J. Phys. Ther. Sci. 29: 1254–1258, 2017

The Journal of Physical Therapy Science

Original Article

Effect of yoga practices on micronutrient absorption in urban residential school children

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Abstract. [Purpose] This study was conducted with a view to find out the effect of yoga practices on micronutrient absorption in urban residential school children. [Subjects and Methods] The study population comprised 66 urban school children aged 11–15 years staying in a residential school in Pune City, Maharashtra, India. A stratified random sampling method was used to divide the students into experimental and control groups. There were 33 students in experimental group and 33 students in control group. Both experimental and control groups were assessed for the status of zinc, copper, iron and magnesium at the baseline and at the end of 12 weeks of yoga training. The study participants of experimental group underwent yoga training for 12 weeks, for one hour in the morning for six days a week. The control group did not undergo any yoga training during this time period. [Results] The experimental group participants showed significant improvement in micronutrient absorption as compared to control group. [Conclusion] The findings of this study indicate that yoga practices could improve micronutrient absorption in urban residential school children.

Key words: Micronutrient, Yoga, Urban school children

(This article was submitted Apr. 6, 2017, and was accepted Apr. 30, 2017)

INTRODUCTION

Malnutrition is a major health concern in both rural and urban adolescent children in India[1)], as well as, other parts of the World[2)]. Micronutrients are the substances which are needed by the body in minuscule amounts, which enable the body to produce hormones, enzymes and other essential substances for proper growth and development. Nevertheless, the consequences of their absence are extremely severe. Lack of micronutrients such as Iodine, vitamin A and iron represent a major threat to growth and development of populations throughout the world. Children and pregnant women are at major risk of micronutrient deficiency in low-income countries[3)]. Micronutrient deficiency leads to Iron deficiency anaemia[4)], stunting, underweight, thinness[2)]. The 2016 Global Hunger Index Report ranked India 28th, which represents serious hunger situation[5)]. Adolescents from rural areas, generally having low socio economic background, are found to be more nutritionally deprived as compared to urban adolescent children[6)]. The diet of rural children was found to be deficient in several micronutrients such as iron, calcium, phosphorus, potassium, magnesium, vitamin A and C, and beta-carotene[7)]. Generally, a deficiency in micronutrients and macronutrients is observed among children belonging to low-income countries[8)]. Nevertheless, due to progressive urbanisation and associated changes in lifestyle, the energy expenditure balance is changing[9)]. Obesity in children is an equally challenging health problem in many developing countries. However, it is under- recognized[10)].

In India, overall nutritional status of urban adolescents was found to be unsatisfactory[11)]. According to a study, micronutrient deficiencies and malnutrition are widely prevalent in school going children of urban area[12)]. Further, childhood obesity is a major health problem among adolescent school children of urban area. In spite of persistently high burden of malnutrition,

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a rapid rise in the number of obese and overweight children has been observed[13]. A study conducted in India showed an increasing prevalence of obesity and overweight in urban male[14], as well as, female adolescent school children[15].

Micronutrient deficiency may have bearing upon improper dietary practices such as inadequate food allocation in the family and individual likes and dislikes, high phytate content of Indian diet, worm infection, parents' education, living conditions, family income, fathers' income, family size, fathers' profession, and physical activities.

Micronutrient deficiency leads to poor physical and mental health among adolescent children. In fact, nutritional education to improve the micronutrient intake is considered to be necessary. Food-based approaches with dietary diversification and provisions of hygienic environment are important sustainable strategies for correction of micronutrient deficiency[16]. Educational strategies focussing on consumption of balanced diet along with provision of variety of nutrient rich healthy food, are needed[17]. Nevertheless, physical activity is useful to improve digestion, metabolism and micronutrient absorption in urban children. In this context, ancient Indian traditional Yoga practices may be useful in improving digestion, metabolism and micronutrient absorption. Yoga is also useful in improvement of mental and physical health. Effect of yoga in micronutrient absorption in rural adolescent children has been studied[18]. However it is unknown whether the same would be effective in urban adolescent school children in India. Therefore, this study was conducted with a view to observe the effect of yoga practices on selected micronutrient absorption in urban adolescent school children.

SUBJECTS AND METHODS

The study was conducted in Pune City, Maharashtra, India in the year 2015–16. The study population consisted of 66 urban school children (48 Males and 18 females) aged 11–15 years (12.63 ± 1.01), staying in a residential school in Pune District. A stratified random sampling method was used to divide the students into experimental and control groups. There were 33 students (24 males and 9 females) in experimental group and 33 students (24 males and 9 females) in control group. Both experimental and control groups were assessed at the baseline and at the end of 12 weeks of yoga training. The study participants of experimental group underwent yoga training for 12 weeks, under the supervision of yoga teacher, for one hour in the morning, excluding Sundays and holidays for a period of 12 weeks. The control group did not undergo any yoga training during this time period. Nevertheless, both the groups continued participating in extracurricular activities such as sports, dance, physical exercise, etc. during their school hours. However, at the end of 12 weeks, three students (1 from experimental and 2 from control group) dropped out of the study due to various reasons such as disinterest, ill-health, and not being able to report for post test.

The selected school was located in the urban area of Pune district, Maharashtra, India. The researcher briefed the Principal and warden of the school about the aims and objectives of the research study. The study participants and their parents were also briefed about the research study and procedures involved at the outset for obtaining their written informed consent. The research study was approved by the Institutional Ethics Committee as well as the Research Advisory Board of Kaivalyadhama Yoga Institute, Lonavla, Pune. The Institutional Ethical Clearance number is kdham/SRD/RAC/IEC-04/2013.

The height and weight of each study participant was recorded using a standardized scale and stadiometer at the baseline and at the end of 12 weeks. Height was measured using stadiometer (height to the nearest 1 mm) and weight was measured using a digital weighing scale TANITA (HD-318) (weight to the nearest 0.1 kg). All the students were barefooted and wore school uniforms at the time of measurements. Chronological age was expressed to the nearest month. A comprehensive physical examination was conducted for all the study participants prior to the start of yoga training by a Medical Officer appointed by Kaivalyadhama. Serum Iron (Fe), Zinc (Zn), Magnesium (Mg), and Copper (Cu) were measured at the baseline and at the end of 12 weeks of yoga training. They were measured using Minias Globe Diagnostic SRL (Italy) diagnostic kit on Statfax −2000 analyzer (Awareness Technology, USA). Blood samples were collected in the school premises in a hall provided by school authorities. Non-fasting blood samples were collected from median incubital vein by venipuncture using 5 ml sterile disposable syringe and needle. The collected blood was allowed to clot at room temperature for 30 minutes. The collected blood sample was kept in an ice box and transported to the testing laboratory within 4 hours. Later on, the serum samples were separated from collected blood samples using vaccutainer blood collection tubes (Becton Dickinson) with the centrifugation at 1,000 g for 10 minutes and kept at −40°C until analysis of Fe, Zn, Mg, and Cu was completed.

Yoga training sessions were conducted for about one hour per session for five days a week, for 12 weeks in a practice hall provided by the school authorities. The Yoga module was prepared by a senior Yoga expert from Kaivalyadhama Yoga Institute, Lonavla. The yoga teacher was certified from Kaivalyadhama Yoga Institute. Each Yoga session started with Om chanting and mantra chanting, and concluded with Shanti Path. The yoga practices were selected, based on the experience of Kaivalyadhama's senior yoga teacher while working with students. These practices have been found to be effective in improving physical and mental health. The Experimental Group practiced Yoga asanas (postures) and Pranayama (breathing techniques) as per the yoga protocol. Each asana was initially held for 15–30 sec, and for 1 minute in the later stages. Duration of Pranayama was initially 2–3 minutes and was increased to 5 minutes in the later stages, gradually.

The supine pose asanas included were *Ekpaduttanpadasana (Single leg raise pose), uttanpadasana (leg raise pose), ardha halasana (half plough pose), ardha pavanmuktasana (half wind release pose), pavanmuktasana (wind release pose), naukasana (boat pose), viparitakarani (inverted pose), matsyasana (fish pose), setubandhasana (bridge pose) and shavasana (dead pose)*. The prone pose asanas *included were bhujangasana (cobra pose), sarpasana (snake pose), ardha shalabhasana*

Table 1. Baseline characteristics of study participants

Variables	Yoga group (n=32)	Control group (n=31)
	Mean ± SD	Mean ± SD
Age (years)	12.63 ± 1.01	11.90 ± 1.32
Height (meters)	1.46 ± 0.13	1.44 ± 0.14
Weight (kg)	35.06 ± 9.61	34.72 ± 8.90
BMI (index)	16.35 ± 3.51	16.61 ± 3.02

Table 2. Results of within group analysis

Variables	Yoga group (n=32)		Control group (n=31)	
	Pre (Mean ± SD)	Post (Mean ± SD)	Pre (Mean ± SD)	Post (Mean ± SD)
Zinc (µg/dl)	95.90 ± 24.98	106.28 ± 21.15**	91.51 ± 22.87	94.41 ± 16.94
Iron (µg/dl)	118.65 ± 26.64	126.96 ± 29.09**	110.35 ± 28.95	110.58 ± 24.70
Copper (µg/dl)	124.12 ± 17.36	140.81 ± 16.07**	133.03 ± 17.13	134.32 ± 27.67
Magnesium (mg/dl)	1.89 ± 0.25	2.16 ± 0.21**	1.92 ± 0.30	1.98 ± 0.26

*p<0.05, **p<0.001

Table 3. Results of between group analysis

Variables	Yoga-Post- (Mean ± SD) n=32	Control Post- (Mean ± SD) n=31	Difference in Mean 95% CI lower/upper
Zinc (µg/dl)	106.28 ± 21.15	94.41 ± 16.94	11.86 (2.19–21.54)*
Iron (µg/dl)	126.96 ± 29.09	110.58 ± 24.70	16.38 (2.77–30.01)*
Copper (µg/dl)	140.81 ± 16.07	134.32 ± 27.67	6.49 (–4.87–17.85)
Magnesium (mg/dl)	2.16 ± 0.21	1.98 ± 0.26	0.18 (0.06–0.30)*

*p<0.05, **p<0.001

(half locust pose), shalabhasana (locust pose), dhanurasana (bow pose) and makarasana (crocodile pose). The sitting pose asanas included were *vakrasana (twisted pose), ardha matsyendrasana, gomukhasana (cow face pose), paschimatanasana (posterior stretching pose), ushtrasana (camel pose), mayurasana (peacock pose), vajrasana (pelvic pose), padmasana (lotus pose), yog mudra (yoga pose), brahma mudra (Brahma pose).* The standing pose asanas included were *tadasana (mountain pose), chakrasana (wheel pose), trikonasana (triangle pose), vrikshasana (tree pose), and utkatasana (chair pose).* The *pranayama* practices for this study were *anulom-vilom, kapalabhati, ujjayi,* and *bhramari*. The data was analyzed using IBM SPSS version 20 software. The paired sample t-test and unpaired sample t-test was used for within group and between group comparisons respectively.

RESULTS

The baseline demographic data of age, weight, height and BMI of yoga and control group have been presented in Table 1. The results of within group comparison of experimental and control groups have been presented in Table 2. The experimental group showed significant improvement in zinc, iron, copper and magnesium ($p<0.001$) after twelve weeks of yoga intervention. Whereas wait list control group did not show significant improvement in zinc, iron, copper and magnesium ($p>0.05$). The result of between group comparison (Table 3) revealed significant change in zinc ($p<0.05$), iron ($p<0.05$) and magnesium ($p<0.05$) in yoga group as compared to wait-list control group. However, no significant change was observed in copper ($p>0.05$) in either groups. These results indicate that yoga intervention can improve micronutrient absorption in urban residential school children.

DISCUSSION

The results of this randomized controlled trial showed significant improvement in Zinc, Iron, Copper and Magnesium. These micronutrients are essential for proper mental and physical development of young rural, as well as, urban adolescent residential school children[1]. Past studies showed that malnutrition and micronutrient deficiencies are highly prevalent in the adolescent urban residential school children[12]. However, in spite of increasingly high burden of malnutrition, urban children are found to be obese and overweight[11, 13, 15]. This is probably due to intake of high calorie junk food, which has extremely low nutritional value along with sedentary lifestyle of young urban children[19, 20]. Micronutrient deficiency is

related to poor mental and physical growth of young adolescent urban children, which includes poor cognitive development, depression, anxiety, poor memory, growth retardation, and low scholastic achievements. It has been found that the effect of micronutrient deficiency can be irreversible, long-term and detrimental to the mental and physical health of young adolescent children[21–23]. In the present study, Zinc, Iron, Copper and Magnesium showed significant improvement after twelve weeks of yoga practices in experimental group while wait-list control group did not show any significant improvement. Earlier studies also reported that physical activity and yoga have led to improvement in micronutrient absorption[24–26]. Improvement in Zinc, Iron, Copper, and Magnesium in experimental group can be attributed to twelve weeks of yoga training. The yoga postures involved in training program helped in improved digestion by massaging of internal digestive glands, which in turn, helped in an enhanced absorption of micronutrients. Yoga practices help in gentle and automatic massaging of internal organs and, therefore, facilitate the functioning of digestive system, respiratory system, circulatory system, nervous system, endocrine system, and excretory system[27]. Past research studies also showed that yoga practices may be helpful in improving gastrointestinal and digestive problems[28, 29]. The diet of the study participants of both experimental and control group consisted of food provided by the school canteen which mostly comprises of fast food. The researcher did not suggest any food fortification or micronutrient supplementation during the entire study period. However, there was improvement in micronutrient status of experimental group, which suggests that it might be solely due to yoga practices.

Although, the results obtained are highly encouraging, there are some limitations in the study. The duration of the study was only twelve weeks and no follow-up was conducted. Also, both experimental and control groups comprised of disproportionate number of girls and boys. This might affect the results of the study as there are various factors such as hormonal differences in boys and girls, in adolescence, which may influence the findings of the present study. Follow-up studies with larger sample size, other essential micronutrients and homogenous groups are recommended for further studies. The present study demonstrated that twelve weeks of yoga intervention improved micronutrient absorption in young, adolescent urban school children. Although no external micronutrient supplementation was provided to the study participants, they showed significant improvement in micronutrient status. Thus, yoga, being inexpensive and simple regimen, can be included in child health initiatives as an effective therapy in schools of rural, as well as, urban areas of India. Future studies with larger sample size and longer duration of intervention are recommended to substantiate the findings of this study.

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