

Effectiveness of School-based Physical Activity of Obesity and Hypertension

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Abstract

Obesity and high blood pressure (BP) are well-known cardiovascular disease risk factors. As both risk factors have an impact early in life, and BP is linked to body weight. Both obesity and high BP should be prevented and controlled through early identification and prevention. The aim of this study was to assess how rope exercise improves BP and body mass index (BMI) in school children. The multi-stage cluster sampling technique was used in a true experimental design. Among 2,581 screened, 239 overweight and pre-hypertensive children were identified using a pre-designed proforma and their demographic variables were collected. A total of 104 and 97 children were assigned to the research and control groups at random. A 6-week rope exercise programme was provided to the study group. Among the screened children, 239 children (9.26%) were overweight and among the overweight children, the prevalence of pre-hypertension was 32 percent. The results showed a significant reduction in weight and BP ($p=0.000$) and a positive correlation found between BMI and SBP ($p=0.000$), though it took longer time to bring the positive changes in dietary habits and DBP. The sex, family type, number of family members, and family history of chronic illness of children were found to have a significant relationship with BMI and SBP. The study concludes that rope exercise and dietary modifications help to prevent, and also control obesity and hypertension and school health intervention is the need of the hour.

The children of today will inherit the world of tomorrow. It is, first and foremost, a moral obligation to invest financially on children to help them survive and grow to their fullest potential. However, we are steadily gaining weight with a younger-age trend as a result of the steady growth of economic level and subsequent changes in life style. According to the Centres for Disease Control and Prevention (CDC) in the United States, obesity prevalence in children and adolescents aged 2–19 years has nearly tripled since 1980; approximately 17 percent (i.e. 12.5 million) of children and adolescents aged 2–19 years are obese (CDC, 2012). Viewed from an absolute perspective, the World Health Organisation (WHO) reported that 41 million children under the age of 5 and more than 340 million children and adolescents aged 5 to 19 were overweight or obese in 2016.

Obesity has become a major social and public health issue around the world because it is

considered to be a major risk factor for type 2 diabetes, hypertension, stroke, cardiovascular disease, musculoskeletal disorders, and cancer. According to the WHO, childhood obesity has been shown to be closely linked to a higher risk of premature death and disability in adulthood (SEARO-WHO, 2008; Colman et al, 1995). Hypertension, elevated plasma lipid concentrations, lipoprotein concentrations, C-reactive protein (CRP) levels, insulin resistance (IR) (Colman et al 1995), and changes within the vasculature such as increased arterial stiffness (CDC, 2000), and blood pressure (NHBPEP, 2004) in children and adolescents (Evensen et al, 2016) have all been linked to central adiposity, which is characterised as fat mass accumulation around the abdomen. In children and adolescents, high blood pressure appears to develop more rapidly and persists into adulthood suggesting that the mechanisms for the disease may be distinctive. Despite of the pathology, the manifestation of obesity-related high blood pressure in children forecasts a major health care burden and a need for early intervention strategies.

Behavioural risk factors such as an unhealthy diet and physical inactivity are also believed to be responsible for around half of all

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cases of hypertension. Insufficient physical activity is the fourth most common cause of death. Physical inactivity is linked to approximately 20 percent of hypertension, and obesity is linked to approximately 30 percent of hypertension (World Hypertension League, 2017). According to WHO criteria, more than two-thirds of adolescents aged 11 to 17 are physically inactive in India. Any preventive and promotive health measures aimed at this age would be relatively inexpensive, but will have long-term benefits to people, communities, and economies.

A study conducted by Kim et al (2020) on the effects of a 12-week jump rope exercise programme on body composition, insulin sensitivity, and academic self-efficacy in obese adolescent girls concluded that jump rope exercise can be a useful therapeutic intervention to improve the cardiovascular risk factors in obese adolescents with pre-hypertension. Similar findings also given by the study by Seo (2017) and Lee et al (2020). Hence, a school-based healthy lifestyle programme implementation is critical for school-aged children. The aim of this study was to assess the effect of the rope exercise on BMI and BP in school children.

Objectives

The study was set out with following objectives.

- To assess the level of body mass index and blood pressure among school children before the rope exercise;
- To assess the effectiveness of rope exercise on body mass index and blood pressure among school children;
- To examine the relationship between body mass index and blood pressure among school children;
- To associate the demographic variables with body mass index and blood pressure among school children.

Materials and Methods

A true experimental design was adopted and high schools of Tiruvallur district (Tamil Nadu) were chosen at random. In terms of the rural/urban distribution, using the multistage, stratified random sampling technique, a sampling frame was prepared and 4 schools were chosen at random from 2 rural zones and 2 urban wards. The target population for this study was all children aged 10 -12 years with overweight and increased blood pressure. The sample size was determined using a power analysis with $\alpha = 5$ percent, $\beta = 20$ percent and it was 100 for each study and control group.

The study included children who were in the

85th percentile on the WHO BMI map for their age and gender and had a 90th Systolic/Diastolic Percentile - NHBPEP Working Group on Children and Adolescents of NHLBI (CDC, 2000; Evensen, et al, 2016). The children who have been diagnosed and having other pathological causes of hypertension and with any co-morbid illnesses, children who are already taking treatment for overweight and hypertension as well as the children who had already undergone any programme on yoga and exercise were excluded from the study. Out of 116 and 122 children who met the inclusion and exclusion criteria, 104 and 97 in the study and control group respectively were allotted from different demographic locations to avoid sample contamination.

The tool consisted of 2 parts: (a) screening tool to identify the overweight children with increased blood pressure which included measurement of height, weight, calculated body mass index and blood pressure; (b) assessment tool to collect the demographic variables of the school children like age, gender, religion, level of education, birth order in the family, number of siblings, number of persons in the family, monthly income of the family, mother and father's education and working status, type of family and nature of residence as well as family history of overweight, hypertension and any other chronic illnesses. Cronbach alpha and test-retest approaches were used to determine the tool's reliability ($r=0.92$).

Written consent from head of institutions, parents and children's assent was taken. Following approval from the institutional ethics committee, the baseline data was collected. A 'no harm' certificate from the paediatrician and physical therapist was obtained before implementing the intervention. Participants in the rope exercise programme were warmed up for 5 minutes before completing eight cycles of rope jumping. Each cycle consisted of 2 minutes of rope jumping followed by 2 minutes of rest, ending with a 5-minute relaxation exercise. At the end of each cycle, child's heart rate was registered to maintain the maximum heart rate. Phone calls were used to ensure compliance, and the investigators kept track of physical activity and diet dairy for six weeks.

Statistical Analysis

The results from this study are presented as mean $\pm$ standard deviation. Bi-variate analysis, co-relation co-efficient, chi-square test, paired, unpaired 't' test, repeated measures ANOVA were used to determine the effect, correlate, and associate the variables. Statistical significance was set at $p<0.05$ and all analyses were performed using SPSS Complex Sample TM version 18.0

Results

The investigators screened a total of 2,581 children aged 10 to 12 years for overweight and hypertension in this pilot project. Among 2,581 children screened, 741 children (28.70%) were found to be overweight, with 239 children (9.26%) being overweight and prehypertensive. Among the overweight children, the prevalence of pre-hypertension (PHT) was 32 percent. According to the geographical location, 104 and 97 children were assigned to the intervention and control groups, respectively to avoid contamination of samples.

Eighteen (17%) of the study group children gained normal weight in the first post-test, and after 6 weeks, 43 (41%) children in the study group gained normal weight, none were obese, and 56 (59%) were overweight (statistically significant at $p=0.000$). The comparison of BP for study and control group revealed that 19 (19%) and 48 (46%) study group children became normal respectively in the first and second post-test, which were statistically relevant at $p=0.000$, while only 8 (8%) of control group children became normotensive after 6 weeks (Table 1). This shows that the rope exercise programme is effective in reducing weight and BP among children and there is a need for long-term intervention and this physical activity should be adopted as daily endeavour in the schools.

In the comparison of effective score for BMI and BP between study and control which was done by independent “t” test, the difference found during both study periods confirms that

the rope exercise programme was highly effective in reducing BMI and systolic blood pressure (SBP) among study group and that it requires long-term intervention with adequate reinforcement. Further, the degree of significance after 3 and 6 weeks indicates that initially lowering BMI is easy, but maintaining it was more difficult. In contrast, the mean differed diastolic blood pressure (DBP) was minimal which confirms that the intervention should be long-term to bring desired change in DBP.

Regarding the relationship among BMI, SBP, DBP of study group, BMI and SBP shows a significant positive correlation at $p=0.000$ level in all the three study periods, which once again proves that BMI is strongly correlated with BP and there is a greatest need for early diagnosis and treatment of overweight to have significant reduction in BP (Table 2).

Discussion

According to the first objective, the baseline level of BMI and BP among school children was assessed. Among 2581 screened, 741 children (28.70%) were found to be overweight, with 239 children (9.26%) being overweight and pre-hypertensive. Many researches, including the current report found that the prevalence of hypertension was significantly higher among overweight and obese children. Based on BMI percentile cut-points, the prevalence of hypertension has been shown to be greater, 5 and 7 times more likely to have hypertension while those with obesity and severe obesity respectively, compared to their healthy weight counterparts. These findings suggest that children with obesity are at the greatest

Table 1: Obesity/Overweight and BP status in the study subjects before and after intervention

Group	Pre-test				Post-test 1				Post-test 2			
	Overweight & obese		PHT		Overweight & obese		PHT		Overweight & obese		PHT	
	n	Chi square & p value	n	Chi square & p value	n	Chi square & p value	n	Chi square & p value	n	Chi square & p value	n	Chi square & p value
Study group	104	$\chi^2 = 10.102$, d.f = 1, $p=0.001$ ***	104	NA	86	$\chi^2 = 28.546$, d.f = 2 $p=0.000$ ***	81	$\chi^2 = 26.629$, d.f = 1, $p=0.000$ ***	61	$\chi^2 = 108.12$, d.f = 2, $p=0.000$ ***	56	$\chi^2 = 174.85$ d.f = 1, $p=0.000$ ***
Control group	97		97		93		95		86		89	

Table 2: Relationship among BMI, SBP and DBP of study and control group

Study Periods	Correlation variables	Study group		Control group	
		r value	p value	r value	p value
Pre-test	BMI and SBP	0.324	0.000***	0.191	0.01
	BMI and DBP	0.06	0.816	0.007	0.793
First Post-test	BMI and SBP	0.36	0.000***	0.02	0.3 *
	BMI and DBP	0.05	0.502	0.005	0.597
Second Post-test	BMI and SBP	0.421	0.000***	0.0339	0.30*
	BMI and DBP	0.134	0.191	0.002	0.982

risk of having elevated levels of resting SBP and DBP (Ranjani et al, 2016).

According to the second objective of the study, the effectiveness of rope exercise on body mass index and blood pressure among school children, the BMI and BP was assessed after 3 and 6 weeks of intervention. At 3 and 6 weeks of intervention, the BMI and BP of the intervention group children were found to be statistically relevant at $p=0.000$. An independent “t” test revealed that rope exercise programme was very successful at lowering BMI and BP in the study group. It also emphasises the importance of a long-term intervention with sufficient reinforcement to achieve the desired improvement.

The following studies have similar outcomes. Andrew Decelis et al (2014) investigated objectively assessed physical activity and weight status in Maltese 11–12 year olds. According to the results, more opportunities to participate in physical activity should be given, with an emphasis during the school hours. The effect of a dietary intervention or a dietary intervention plus exercise for a duration of 20 weeks was examined and found that the exercise and diet group showed a substantial decrease in SBP (Lone et al, 2014).

The findings of the present study also aligned with a few previous studies. In their research on the impact of a 12-week jump rope exercise programme on abdominal adiposity, vasoactive substances, inflammation, and vascular function in adolescent girls with pre-hypertension and concluded that jump rope exercise could be an effective intervention to enhance these CVD risk factors in pre-hypertensive adolescent girls (Sivakumar et al, 2017).

The third objective of the study was to examine the relationship between BMI and BP among school children. In terms of the relationship between BMI, SBP, and DBP in different study periods, BMI and SBP show a substantial posi-

tive relationship at the $p=0.000$ level, proving again that BMI is closely associated with blood pressure and that early diagnosis and treatment of overweight would result in a significant reduction in hypertension. Several studies have been done all over the world to see whether physical activity has a major positive association with weight and cardiovascular risk factors and confirmed the relationship between BMI with BP (Sivakumar et al, 2017; Sung et al, 2020).

As per the fourth objective of the study associate the demographic variables with BNI and BP among school children, the relationship between BMI and demographic characteristics of the children were assessed using ANOVA. The results revealed a statistically significant relationship between demographic variables such as gender, number of family members and family history of chronic illness with BMI and systolic BP. The findings of the current research are consistent with those of the following studies (Ghosh et al, 2010).

The findings of these studies are reasonably conclusive that there is a strong positive relationship between BMI and BP though the correlation coefficient varies from study to study. The intervention given by the investigators was well accepted by the family, children and school authorities which was evident by their daily diaries. The researchers also got numerous phone interactions with the parents and children regarding the diet and exercise which also enhanced the compliance of children to stick with the diet plan though it took little longer time to adopt the changes. Hence, school-based exercise intervention with family support can positively enhance some cardio metabolic risk factors and prevent CVD risk during adulthood.

Nursing Implications

- The findings of the study will help the nurse educator to pay more attention on training the nursing students regarding educating the school children regarding importance of physical exercise and diet modifications.
- Nurses can provide school health education programme by using various methods like child-to-child approach, role play, flash cards, puppet show drama mass media etc. including parents and teachers.
- Periodical and regular reinforcement should

be encouraged during the community home visit on physical activity and diet.

- Nursing research can be focused on parent's/teacher's knowledge, practice and skill on physical activity and diet with larger sample size.

Recommendations

- Regular physical exercise, as well as dietary changes, should be integrated into the school curriculum and should be made mandatory.
- A retrospective analysis on the intervention group can be conducted to determine compliance with the rope exercise, as well as the obstacles and facilitators to compliance.

Conclusion

The study revealed that routine physical activity such as rope exercise helps to reduce the BMI and BP among the overweight and pre-hypertensive children. As several studies endorse the same findings, the school-based regular physical activity programme should be made as mandatory for maintenance of body weight, blood pressure among school children, to prevent occurrence of cardiovascular diseases in later life.

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