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Research Article

Effect of 8 Weeks Surya Namaskar and Yogic Breathing Practice on Muscular Endurance and Flexibility Among Male Adolescents School Students in Imphal East District of Manipur

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Abstract

The present study investigates the impact of *Surya Namaskar* and yogic breathing exercises on muscular endurance and flexibility among male adolescent school students in Imphal East District of Manipur, India. As physical inactivity and poor postural habits continue to rise among adolescents, the integration of holistic practices such as yoga into the school curriculum presents a promising approach to enhance physical fitness. This quasi-experimental study was conducted on 40 male students aged 11–18 years, who were randomly assigned to an experimental group (n = 20) and a control group (n = 20). The experimental group underwent an 8-week (2 months) intervention program that included daily sessions of *Surya Namaskar* and selected yogic breathing techniques (*Pranayama*) for 45 minutes, five days a week, while the control group continued with their routine physical education activities.

Pre- and post-intervention assessments were conducted to measure muscular endurance through the one-minute sit-up test and flexibility through the sit-and-reach test. Statistical analysis using paired and independent sample t-tests revealed significant improvements in both muscular endurance and flexibility in the experimental group compared to the control group ($p < 0.05$). These results suggest that the combined practice of *Surya Namaskar* and yogic breathing exercises is effective in improving core muscular strength, endurance, and flexibility among adolescent boys.

The findings support the integration of structured yoga modules into school physical education programs as a non-competitive, low-cost, and accessible means to promote overall physical fitness and mental well-being in students. The study also highlights the potential of yoga as a preventive measure against lifestyle-related health issues during adolescence. Future research may explore the long-term benefits of yoga-based interventions and their influence on other health parameters such as cardiovascular fitness, stress levels, and academic performance.

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KEYWORDS: Surya Namaskar, Yogic Breathing, Muscular Endurance, Flexibility, Adolescents, School Students

1. INTRODUCTION

1.1 Yoga

Yoga is a 5000 years old Indian Wisdom which bring Holistic Physical, Mental, and Emotional well-being to mankind Within this rich tradition of Yoga, Surya Namaskar, commonly known as Sun Salutation, and Pranayama, the science of breath control, stand out as potent techniques with profound implications for overall well-being. Surya Namaskar is a dynamic sequence of interconnected asanas (postures) performed in a flowing rhythm, often synchronized with breath. This practice is not merely a physical exercise; it is a holistic ritual that engages major muscle groups, enhances cardiovascular function, and improves flexibility. Pranayama, on the other hand, delves into the conscious regulation of breath to manipulate prana, the vital life force, within the body. Various Pranayama techniques, such as Bhastrika, Kapalabhati, and Anulom Vilom, are known to calm the nervous system, increase lung capacity, improve mental focus, and enhance energy levels.

1.2 Surya Namaskar

Surya Namaskar, Salute to the Sun or Sun Salutation, is a branch of contemporary yogic practices that comprises of a series of about twelve elegantly linked asanas. These sequences of asanas were foremost recorded in the early 20th century. The name Surya Namaskar is of Sanskrit root. It combines Yogasanas and Pranayama. It comes in between Sithilikarana Vyayama and Yogasanas. The name recognizes the sun being at the center as the 'soul' and source of all life. The first recorded history of Surya Namaskar is accorded to early 20th century, to the Raja of Aundh, Patinidhi Pant who named it and also popularized the practice. It brings about the general flexibility of the body preparing it for Asanas and Pranayama's. It is done both at sunrise and sunset, facing the Sun, after chanting the following verse: "Om Hiranmayena Patrena Satyasyapihitam Mukham, Tat Tvam Pusan Apavrnu Satya Dharma ya Drstaye". The alternating backward and forward bending asanas flex and stretch the spinal column and limbs through their maximum range. Synchronizing the breath with the movements is the next step. The basic breathing principle followed is Inhalation during Backward bending postures due to expansion of the Chest, and Exhalation with Forward bending postures due to compression of the Chest and Abdomen.

1.3 Pranayama

Pranayama is defined as Breath Control. The word Pranayama is comprised of two roots: Prana plus Yama. Prana means 'Vital Energy' or 'Life Force' and Yama means "to Control"' or Extension or Expansion" which is used to denote various rules or codes of Conduct. It is the fourth limb of the Eight-Fold Path of Yoga. One would learn Asana before learning the steps of Pranayama. It is the force which exists in all things, whether animate or inanimate. Although closely related to the air we breathe, it is more subtle than air or oxygen. Pranayama utilizes breathing to influence the flow of Prana in the Nadis or Energy Channels of the Pranayama Kosha or Energy Body. The techniques of Pranayama provide the method whereby the Life Force can be activated and regulated in order to go beyond one's normal boundaries or limitations and attain a higher state of vibratory energy. There are four important aspects of Breathing in Pranayama which are utilized. These are: 1) Pooraka or Inhalation, 2) Rechaka or Exhalation, 3) Antar Kumbhaka or Internal Breath Retention and 4) Bahir Kumbaka or External Breath Retention. The different Practices of Pranayama involves various techniques which utilize these Four Aspects of Breathing.

1.4 Muscular Endurance

Muscular Endurance are fundamental components of physical fitness, playing vital roles in daily functioning, athletic performance, and overall well-being. Muscular endurance is the ability of a muscle to repeatedly exert force or sustain a contraction over time, is crucial for prolonged activities like maintaining posture, cycling, or repetitive tasks. Both Surya Namaskar and Pranayama offer distinct yet complementary pathways to enhance these aspects of muscular fitness. As evidenced by studies like Suwannakul et al. (2024) and Sarkar (2022), regular Surya Namaskar practice leads to noticeable improvements in both muscular strength and endurance. As suggested by Vallimurugan (2020) and Bal (2015), Pranayama can refine the body's ability to efficiently engage muscles, leading to improved force production and sustained muscular effort.

1.5 Flexibility

Flexibility, the range of motion around a joint, is a vital component of health-related physical fitness. It ensures ease of movement, prevents stiffness, and significantly reduces the risk of injuries. Both Surya Namaskar and Pranayama are recognized for their ability to enhance flexibility through distinct yet complementary approaches. As studies like Suwannakul et al. (2024) and Sarkar (2022) confirm, consistent Surya Namaskar practice leads to tangible improvements in overall flexibility. Muscle tension is a significant barrier to flexibility, and by promoting relaxation, Pranayama allows muscles to lengthen more easily during stretching exercises, potentially enhancing the effectiveness of flexibility practices and contributing to overall improved range of motion, as suggested by Vallimurugan (2020) and Bal (2015).

2. AIMS AND OBJECTIVES

The present study aims at the Physical Improvement of the school going Male Adolescent students with the age group 11-18 years with Intervention of Surya Namaskar, Pranayama, and Yoga Practice. The study emphasized on the improvement of Flexibility and Muscular Endurance Male Adolescent students by giving Surya Namaskar and Pranayama for a duration of 8 weeks.

3. MATERIALS AND METHODS

3.1 Selection of Subjects

Selection of 40 male students from two different schools in Imphal East District with age ranging from 11 to 18 years were

selected randomly for the present study. The subjects were divided into two groups viz. 1) Experimental and 2) Control, with 20 students of both groups for Pre and Post Intervention by lottery system. The health-related physical fitness variables of both groups were measured by using selected standardized tests. The study was based on the generally practiced of Surya Namaskar postulated by S-VYASA, having 12 Steps with some different Pranayama.

3.2 Variables

Health-related physical fitness variables, i.e., Muscular Endurance and Flexibility, were considered for the quantitative measurement. The standard tools needed for measuring Flexibility and Muscular Endurance are given below:

Table 1: Standard tool for measuring Flexibility and Muscle Endurance

Sl. No	Variables	Tools/Techniques	Units
1	Muscular Endurance	Sit Ups Bar Assistant /Bent Knees (Flex)	Counts
2	Flexibility	Sit & Reach Box (Texon)	Centimetres

3.3 Yoga Module for the present Study

A Yoga Module comprising of some Loosening Stretching Exercises, and Breathing Techniques related to "Surya Namaskar and Pranayama" was prepared with the help of different practices at different Hatha Yoga Institutes. The Yoga Protocol includes

- Opening Session Prayer/Mantra Therapy (3 Minutes)
- Breathing Exercises (Hand in and Out, Hand Stretch, Ankle Stretch, Tiger Breathing) 5 Minutes)
- Kapalabhati Kriya/ Pranayama (60 strokes per minute) (1-2 Minutes)
- Bhastrika Pranayama (60 Counts) (1 Minute)
- Stretching Exercises (Jogging, Twisting, Side Bending, Forward and Backward Bending, Hip rotation) (5-6 Minutes)
- Surya Namaskar (12 rounds) (10-15 Minutes)
- Nadi Shudhi / Anuloma Viloma Pranayama (9 rounds) (4-5 Minutes)
- Bharmari/Cooling Pranayama (3 rounds) (2 Minutes)
- Shavasana/Nadanusandhayana/AUM Meditation (6 Minutes)
- Closing Session Prayer / Mantra Therapy (3 Minutes)

The Experimental Group of 20 students was given the Yoga practice for 8 weeks in the morning for 45-50 minutes, 5 days per week. The Control group was not given any Physical exercise or Yoga practice, except for attending some games and sports

3.4 Experimental Design

A Randomized Controlled design is adopted for this study. The subject was randomly selected and randomly divided into two groups by lottery method; one group served as the experimental group and the other as the control group, comprising of 20 Students per group.

3.5 Data Collection

Muscular Endurance and Flexibility of adolescent students of schools were measured by using Internationally/ Nationally accepted Standard Instruments (Sit Up Bar Assistant, Sit and Reach Box). In order to test the effect of Surya Namaskar and Pranayama training and practice, the data collected from both groups (Experimental group and Control group) before and after experimentation (Pre and Post Test) on health-related physical fitness variables were statistically analyzed by using the Statistical Package. The collection of Data for this Research is done at two (2) different Schools. They are (1) Bal Vidya Mandir School, and (2) Irilbung High School, located in Imphal East District, Manipur State. A total of 40 Students are respondents.

3.6 Data Analysis

1. Independent t-test, Paired Sample t-test, correlation coefficient, and ANCOVA (Analysis of Covariance) were employed to find out the significance of difference between control and experimental groups, in terms of physical fitness (Muscular Endurance and Flexibility).
2. In all the cases, the level of confidence is fixed at 0.05 to significance.

4.0 RESULTS

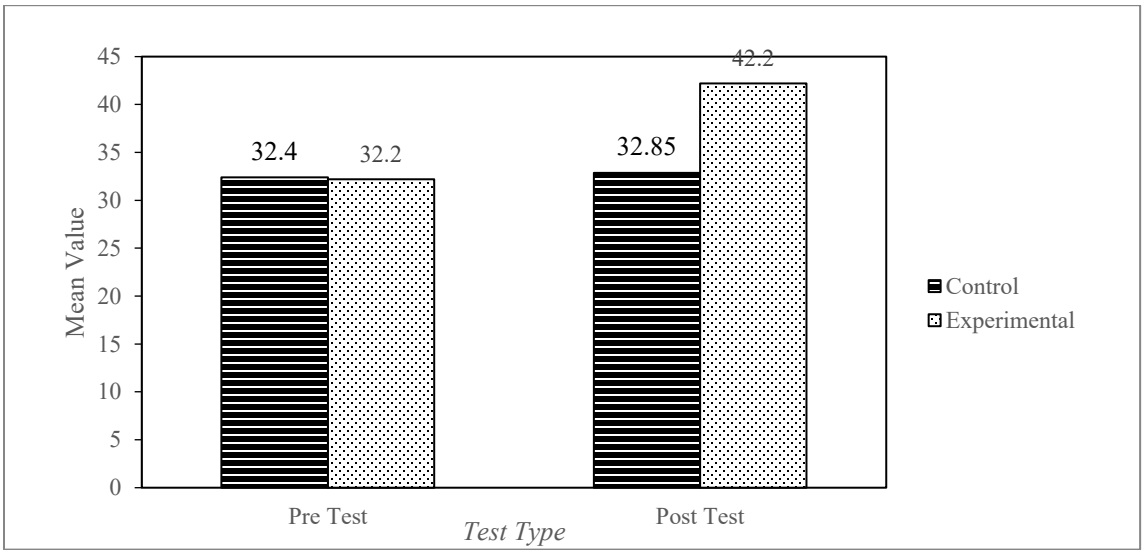
4.1 Descriptive Statistics

4.1.1 Muscle Endurance

Table 2: Muscle Endurance Comparison Statistics

Group	Test Type	N	Mean	SD	SE	Coefficient of variation
Control	Pre Test	20	32.4	9.144	2.045	0.282
Control	Post Test	20	32.85	8.487	1.898	0.258
Experimental	Pre Test	20	32.2	8.414	1.881	0.261
Experimental	Post Test	20	42.2	10.807	2.417	0.256

Figure 1: Comparison Statistics of Muscle Endurance

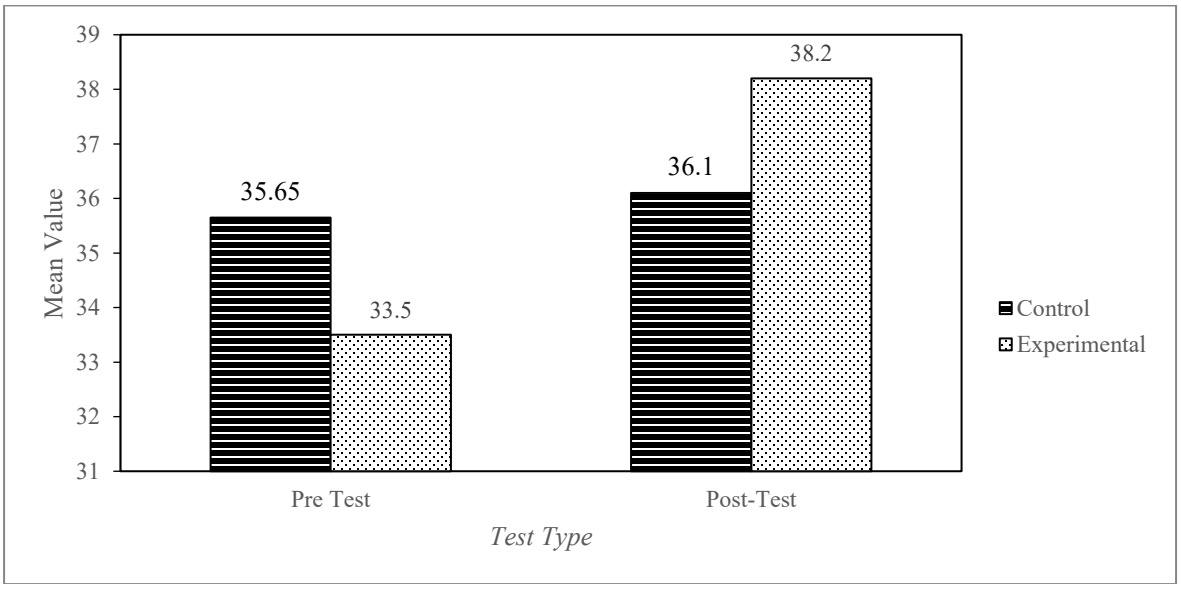


4.1.2 Flexibility

Table 3: Flexibility Comparison Statistics

Group	Test Type	N	Mean	SD	SE	Coefficient of variation
Control	Pre Test	20	35.65	4.913	1.099	0.138
Control	Post-Test	20	36.1	5.562	1.244	0.154
Experimental	Pre Test	20	33.5	6.022	1.347	0.18
Experimental	Post-Test	20	38.2	3.427	0.766	0.09

Figure 2: Comparison Statistics of Flexibility



4.2 Independent t-test

Table 4: Independent t-test of the two measures - Muscle Endurance and Flexibility

Measure	Group	Mean (M)	SD	*t*	*df*	*p-value*
Muscle Endurance	Control	0.45	2.544	-6.36	38	< 0.001
	Experimental	10.00	6.215			

Flexibility	Control	0.45	1.986	-4.04	38	< 0.001
	Experimental	4.70	4.256			

For the Muscle Endurance, $p < 0.001$ for the independent t-test value (-6.36). The study signifies that there is a statistically significant difference in Muscle Endurance between the control and experimental groups.

For the Flexibility, $p < 0.001$ for the independent t-test value (-6.36). The study signifies that there is a statistically significant difference in Flexibility between the control and experimental groups.

4.3 Paired Sample t-test

Table 5: Paired Sample t-test within the two groups- Control and Experimental

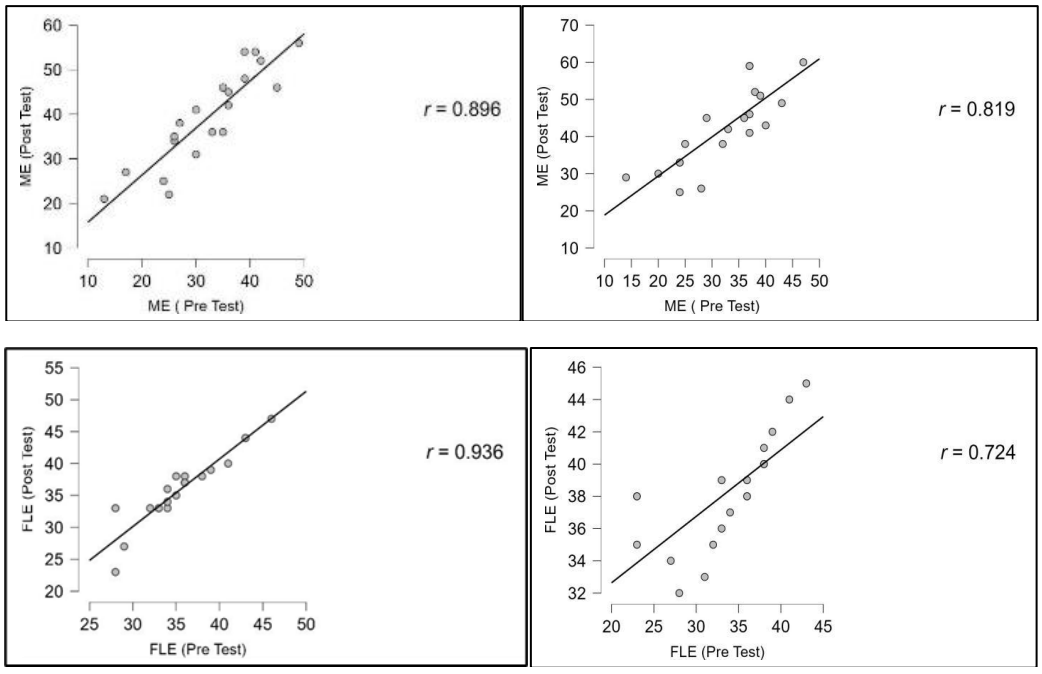
Group	Measure	Pre (M ± SD)	Post (M ± SD)	*t*	*df*	*p-value*
Control	Muscle Endurance	32.4 ± 9.144	32.850 ± 8.487	-0.791	19	0.439
	Flexibility	35.65 ± 4.913	36.100 ± 5.562	-1.013	19	0.324
Experimental	Muscle Endurance	32.20 ± 8.414	42.200 ± 10.807	-7.195	19	< .001
	Flexibility	33.50 ± 6.022	38.200 ± 3.427	-4.938	19	< .001

In the Control Group, there is no significant difference in muscular endurance (0.439) and flexibility (0.324) before and after the testing period. Meanwhile, in the Experimental Group, there is a statistically significant improvement in muscular endurance (<0.001) and flexibility (<0.001) before and after the testing period.

4.4 Coefficient of Correlation

Table 6: Pearson Correlation between Pre-test and Post-test Scores for Muscle Endurance and Flexibility

Group	Variab le	r (Pearson)	*p*-value	Covariance
Control	Muscle Endurance	0.896	< .001	88.337
	Flexibility	0.936	< .001	25.563
Experimental	Muscle Endurance	0.819	< .001	74.484
	Flexibility	0.724	< .001	14.947



1. Flexibility of Control Group

4.5 ANCOVA (Analysis of Covariance)

Table 7: ANCOVA for the two measures - Muscle Endurance and Flexibility

Measure	Source	Sum of Squares	*df*	Mean Square	*F*	*p-value*
Muscle Endurance	Group	910.58	1	910.58	39.478	< .001
	Pre-Test (Cov.)	3261.88	1	3261.88	118.54	< .001
	Residuals	853.43	37	23.06	-	-
Flexibility	Group	120.61	1	120.61	15.14	< .001
	Pre-Test (Cov.)	516.26	1	516.26	64.81	< .001
Note: Type III Sum of Squares						

There is a statistically significant difference between the control and experimental groups after Yoga Intervention, controlling for Pre-Test Muscle Endurance (p is <0.001). This implies that the intervention had a real effect, not just due to initial differences. The pre-test scores significantly influence the post-test scores, meaning it was correct and necessary to adjust for baseline ability.

There is a statistically significant difference in post-test Flexibility scores between the Control and Experimental groups. This implies that the intervention had a significant effect on flexibility improvement. Pre-test flexibility scores strongly predicted post-test scores, as expected. Participants with higher initial flexibility tended to have higher post-test values.

5.0 Mechanisms and Inclusive Studies

Hypothalamus -Pituitary- Axis (HPA), as such, the Organs involved in the Surya Namaskar practice are stimulated and bring Holistic balance, resulting in increases in balance, strength, and flexibility. The Surya Namaskar practice is almost considered a Yogic Exercise at Annamaya Kosa level, touching all the body parts. Besides, Pranayama - Breath Control is the practice at the Pranamaya Kosha level, enhancing the Vital Energy of the Body Holistically.

6. DISCUSSION

Surya Namaskar involves dynamic stretching and body-weight resistance, improving muscular endurance. Breathing exercises improve oxygenation, mental focus, and overall physical capacity. The present study findings showed a significant improvement in Spine Flexibility and Muscular Endurance of Abdominal Muscle, which increases the Stamina of the Body after Surya Namaskar regular practice. The results align with previous studies showing yoga's positive impact on adolescent health. The Co-efficient of Correlation studies of the Control group and Experimental group (Yoga group) in respect of Muscular Endurance and Flexibility after 8 weeks (2 months) of Yoga Intervention shows that the Muscular Endurance is observed highly significant value (r=0.896, r=0.819) in case Pre and Post comparison (Figure 3a, and 3b). Further in respect of Flexibility, it is found a correlated value (r= 0.936, r=0.24) is found between Pre and Post Comparison (Figure 4a and 4b).

There is a statistically significant difference between the control and experimental groups after Yoga Intervention, controlling for Pre-Test Muscle Endurance (p <0.001) in Tables 6 and 7. This implies that the intervention had a real effect, not just due to initial differences. The pre-test scores significantly influence the post-test scores, meaning it was correct and necessary to adjust for baseline ability. There is a statistically significant difference in post-test Flexibility scores between the Control and Experimental groups (p<0.001) in Tables 6 and 7. This implies that the intervention had a significant effect on flexibility improvement. Pre-test flexibility scores strongly predicted post-test scores, as expected. Participants with higher initial flexibility tended to have higher post-test values.

The present finding conforms with the findings of Halder *et al.* (2014), Gauri *et al.* (2011), Safa *et al.* (2017), Shikalgar (2017), and Kristine M. Fondran (1992), who observe that their improvement of the Muscular Endurance of Abdominal muscles and also improvement in overall flexibility through regular practice of Yoga and Surya Namaskar.

Shikalgar (2017) indicates that the two weeks of Surya Namaskar training may be effective in observing and improving flexibility in female students. Kristine M. Fondran (1992) concluded that Surya Namaskar and Pranayama are effective in increasing the flexibility of the hamstrings and improving Upper Body Muscular Endurance. Thus, the study was justified about the present study.

7. CONCLUSION

Regular practice of Surya Namaskar and Yogic Breathing significantly enhances Muscular Endurance and Flexibility. Health-related Physical Fitness of a person is extremely important to lead a Peaceful and Happy Life. The goal of Holistic Health can be attained by practicing Surya Namaskar and Pranayama. To provide a Scientific basis to the claim that Surya Namaskar and Pranayama are effective in improving health-related Physical Fitness of Adolescent School Students, the present study was conducted. Thus, after a training Period of 8 weeks (2 months) significant difference was found in Flexibility and Muscular Endurance. These practices should be integrated into school physical education curricula to promote holistic health.

Recommendations

- The same study can also be conducted at the Community Level for efficiency assessment.
- Schools should adopt structured yoga programs.
- Further research can explore effects on other parameters like balance, coordination, and mental health.

- A similar type of study may be conducted by selecting a large sample pool size and for a long duration of Yoga Practice
- Studies may also be conducted for different age categories.

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