion

The study sort to investigate the impact of aerobic physical exercise on cardiovascular health-related parameters among in-school adolescents by comparing the outcomes of two programmes of physical education and physical aerobic exercise at the end of eight weeks. The prevalence of chronic illnesses such as raised blood pressures and obesity, resulting from inactivity and improper dietary practices, is beginning to be observed among adolescents in many developing and developed countries, not excluding Nepal.

These are important risk factors for cardiovascular morbidity and mortality that may become the common morbidity in adulthood which could have been prevented earlier in life by implementing lifestyle practices that consists of simple and regular physical activity It is an established fact that exercise reduces risk of CVD by modifying CVH-related parameters to be consistent heart health [13, 14]. If aerobic exercise is initiated early as young people grow yield more long-term benefits. In this study, we tried to intervene by developing planned regular aerobic physical exercise among in-school adolescents with control group that received physical education without planned exercise similar to previous studies elsewhere [14]. Risk factor modification at adolescent level has preventive health benefits and is considered very helpful in reducing morbidity from CVD. Presently, cardiovascular diseases constitute an important public health disease of immense proportion and broad impact that require concerted efforts to address the growing burden on the global health system. It is thought that halting the rising trends of obesity and CVD at the primordial level of prevention is the key role of health education planners.

Well established method in adults such as aerobic exercise is believed to work in adolescent age group as well by directly improving cardiovascular health parameters or indirectly by implementing healthy lifestyle. Nepalgunj is a well-developed city of western part of Nepal, a city with culturally diverse populations which includes both in-school adolescents [15].

Physical exercise on CVH related parameters

Aerobic physical exercise as an intervention in this study provided significant changes in CVH related parameters such as resting heart rate, BMI and DBP. However, there was no statistically significant changes observed for SBP. Many studies have reported decreased risk of CV morbidity and improved CVH-related parameters with increased level of aerobic fitness, however, these change may be slow in becoming well established[15-18].

Table 1. Demographic characteristics of participants in the study

Demographic Variables	Physical education group (Control)		Physical exercise group (Intervention)	
	Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
Sex:				
• Male	51	57.3	48	53.9
• Female	38	42.7	41	46.1
Religion:				
• Buddhism	4	4.5	2	2.2
• Hindu	82	92.1	83	93.3
• Islam	3	3.4	4	4.5

Ethnicity:				
• Lower Caste	50	56.2	14	15.7
• Upper Caste	39	43.8	75	84.3

Table 2. Comparing Measures of Cardiovascular Health-Related parameters at Baseline for the two Groups in the study

VARIABLES	**Physical Education N=89**		**Physical Exercise N=89**			**p-value**
	$\overline{X}(SE)$	**±SD**	$\overline{X}$ **(SE)**	**±SD**	**z-value**	
Resting Heart Rate	74.33(0.60)	5.62	72.03(0.58)	5.29	2.80	0.001
Body Mass Index	21.66(0.21)	2.01	22.34(0.25)	2.21	-2.10	0.037
Diastolic Blood Pressure	65.17(0.70)	6.58	65.07(0.70)	6.08	0.11	0.915*
Systolic Blood Pressure	99.31(0.62)	5.83	98.94(0.63)	5.94	0.42	0.675*

Table 3. Comparing Measures of Cardiovascular Health-Related parameters at Endline for the two Groups in the study

VARIABLES	**Physical Education N=89**		**Physical Exercise N=89**			**p-value**
	$\overline{X}(SE)$	±SD	$\overline{X}$ (SE)	±SD	**z-value**	
Resting Heart Rate	73.20(0.56)	5.31	71.19(0.54)	5.07	2.59	0.01
Body Mass Index	21.72(0.21)	1.99	22.21(0.23)	2.21	-1.54	0.13*
Diastolic Blood Pressure	65.43(0.68)	6.44	64.47(0.60)	5.62	1.06	0.29*
Systolic Blood Pressure	99.39(0.61)	5.79	98.53(0.54)	5.10	1.06	0.29*

Table 4. Measure of impact of Physical Education on Cardiovascular Health-Related Parameters in the study

VARIABLES	**Baseline N=89**		**Post-Intervention N=89**		***ES**	**p-value**
	$\overline{X}(SE)$	±SD	$\overline{X}(SE)$	±SD		
Resting Heart Rate	74.33(0.60)	5.62	73.20(0.56)	5.31	0.64	0.000
Body Mass Index	21.66(0.21)	2.01	21.72(0.21)	1.99	0.19	0.211**
Diastolic Blood Pressure	65.17(0.70)	6.58	65.43(0.68)	6.44	0.24	0.112**
Systolic Blood Pressure	99.31(0.62)	5.83	99.39(0.61)	5.79	0.23	0.127**

*ζES; effect size evaluating the impact of health education computed from Cohen's d, and corresponding level of significance. **Not significant.*

Table 5. Measure of impact of physical Exercise on Cardiovascular Health-Related Parameters in the study.

VARIABLES	**Baseline N=89**		**Post-Intervention N=89**		**ζES**	**p-value**
	$\overline{X}(SE)$	±SD	$\overline{X}(SE)$	±SD		
Resting Heart Rate	72.03(0.58)	5.29	71.19(0.54)	5.07	0.560	0.000
Body Mass Index	22.34(0.25)	2.32	22.21(0.23)	2.21	0.474	0.002
Diastolic Blood Pressure	65.07(0.70)	6.08	64.47(0.60)	5.62	0.355	0.021
Systolic Blood Pressure	98.94(0.63)	5.94	98.53(0.54)	5.10	0.073	0.632**

*ζES; effect size evaluating the impact of health education computed from Cohen's d, and corresponding level of significance. **Not significant.*

Impact of physical education and physical exercise on CVH related parameters

Comparing two groups regarding changes in CVH related parameters, means resting heart rate and DBP were initially large in the group that received physical education than physical exercise group. Resting heart rate is found lower when intensity of exercise is increased in other study whereas in our study it is contradictory which may be because of different age group of study.[19].

Differences in mean SBP and BMI among physical exercise group was not significant for both baseline and end line, however, when the impact of physical exercise was considered changes observed in the group that received physical aerobic exercise demonstrated high impact on BMI and DBP than the group that received physical education. *(See Table 5)* The results in this study provide support for the hypothesis that physical aerobic exercise will produce improved CVH-related parameters of resting-Heart Rate, BMI and DBP than the reference group as observed by similar studies elsewhere.[20, 21].

Limitation

Study design of the study was quasi-experimental. Study design employed a control group as the reference for the study which may not be completely acceptable in the absence of a group that did not receive any form of intervention related to body activities. Each group act was its own control by considering their pre- and post-intervention scores for the various parameters related to cardiovascular health. Cohen's effect size (d) for difference in means of each group was included in statistic to compensate for not having control. Study period to perform exercise was short which could have been better with longer duration to observe fully the effects of exercise. Only one kind of physical exercise(running) was done in this study. Study setting was selected purposively, hence generalization cannot be done.

Conclusion

Aerobic physical exercise implemented among in-school adolescents would be beneficial in decreasing BMI, resting heart rate and diastolic blood pressure if made part of school activity. These known risk factors for cardiovascular diseases that are preventable when implemented early as the individual is growing contributes significantly to reducing the burden of CVD in the population.

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