

**EFFECT OF PHYSICAL EXERCISE AND YOGA ON BLOOD PRESSURE AMONG SCHOOL CHILDREN**PREMALATHA P<sup>1\*</sup>, KANNIAMMAL C<sup>2</sup>, VALLI G<sup>3</sup>, JAYDEEP MAHENDRA<sup>4</sup>

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**ABSTRACT**

**Objective:** The principal aim of the study is to identify the effect of physical exercise and yoga on blood pressure (BP) among children, a common cardiovascular risk factor among children in recent years.

**Methods:** A true experimental design was adopted to find the effect of physical exercise and yoga on selected children with increased BP and weight. The weight was inferred based on the World Health Organization (WHO) chart on body mass index for age. BP and height were measured and interpreted using the WHO height percentile chart for boys/girls and BP references of National Heart, Lung, and Blood Institute, to identify hypertensive children. Hypertensive children were given physical exercise and yoga, 5 days a week, for 6 months and control group led a normal lives.

**Results:** In the pretest, 100% of the study and control group were prehypertensive. After 3 months of physical exercise and yoga, 21% of study group became normotensive which was significant at  $p=0.000$  and it increased to 93% after 6 months with the significance of  $p=0.000$ . The weight and systolic BP (SBP) had a significant positive correlation. The age ( $p=0.001$ ), number of family members, type of family ( $p=0.01$ ), mother's occupation, family history of obesity, and chronic illness among fathers ( $p=0.05$ ) had a significant association with SBP of the children.

**Conclusion:** The study concluded that physical exercise and yoga reduced childhood hypertension as well as is a cost effective and easily practicable intervention for children to minimize cardiovascular risk during their adulthood.

**Keywords:** Children, Effect, Physical exercise, Yoga, Childhood hypertension, School children.

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**INTRODUCTION**

High blood pressure (BP), a major risk factor of non-communicable diseases (NCD), is a silent killer affects approximately 1 billion people worldwide, and this will increase to 1.56 billion people by the year 2025 [1]. This means 1 out of every 4 adults are being afflicted with hypertension, and it ranks fourth leading cause of mortality and morbidity in the world.

Globally, NCDs cause 7.5 million premature deaths, i.e. 13% of total deaths each year and accounts for 57 million disability-adjusted life years (DALYs) or 3.7% of total DALYs [2]. The high BP is one of the major biological/metabolic risk factors of NCDs.

Hypertension is not only a global pandemic but it is also rapidly increasing in developing countries like India. The World Health Organization (WHO) (2012) has already issued a warning that, in India, hypertension affects more than 100 million individuals and 60% of the world's cardiac patients will be Indian by 2020. While the awareness of hypertension is poor in India, the treatment and control rates are abnormally low.

Rapid economic development and changes of lifestyle in the past few decades made the prevalence of hypertension, once considered a rare occurrence, reached in alarming proportions among Indian children in the recent years. The prevalence of hypertension among healthy school children aged 10-15 years in Tamil Nadu was 11.4%, and prehypertension was 23.2%, and prevalence of hypertension was found to be higher among obese children (38.5%) than non-obese (7.4%) [3,4].

Several studies [5,6] have reported the tracking effect of BP from childhood to adulthood. Therefore, the tracking and treating of BP in children may have a significant advantage, and it may help to control and possibly prevent high BP before its harmful sequelae can occur [7].

**METHODS****Study design and participants**

A true experimental design was used with multistage cluster sampling technique. From the 16 selected schools from urban and rural zones of Tiruvallur district, Tamil Nadu, the children aged 10-12 years were screened for increased BP and weight.

**Sample**

The school children aged 10-12 years, who fell above 85<sup>th</sup> percentile according to the WHO chart on body mass index (BMI) for age (boys and girls) as well as having >90<sup>th</sup> percentile of systolic/diastolic pressure as per the 4<sup>th</sup> report from National High BP Education Program (NHBPEP) working group on children and adolescents of National Heart, Lung, and Blood Institute (NHLBI) [8] according to sex, age, and height, were selected for the study. Initially, 2581 children were screened for overweight and hypertension. Among those 2581 children, totally 238 children were identified with prehypertension and overweight. By probability - simple random sampling technique, 104 and 97 samples were selected for study for the control group, respectively.

**Measurement tools**

The data were collected using structured interview schedule. The demographic details and biophysiological variables such as BP, weight,

height, and BMI were taken. The average of the three consecutive readings of BP was taken as the BP of the child. For BMI and BP, WHO growth charts such as WHO BMI for age chart, height percentile chart for boys and girls and BP references of NHLBI were used to identify children with increased BP and weight [8]. The reliability of the tool was established using test-retest, inter-rater method and its  $r$  - values were 0.92 (BP) and 0.94 (BMI).

### Ethical considerations

The investigator followed the principles of human rights, beneficence, non-maleficence, dignity, confidentiality, and justice. The objective

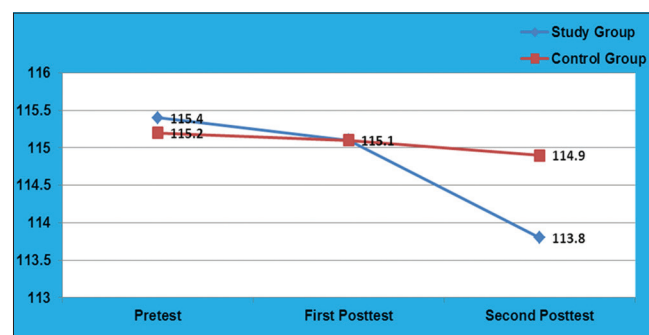


Fig. 1: Comparison of systolic blood pressure among study and control group by RM -ANOVA

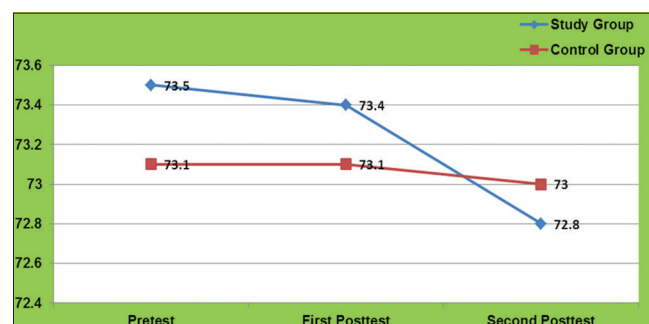


Fig. 2: Comparison of diastolic blood pressure among study and control group by RM-ANOVA

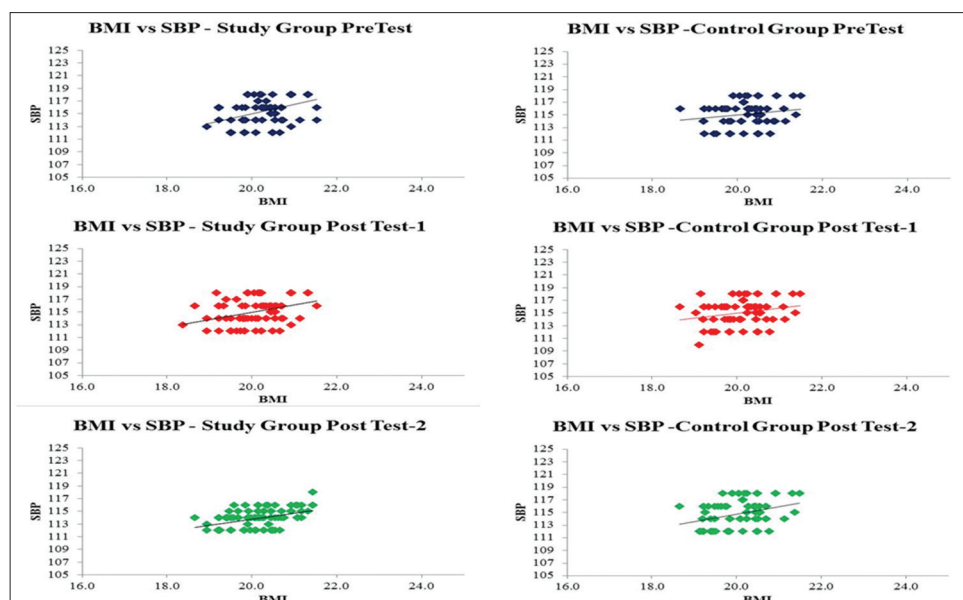


Fig. 3: Relationship between BMI and systolic blood pressure of study and control group

of the study was clearly explained to all participants, parents, school authorities and written consent, as well as assent, was obtained. Ethical Committee Approval was received from the institution and permission from the Director, Directorate of Education, Tiruvallur district was obtained. Content validity was received from various experts in the field of pediatrics, pediatric cardiology, community medicine, child health nursing, nutrition and dietetics, yogic science, and statistics. No harm certificate was received from the pediatrician, clinical nutritionists and an expert from yogic science for the intervention. The children of the control group were also given the information booklet related to intervention after the entire data collection process.

### Description of intervention

Physical exercise and yoga were given for 5 days a week which includes 45 min of physical exercise and 15 min of yoga per day. The physical exercise included warm-up, running and chasing, bicycle riding, jumping ropes/hopping, and dancing. The yoga included asana such as forward/backward bending exercises, Ardha Chakrasana of both sides, padahasthasana, Yoga Mudhra, Sasangasana, Ustrasana, Supta-Vajrasana, Ardha Matsyendrasana (both sides), Bhujangasana, Matsyasana (each asana for 3 times), and Savasana. This is followed by Nadi Suddi Pranayama of 9 cycles. The reinforcement was given in 2<sup>nd</sup>, 6<sup>th</sup>, and 10<sup>th</sup> weeks as well as 4<sup>th</sup> and 5<sup>th</sup> months for the study group. Post-test - 1 and 2 were done after 3 and 6 months of intervention, respectively. Control group led their life under normal circumstances for the entire period of intervention and was provided with the study materials on physical exercise and yoga after data collection.

### Statistical analysis

Frequency, percentage, and mean and standard deviation were used to describe demographic variables. Inferential statistics such as bivariate analysis, correlation coefficient, Chi-square test, paired, unpaired  $t$ -test, repeated measures ANOVA, and multiple regression analysis for the comparison of scores over a period of time, within and between groups were used to determine the effect, correlate and associate the variables.

### RESULTS

Table 1 summarizes the distribution of demographic variables of children with overweight and hypertension. The test of "Goodness of Fit" among variables showed that majority of the variables was non-significant between study and control group which shows that the samples were homogeneous among both the groups.

Table 1: Demographic characteristics of children with overweight and hypertension

| Demographic variables    | n (%)       |               | Chi-square value and P value               |
|--------------------------|-------------|---------------|--|
|                          | Study group | Control group |  |
| Gender                   |             |               |  |
| Male                     | 47 (45)     | 55 (57)       | $\chi^2=2.660$ , d.f=1<br>p=0.103 (N.S)    |
| Female                   | 57 (55)     | 42 (43)       |  |
| Religion                 |             |               |  |
| Hindu                    | 49 (47)     | 50 (52)       | $\chi^2=1.436$ ,<br>d.f=2<br>p=0.488 (N.S) |
| Christian                | 37 (36)     | 27 (28)       |  |
| Muslims                  | 18 (17)     | 20 (21)       |  |
| Education                |             |               |  |
| 5 <sup>th</sup> standard | 24 (23)     | 12 (12)       | $\chi^2=4.00$ ,<br>d.f=2<br>p=0.135 (N.S)  |
| 6 <sup>th</sup> standard | 33 (32)     | 37 (38)       |  |
| 7 <sup>th</sup> standard | 47 (45)     | 48 (50)       |  |
| Birth order              |             |               |  |
| First                    | 51 (49)     | 50 (52)       | $\chi^2=11.029$ ,<br>d.f=2<br>p=0.004**    |
| Second                   | 49 (47)     | 31 (32)       |  |
| Third                    | 4 (4)       | 16 (17)       |  |
| Number of siblings       |             |               |  |
| Single child             | 13 (13)     | 3 (3)         | $\chi^2=24.458$ ,<br>d.f=3<br>p=0.000***   |
| One                      | 76 (73)     | 50 (53)       |  |
| Two                      | 15 (14)     | 42 (44)       |  |
| Number of family members |             |               |  |
| ≤3                       | 11 (11)     | 5 (5)         | $\chi^2=5.856$ ,<br>d.f=3<br>p=0.119 (N.S) |
| 4                        | 46 (44)     | 33 (34)       |  |
| 5                        | 26 (25)     | 36 (37)       |  |
| ≥6                       | 21 (20)     | 23 (24)       |  |
| Family income Rs.        |             |               |  |
| 10001–15000              | 52 (50)     | 51 (53)       | $\chi^2=0.421$ ,<br>d.f=2<br>p=0.810 (N.S) |
| 15001–20000              | 47 (45)     | 40 (41)       |  |
| >20,000                  | 5 (5)       | 6 (6)         |  |
| Mother's education       |             |               |  |
| Primary                  | 11 (10)     | 18 (19)       | $\chi^2=20.180$ ,<br>d.f=4<br>p=0.000***   |
| High school              | 22 (21)     | 7 (7)         |  |
| Higher secondary         | 51 (49)     | 50 (51)       |  |
| Diploma                  | 8 (8)       | 0 (0)         |  |
| Degree                   | 12 (12)     | 22 (23)       |  |
| Father's education       |             |               |  |
| Primary                  | 26 (25)     | 36 (37)       | $\chi^2=9.028$ ,<br>d.f=4<br>p=0.060 (N.S) |
| High school              | 5 (5)       | 0 (0)         |  |
| Higher secondary         | 50 (50)     | 45 (47)       |  |
| Diploma                  | 2 (2)       | 0 (0)         |  |
| Degree                   | 18 (18)     | 15 (16)       |  |
| Father's occupation      |             |               |  |
| Government               | 5 (5)       | 2 (2)         | $\chi^2=1.801$ ,<br>d.f=2<br>p=0.406 (N.S) |
| Private                  | 62 (60)     | 54 (56)       |  |
| Self-employment          | 37 (35)     | 41 (42)       |  |
| Mother's occupation      |             |               |  |
| Home maker               | 27 (26)     | 29 (30)       | $\chi^2=0.488$ ,<br>d.f=2<br>p=0.783 (N.S) |
| Private                  | 63 (61)     | 57 (59)       |  |

(Contd...)

Table 1: (Continued)

| Demographic variables | n (%)       |               | Chi-square value and P value               |
|-----------------------|-------------|---------------|--|
|                       | Study group | Control group |  |
| Self-employment       | 14 (13)     | 11 (11)       |  |
| Residence             |             |               |  |
| Urban                 | 54 (52)     | 51 (52)       | $\chi^2=4.00$ ,<br>d.f=2<br>p=0.135 (N.S)  |
| Rural                 | 20 (19)     | 23 (24)       |  |
| Semi urban            | 30 (29)     | 23 (24)       |  |
| Type of family        |             |               |  |
| Nuclear               | 68 (65)     | 76 (79)       | $\chi^2=4.465$ ,<br>d.f=2<br>p=0.107 (N.S) |
| Joint                 | 16 (16)     | 11 (11)       |  |
| Extended              | 20 (19)     | 10 (10)       |  |

\*\*p<0.01, \*\*\*p<0.001 level of significant, N.S: Not significant

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

| Study periods    | Correlation variables | Study group |          | Control group |       |
|------------------|-----------------------|-------------|----------|---------------|-------|
|                  |                       | r           | p        | r             | p     |
| Pre-test         | BMI and SBP           | 0.412       | 0.000*** | 0.169         | 0.099 |
|                  | BMI and DBP           | 0.01        | 0.918    | 0.004         | 0.973 |
| First post-test  | BMI and SBP           | 0.355       | 0.000*** | 0.0222        | 0.29* |
|                  | BMI and DBP           | 0.052       | 0.607    | 0.005         | 0.959 |
| 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 |

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001 level of significant. BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

For the study group, in the pre, first and second post-test, BMI and systolic BP (SBP) showed a significant positive correlation at p=0.000, which proves that BMI is strongly correlated with BP. It emphasizes that there is the greatest need for prevention, early diagnosis and weight management among children to have a significant reduction in BP. Although there is no significance, BMI and DBP have a positive correlation which proves that if BMI increases DBP increases (Table 2)

The ANOVA test findings in Table 3 revealed that there was statistically significant association found between the demographic variable such as age, number of family members, type of family, mother's occupation, and family history of obesity and chronic illness among fathers had a significant association with SBP of the children in pre-test. Family history of obesity and chronic illness among fathers had a significant association with DBP also.

## DISCUSSION

The comparison of BP status for study and control group children showed that after 3 months of intervention, 21 (21%) study group children became normal whereas it was increased 90 children (93%) after 6 months which was statistically significant at p=0.000. In control group, only 8 (8%) children became normotensive after 6 months of intervention. The comparison of Systolic and diastolic blood pressure among study and control group is shown in Fig. 1 and Fig. 2. Several studies [9-12] illustrated the similar findings that the exercise and yoga showed significant improvement on BMI and SBP. These results highlighted the importance of multidisciplinary approach including physical exercise and yoga for the treatment of childhood hypertension, overweight/obesity and emphasized its encouraging long-term positive effects. The comparison of the effective score for BP between study and control group as shown in Table 4 revealed that the intervention should

Table 3: Association between SBP and demographic variables of study group

| S. No.                   | Demographic variables     | SBP in pre-test |         |                     |
|--------------------------|---------------------------|-----------------|---------|---------------------|
|                          |                           | n               | Mean±SD | ANOVA F and P value |
| 1                        | Education                 |                 |         |                     |
|                          | 5 <sup>th</sup> standard  | 24              | 114±2.4 | F=11.94 P=0.000***  |
|                          | 6 <sup>th</sup> standard  | 33              | 115±2.1 |                     |
| 7 <sup>th</sup> standard | 47                        | 116±1.4         |         |                     |
| 2                        | Number of family members  |                 |         | F=4.354 P=0.006**   |
|                          | ≤3                        | 11              | 116±1.2 |                     |
|                          | 4                         | 46              | 116±2.2 |                     |
|                          | 5                         | 26              | 115±2.4 |                     |
|                          | ≥6                        | 21              | 115±0.9 |                     |
| 3                        | Mother's occupation       |                 |         | F=4.59 P=0.012*     |
|                          | Home maker                | 27              | 116±1.8 |                     |
|                          | Private                   | 63              | 115±2.1 |                     |
| 4                        | Type of family            |                 |         | F=6.72 P=0.002**    |
|                          | Nuclear                   | 68              | 116±2.1 |                     |
|                          | Joint                     | 16              | 114±1.8 |                     |
| 5                        | Extended                  | 20              | 115±1.6 | F=2.791 P=0.030*    |
|                          | Family history of obesity |                 |         |                     |
|                          | No                        | 94              | 115±2.1 |                     |
|                          | Father                    | 2               | 112±0   |                     |
| 6                        | Mother                    | 1               | 116±0   | F=3.083 P=0.031*    |
|                          | Grandparents              | 1               | 117±0   |                     |
|                          | Relatives                 | 6               | 117±1   |                     |
|                          | Chronic illness-father    |                 |         |                     |
|                          | Nil                       | 92              | 115±2   |                     |
|                          | DM                        | 9               | 117±2   |                     |
| HT                       | 2                         | 116±0           |         |                     |
| Asthma                   | 1                         | 118±0           |         |                     |

\*p<0.05, \*\*p<0.01, \*\*\*p<0.001 level of significant, N.S: Not significant. DM: Diabetes mellitus, SBP: Systolic blood pressure, SD: Standard deviation

be long-term to bring the desired change in DBP than SBP which is also consistent with various study findings [13-16].

The significant association between BP and demographic variables highlighted that the age, number of family members, type of family, mother's occupation, and family history of obesity and chronic illness among fathers should be considered as risk factors of hypertension among children and those children to be screened periodically to

Table 4: Comparison of effective score for BP among children of study and control group

| Effect Period           | SBP         |                      |               |                      |                           | DBP         |                      |               |                      |                           |
|-------------------------|-------------|----------------------|---------------|----------------------|---------------------------|-------------|----------------------|---------------|----------------------|---------------------------|
|                         | Study group |                      | Control group |                      | Independent t and P value | Study group |                      | Control group |                      | Independent t and P value |
|                         | Mean (SD)   | Paired t and P value | Mean (SD)     | Paired t and P value |                           | Mean (SD)   | Paired t and P value | Mean (SD)     | Paired t and P value |                           |
| Pre to first post-test  | 0.27 (0.96) | t=2.81<br>P=0.006*** | 0.08 (0.57)   | t=1.1<br>P=0.16      | t=1.66<br>P=0.10          | 0.09 (0.34) | t=2.23<br>P=0.03 *   | 0.03 (0.2)    | t=1.00<br>P=0.32     | t=1.67<br>P=0.10          |
| Pre to second post-test | 1.57 (1.53) | t=9.93<br>P=0.000*** | 0.31 (1.01)   | t=2.35<br>P=0.03*    | t=6.62<br>P=0.000***      | 0.69 (1.26) | t=5.39<br>P=0.000*** | 0.12 (0.75)   | t=1.617<br>P=0.11    | t=3.801<br>P=0.000***     |

\*\*\*p<0.001 level of significant, N.S: Not significant. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, SD: Standard deviation

prevent and control BP. As there is a tracking effect of BP in children into adulthood, halting the menace of childhood itself will benefit the entire society from the tentacles of NCDs.

### CONCLUSION

The present study concludes that the physical exercise and yoga significantly reduced SBP in children but necessitates a long-term intervention with appropriate reinforcement to bring the desired change in DBP. Weight and SBP showed a significant positive correlation ( $p=0.000$ ) as shown in Fig. 3, which emphasises the importance of weight management among hypertensive children. The demographic variables such as age and family history of hypertension, diabetes mellitus, and chronic illness among family members showed highly significant association with BP which highlights the need for early screening and treatment of children for hypertension as a means of primordial prevention of NCDs.

### AUTHORS CONTRIBUTIONS

Premalatha P developed the study, did data collection, data analysis and wrote the first draft of the paper. Also, she rectified and approved the final manuscript. Kanniammal C read and approved the final manuscript. Valli G, read and sanctioned the first draft. Jaydeep Mahendra read and sanctioned the first draft.

### CONFLICTS INTERESTS

The authors declare that there is no conflict of interest.

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