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# Autonomic and Respiratory Measures in Children with Impaired Vision Following Yoga and Physical Activity Programs

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*We conducted assessments of 28 children with impaired vision (VI group), with ages ranging from 12 to 17 years, and an equal number of age-matched, normal-sighted children (NS group). The VI group had significantly higher rates of breathing, heart rates, and diastolic blood pressure values compared to the NS group (Mann–Whitney U test). Twenty-four of the VI group formed pairs matched for age and degree of blindness, and we randomly assigned members of the pairs to two groups,* viz., *yoga and physical activity. Both groups spent an hour each day practicing yoga or working in the garden, depending on their group. After 3 weeks, the yoga group showed a significant decrease in breath rate (Wilcoxon paired signed ranks test). There was no change after the physical activity program. The results showed that children with visual impairment have higher physiological arousal than children with normal sight, with a marginal reduction in arousal following yoga.*

**KEY WORDS:** visual impairment; normal sight; autonomic measures; yoga; gardening.

## INTRODUCTION

Young people with impaired vision have significantly higher levels of anxiety related to physical injury compared to an age-matched group of subjects with normal vision (Ollendick *et al.*, 1985). In addition, one study reported that, in comparison to persons who have vision, persons who are blind have a significantly higher heart rate while walking along an unfamiliar route as well as for 5 minutes afterward (Wycherley and Wicklin, 1970). The authors ascribed this to psychological rather than physical stress.

The purpose of the present study was to compare the autonomic and respiratory measures of children with congenital visual impairment with those of a group of age- and sex-matched children with normal vision. This was the first part of the study. The second part of the present study aimed at comparing the effects of yoga practice with physical activity in children with visual impairment. The practice of yoga, as based on relaxation

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(Nagendra, 1989), is able to bring about reduced sympathetic activity along with other physiological signs of reduced arousal (Joseph *et al.*, 1981; Wallace *et al.*, 1971).

## METHODS

### Subjects

In the first part of the study, we selected 28 children (aged between 11 and 17 years; group average age ± SD, 14.2 ± 1.9 years) at random from a special school for persons with visual impairements (Raman Maharshi Academy for the Blind, Bangalore, India). All of them had congenital visual impairment with an uncorrectable visual acuity of 6/60 or less in the better eye from birth, which is the conventional description of blindness (Sheridan, 1969). Blindness was due to peripheral causes, e.g., microphthalmos, congenital cataract, or optic atrophy. We selected 28 children with normal vision (6/6 without correction) so as to match exactly those with impaired vision with respect to age and sex. We obtained informed consent of the subjects and their guardians in accordance with the ethical guidelines of the Indian Council of Medical Research, New Delhi, India.

The second part of the study involved 24 children of the 28 assessed in the first part of the study. We selected these 24 children because we could match them to form pairs on the basis of age, sex, and degree of visual impairment. The method for grading appears below, under Measurements. We then randomly assigned subjects of a pair to either of two groups, *viz.*, yoga or physical activity. The group average ages ± SD were 14.1 ± 1.9 years (yoga group) and 14.1 ± 2.2 years (physical activity group).

### Design of the Study

In the first part of the study, we randomly selected 40 children with ages between 11 and 17 years from among a total of 340 children attending a special school for persons who are blind. Of the 40, we selected 28 children with congenital visual impairment for the first part of the study (VI group) because we could exactly match them with 28 children with normal sight (NS group). We based matching on age and sex and assessed both groups (visually impaired and normal sighted) under similar conditions, described in detail below.

The second part of the study involved 24 children with impaired vision of the 28 assessed in the first part of the study. We conducted the baseline assessment in the same way as in the first part of the study, 1 month later. After this, the yoga group received training in yoga and the physical activity group spent time in an outdoor activity (i.e., gardening) for the allotted hour for 5 days a week. The yoga instructor spent an equal amount of time with children of both groups. After 3 weeks, we assessed both groups once more, with the final assessments performed by the same persons under similar conditions as the baseline assessments.

### Measurements

Recordings for the first part of the study (VI group versus NS group), as well as for the second part (yoga versus physical activity group of visually impaired children), took place in a moderately lit, sound-attenuated room. After an initial 15-min period of supine rest,

we conducted assessments for 10 min, also in the supine position and with eyes closed. We recorded the blood pressure from the right arm using a standard sphygmomanometer while the subject was in a seated position. It was not possible to obtain blood pressure records for the second part of the study.

We used a 10-channel polygraph (Polyrite, Recorders and Medicare, Chandigarh, India) to record the electrocardiogram (EKG), respiration, and skin resistance level (SRL). We recorded the EKG using the standard limb lead I configuration. We recorded skin resistance using Ag/AgCl disk electrodes with electrode gel (Medicon, Madras, India) placed in contact with the volar surfaces of the distal phalanges of the index and middle fingers of the left hand. We used a low-level DC preamplifier and passed a constant current of 10 $\mu$A between the electrodes. We recorded respiration using a volumetric pressure transducer. Subjects stood erect and an experimenter placed the transducer around the trunk, approximately 5 cm below the lower costal margin. We recorded blood pressure with a sphygmomanometer.

We graded degree of visual impairment for all the children with impaired vision as follows: grade 0, inability to differentiate between light and dark; grade 1, ability to differentiate between light and dark; grade 2, ability to perceive gross movements; and grade 3, ability to count fingers held at a distance of 30 cm.

## Data Extraction and Analysis

Data extraction took place similarly for both parts of the study. We obtained heart rates (beats per minute) by counting the QRS complexes in successive 60-sec epochs, continuously, and we similarly calculated breath rate (in cycles per minute) by counting the breath cycles in 60-sec epochs, continuously. We sampled SRL at 20-sec intervals and, for data analysis, used the average of the values obtained during the 10 minute session for each subject.

We compared the data for the VI group and the NS group using the Mann–Whitney $U$ test. We compared the data for the yoga and physical activity groups obtained at the end of 3 weeks to the respective baseline data using the Wilcoxon paired signed ranks test.

## Yoga Training

A trained instructor taught the yoga intervention. Individuals with normal vision learn yoga by observing a demonstration while listening to instructions. Persons with visual impairment received detailed verbal instructions to compensate. In addition, the instructor spent time with each subject correcting their practice (e.g., repositioning their limbs) with verbal instructions. Subjects received special emphasis on relaxing between practices and being aware of body sensations. Practices included simple yoga postures and yoga breathing exercises (50 min), followed by guided relaxation (10 min). Throughout the practices, the emphasis was on awareness (of physical and other sensations) and relaxation.

## Physical Activity

The physical activity group did not learn yoga. During the allotted hour, they spent time in the garden doing a comparable amount of physical activity as the yoga group, such as bending forward and stretching upward. The yoga instructor spent time with these children every day and was equally familiar with them as with the yoga group.

## RESULTS

### Part 1

In comparison with subjects who had normal sight, subjects with impaired vision had significantly higher breath rates, diastolic blood pressure values, and heart rates. For breath rate, $Z\alpha = 2.71$ and $Z.01(2)\alpha = 2.57$, hence $p < .01$; for diastolic blood pressure, $Z\alpha = 3.79$ and $Z.001(2)\alpha = 3.20$, hence $p < .001$; and for heart rates, $Z\alpha = 1.66$ and $Z.05(1)\alpha = 1.64$, hence $p < .05$. The group mean values ± SD appear in Table I.

### Part 2

There was a significant decrease in the breath rate of the yoga group at the end of 3 weeks as indicated by the Wilcoxon paired signed ranks test [$t = 10, t.05(2)12 = 13$, hence $p < .05$]. The group mean values ± SD appear in Table II.

## DISCUSSION

The present study occurred in two parts. Part 1 showed that children with impaired vision had higher diastolic blood pressure values and heart and breath rates compared with children of the same age who had normal sight. Comparing children with impaired vision randomly assigned to yoga and physical activity (i.e., gardening groups), 3 weeks of yoga practice caused a reduction in the rate of breathing.

**Table I.** Autonomic Measures in Children with Visual Impairment (VI) and Normal Sight (NS) (Group Means ± SD)

| | VI ($N = 28$) | NS ($N = 28$) |
|---|---|---|
| Heart rate (beats/min) | 88.8 ± 14.5* | 81.6 ± 11.3 |
| Breath rate (cycles/min) | 22.8 ± 5.4** | 19.2 ± 3.2 |
| Skin resistance (kΩ) | 176.7 ± 153.3 | 136.9 ± 100.9 |
| Systolic BP (mm Hg) | 113.0 ± 11.5 | 110.7 ± 9.5 |
| Diastolic BP (mm Hg) | 76.1 ± 6.4*** | 66.5 ± 8.9 |

*Note.* Mann–Whitney *U* test. VI versus NS. *N*, number of subjects.
*$p < .05$ (1).
**$p < .01$ (2).
***$p < .001$ (2).

**Table II.** Heart Rate (HR), Rate of Respiration (RR), and Skin Resistance (SR) in Two Groups (Yoga, Physical Activity) of Children with Impaired Vision Before and After the 3-Week Programs (Group Mean ± SD)

| | Yoga training ($N = 12$) | | Physical activity ($N = 12$) | |
|---|---|---|---|---|
| | Before | After | Before | After |
| HR (beats/min) | 89.0 ± 19.4 | 82.8 ± 13.4 | 84.7 ± 8.1 | 84.9 ± 12.3 |
| RR (cycles/min) | 21.4 ± 6.3 | 17.5 ± 6.9* | 22.9 ± 5.1 | 21.5 ± 4.8 |
| SR (kΩ) | 130.8 ± 124.8 | 67.6 ± 74.0 | 128.7 ± 103.0 | 136.3 ± 172.6 |

*Note.* Wilcoxon paired signed ranks test, after versus before. *N*, number of subjects.
*$p < 0.05$ (2).

An increase in breath rate correlates experimentally with evoked fear and anxiety (Ax, 1953) as well as before situations such as parachute jumping (Fenz and Jones, 1972). The nature of waveforms recorded in a standard spirogram using a strain gauge transducer show that there are different patterns as the immediate response to six selected emotions, including fear and anxiety (Bloch *et al.*, 1991). These two emotions are particularly likely to cause irregularity of breathing, with frequent periods of breath holding, whereas anger and sadness produce regularly recurring abnormal patterns. Visual assessment of the records of the children with impaired vision and those with normal sight showed that the former had irregular breath cycles with frequent periods of breath holding. This may be due to higher levels of fear and anxiety among children with visual impairments. This is in keeping with data that indicate higher levels of fear (particularly related to physical injury) among children with visual impairments (Ollendick *et al.*, 1985). These subjects were possibly apprehensive because they were not familiar with the laboratory. In connection with this, it is important to note that the subjects with normal sight were also visiting the laboratory for the first time. Also, we made equal effort to reduce the apprehension of both groups by explaining the procedure in detail and answering their questions.

A low resting heart rate is an indicator of routine physical activity (Williams and Sperryn, 1962). One study found that children with impaired vision have poor physiological adjustment to exercise compared to their normal-sighted counterparts (Hopkins *et al.*, 1987). The authors of the study ascribed the findings to an overall lower level of physical activity in children with visual impairments. This hypothesis provides an explanation for the higher resting heart rates found in the children with impaired vision in the present study and could also apply to the higher (though not abnormally so) diastolic blood pressure values, relative to the children with normal vision.

In Part 2, we assessed the effect of two programs (yoga and increased physical activity during gardening) using the same parameters as for the first part of the study. Previous reports have shown that yoga reduces psychophysiological signs of arousal (e.g., Wallace *et al.*, 1971). The present results revealed that the yoga group showed a significant reduction in respiratory rate after 3 weeks of practice, but the group who spent time gardening showed no change. The reduction in respiratory rate is consistent with previous literature describing effects of yoga on the rate of respiration. The practice of yoga reduces the breath rate, both as an immediate effect (Wallace *et al.*, 1971) and over a 3-month period (Joseph *et al.*, 1981).

The present study showed that practicing yoga for 3 weeks reduced the breath rate in children with impaired vision. Other known effects of yoga practice (e.g., a reduction in heart rate or an increase in skin resistance) were not present. In fact, there was a nonsignificant decrease in skin resistance following yoga, which was not fully explainable. It is possible that the duration of practice required to bring about a change in these parameters among persons with visual impairments is longer than that for other individuals because the former have higher baseline heart and breath rates and diastolic blood pressure values. The unfamiliar laboratory setting may have contributed to these higher values.

The practice of yoga also modified the irregularity of breathing observed in the baseline assessment. These results are similar to the effects of yoga observed in community home children (Telles *et al.*, 1997). As described earlier, an increase in breath rate occurs in response to fear, anxiety, and other psychological stressors (Ax, 1953).

Hence, the present results suggest that children with visual impairments have higher levels of cardiac sympathetic activation and faster breathing than children with normal

sight. A comparison of 3 weeks of yoga practice with a physical activity program showed that after the practice of yoga, the rate and irregularity of respiration declined among children with visual impairments. There were no other significant changes for these subjects. Yoga techniques involve increased physical activity, with an emphasis on relaxation and awareness. This type of program appears to be useful for children with visual impairments to help them reduce irregularities in breathing associated with anxiety.

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