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ORIGINAL RESEARCH

A Comparative Study of Physical Fitness Index between Residential and Non-residential School Children of Davangere

[1]Dr. Shwetha C. Pondomatti, [2]Dr. Dundesh Maled, [3]Dr. Madhu D.R.

[1,3]Assistant Professor, Department of Physiology, Subbaiah Institute of Medical Sciences and Research Centre, Shimoga, Karnataka, India.
[2]Assistant Professor, Department of Pharmacology, St. Peter's Medical College, Hosur, Tamil Nadu, India.

Corresponding author
Dr. Shwetha C. Pondomatti
Assistant Professor, Department of Physiology, Subbaiah Institute of Medical Sciences and Research Centre, Shimoga, Karnataka, India.

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Abstract

Background: Physical fitness is defined as the ability to perform daily tasks with vigour and alertness without undue fatigue, as well as having enough energy to enjoy leisure time pursuits in order to deal with unusual situations and unexpected emergencies. Physical fitness is a prerequisite for all activities in our society.

An individual's health-related physical fitness is primarily determined by lifestyle factors such as daily physical activity levels. Cardio-respiratory fitness (CRF), muscular strength, and flexibility are the health-related components of physical fitness. In this study, we wanted to evaluate and compare the physical fitness index of residential school children with that of non-residential school children.

Methods: This was a hospital based cross-sectional study conducted among 100 residential and non-residential school boys aged 10 - 15 years who presented with PFI score and pulmonary function tests (PFT) to the Department of Physiology, JJM Medical College, Davangere, from January 2011 to August 2012, after obtaining clearance from Institutional Ethics Committee and written informed consent from the study participants.

Results: Residential school boys showed significant increase in PFI score and PFT i.e. FVC, FEV_1 and PEFR when compared to non-residential boys.

Conclusion: Regular physical exercise and a nutritious balanced diet show beneficial effect on the health of residential school boys.

Keywords: PFI Score, Residential School Boys, Non-residential School Boys, PFT

Introduction

Physical fitness is defined as the ability to carry out daily tasks with vigour and alertness without undue fatigue with ample energy to enjoy leisure time pursuits to meet unusual situations and unforeseen emergencies.[1] Physical fitness is a required element for all the activities in our society. Health related physical fitness of an individual is mainly dependent on lifestyle related factors such as daily physical activity levels. The health related components of physical fitness are cardio-respiratory fitness (CRF), muscular strength, and flexibility.[2]High levels of cardiorespiratory fitness is beneficial forphysical and mental health and low levels of cardiorespiratory fitness is a risk factor for mortality as well as

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morbidities including elevated blood pressure, diabetes mellitus, dyslipidaemia and coronary heart disease.[3,4]

The advantages of physical fitness are many, like increase in the level of intelligence, tolerance, activity, and social behaviour.[5]Childhood and adolescence are complex stages with profound changes due to growth and maturation. The age between 12 and 16 years, the physique is changing. During this period of growth height, weight and maximum aerobic capacity will reach their peak and provides healthy impact on cardiorespiratory system. Physical fitness acquired in youth is sustained throughout life and can be crucial to a healthier future and greater quality of life.[6]

In our country, we are getting acquainted with the modern amenities at a very fast rate. The present attractive education system has helped to improve the educational standards. But, the non-active sedentary stressful life has made the youth physically unfit.[7]Taking into account the decreasing levels of physical activity and health risk factors, scientific and governmental commissions have recommended not only the reduction of sedentary activities, but also the promotion of physical activity in children and adolescents. So, the residential schools are not only improving the quality of knowledge but to bring up the physically fit children. The residential schools like Taralabalu School, Navodaya School, Sainik School and many others have implemented physical training/NCC, games of > 2 hours/day for 6 days in a week are practiced. Physical training by qualified army PT instructors, cross country and games like hockey, football, volleyball, basketball, handball, and athletics - are compulsory. Nutritious food is also provided under the guidance of qualified dieticians and doctors in such schools. Contrary to this in non-residential schools, regular exercises are not compulsory and are not under the balanced diet.[8,9] Previous studies have shown significant improvement in pulmonary function as a result of the effect of exercises. Physical activity rehabilitation is widely used in patients with pulmonary diseases. Study shows that aerobic exercises in an important component of rehabilitation for patients with COPD andasthma leading to improvement in pulmonary functions.[10,11,12] Pulmonary function is known to vary with age, sex, height, weight, race and geographic locations.[13] Lung function tests have been increasingly used for diagnosis, assessment and clinical management of respiratory disorders and have become an integral part of assessment of pulmonary disease. Physical fitness improves the strength of respiratory muscles. Better mechanical factors and lower airway resistance influenced during the training period have benefited in improving lung volumes and flow rates.[14]

Determination of physical fitness index (PFI) is one of the important criteria to assess the cardiopulmonary efficiency of a subject.[15] The American Alliance for Health, Physical, Education Recreation and Dance (AAHPERD)recommended this test to study health related physical fitness programme in youth.[16]

Modified Harvard test is used to determine physical fitness index(PFI). Physical fitness and cardiorespiratory fitness provides objective data regarding cardiac and pulmonary function and is a valuable tool for evaluating children with variety of health problems. The present study is taken to evaluate the patterns of physical fitness in residential and non-residential school children.

Aims and Objectives

- To determine physical fitness index among residential and non-residential school boys aged between 10-15 years.
- To determine pulmonary function tests among residential and non-residential school boys aged between 10-15 years.
- Also to compare the anthropometric and physiological parameters in the above said subject group.

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Methods

This was a hospital based cross sectional study conducted among 100 residential and non-residential school boys aged 10 - 15 years who presented with PFI score and pulmonary function tests to the Department of Physiology JJM Medical College, Davangere, from January 2011 to August 2012 after obtaining clearance from Institutional Ethics Committee and written informed consent from the study participants.

Inclusion Criteria

- Residential school boys of age group between 10-15 years.
- Non- residential school boys of age group between 10-15 years.

Exclusion Criteria

- Subjects with history of congenital heart disease.
- Subjects with history of chronic diseases.
- Subjects with history of respiratory tract infection, allergy, asthma etc.
- Subjects with history of any neuromuscular diseases.
- Subjects with history of endocrine disorders.
- Subjects who are physically challenged.

Statistical Methods

All statistical analysis was done by using the Statistical Package for Social Sciences (SPSS) package 16th version. The unpaired 't' test was used to compare differences between the means of the non-residential and residential school children. To study the relationship between BMI, PFI and PFT, Pearson's correlation coefficients were computed.

Results

Parameters	**Non-residential**		**Residential**		
	MEAN	**±SD**	**MEAN**	**±SD**	**P VALUE**
Age(yrs)	14.5	±0.5	14.5	±0.5	>0.05
Height(cms)	154	±8.7	158	±4.7	<0.001
Weight(kgs)	53	±9.4	58	±5.3	<0.001
MAC(cms)	21.7	±2.3	22.1	±2	>0.05
CC(cms)	71.1	±5.8	76.6	±5.3	<0.001
BMI(kg/mt^2)	20.3	±3.3	23.1	±1.8	<0.001
BSA(sqmts)	1.4	±0.18	1.6	±0.09	<0.001
Parameters	**Non-residential**		**Residential**		
	MEAN	**±SD**	**MEAN**	**±SD**	**P VALUE**
SBP(mmHg)	107.6	±3.4	112.9	±7.2	<0.001
DBP(mmHg)	70.2	±8.0	71.2	±6.9	>0.05
PP(mmHg)	37.4	±7.5	40.7	±10	>0.05
MAP(mmHg)	82.7	±6.9	84.9	±5.6	>0.05
RR(cpm)	15.6	±1.5	14.4	±1.2	<0.001
HR(bpm)	102.1	±14.3	90.1	±13	<0.05
Comparison of Physiological Parameters between Non-residential and Residential School Boys					
Parameters	**Non-residential**		**Residential**		
	MEAN	**± SD**	**MEAN**	**± SD**	**PVALUE**
FVC(L/sec)	2. 3	±0.4	3.0	±0.47	< 0.001
FEV_1(L/sec)	2.1	± 0.4	2.7	±0.4	<0.001

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PEFR(L/min)	371	±30.1	402	±30.8	<0.001
FEV1/FVC(%)	93.3	±4.55	9 2.0	±4.15	>0.05

Comparison of Pulmonary Function Test Parameters between Non-residential and Residential School Boys

Table 1

The anthropometric comparison between non-residential and residential school boys. The mean age of both non-residential and residential school boys were 14.5 ± 0.5 years. Non-residential school boys had statistically significant ($p < 0.05$) lower mean) height (154± 8.7) and weight (53± 9.4). When compared to the non-residential school boys with mean height (158± 4.7) and weight (58 ± 5.3),the MAC is almost similar in both non-residential (21.7± 2.3) and residential (22.1± 2) school boys whereas CC is significantly lower in non-residential (71.1± 5.8) than residential (76.6± 5.3) school boys. The BMI is significantly ($p< 0.001$) lower in non-residential (20.3± 3.3) school boys than residential (23.1± 1.8) school boys. The BSA is significantly ($p< 0.001$) lower in non-residential (1.4± 0.18) school boys than residential (1.6± 0.09) school boys.

The physiologic comparison between non-residential and residential school boys. SBP is significantly ($p < 0.001$) lower in non-residential (107.4± 3.4) than residential (112.4± 7.2). DBP, PP and MAP were almost similar in both. Respiratory rate (RR) and pulse rate (PR) of non-residential school boys is 15.6± 1.8 and 102.1±14.3 respectively, is higher when compared to residential school boys whose RR is 14.4± 1.2 and PR is 90.1± 1.2.

The pulmonary function tests (PFT) in actual volumes recorded between non-residential and residential school boys. Mean values are as follows - FVC in non-residential (2.3± 0.4) and residential (3.0± 0.47), FEV_1 in non-residential (2.1± 0.4) and residential (2.7± 0.4) and PEFR in non-residential (328± 17.1) and residential (410± 15.8) school boys. FVC, FEV_1 and PEFR were significantly ($p < 0.001$) higher in residential school boys than non-residential school boys. FEV_1/FVC ratio was slightly higher in non-residential school boys than residential but was not significant.

Parameters	**Non-residential**		**Residential**		
	MEAN	**±SD**	**MEAN**	**±SD**	**P VALUE**
FVC	84.1	±18.8	102	±16.5	<0.001
FEV_1	88.2	±17.4	101.8	±17.9	<0.001
PEFR	63.7	±17.1	84.9	±15.8	<0.001
FEV1/FVC	105.1	± 5.2	100.2	±5.5	>0.05

omparison of Pulmonary Function Test Parameters in PRED % between Non-residential and Residential School Boys

Parameters	**Non-residential**		**Residential**		
	MEAN	**±SD**	**MEAN**	**±SD**	**P VALUE**
PFI score(%)	31.5	±5.4	52.1	±7.7	<0.001

mparison of Physical Fitness Index (PFI) Score between Non-residential and Residential School Boys

Subjects	**BMI(kgm^2)**		**PFI Score(%)**	
	MEAN	**±SD**	**MEAN**	**±SD**
Non-residential	20.3	±3.3	31.5	±5.4
Residential	23.1	±1.8	N 52.1	±7.7

omparison of BMI (Body Mass Index) and PFI (Physical Fitness Index) between Non-residential and Residential School Boys

Subjects	**PFI Score(%)**		**PEFR(L/min)**	
	MEAN	**±SD**	**MEAN**	**±SD**

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Non-residential	31.5	±5.4	328	±17.1
Residential	52.1	±7.7	410	±15.8

Comparison of PFI (Physical Fitness Index) and PFT (Pulmonary Function Tests) between Non-residential and Residential School Boys

Table 2

The pulmonary function tests (PFT) recorded in % PREDICTED between non-residential and residential school boys. Mean values are as follows - FVC in non-residential (84.1± 18.8) and residential (102± 16.5), FEV_1 in non-residential (88.2±17.4) and residential (101.8±17.9) and PEFR in non-residential (63.7± 17.1) and residential (84.9± 15.8) school boys. FVC, FEV_1 and PEFR were significantly ($p < 0.001$) higher in residential school boys than non-residential school boys. FEV_1/FVC ratio was slightly higher in non-residential school boys than residential but was not significant.

PFI score comparison between the non-residential and residential school boys. Mean value of PFI in non-residential school boys (31.5±5.4) is significantly lower when compared to residential school boys (52.1±7.7).

PFI score and BMI comparison between the non-residential and residential school boys. It showed slight positive correlation but not significant. As BMI increases, PFI score increases. mean value of BMI (20.3± 3.3) and PFI score (31.5± 5.4) in non-residential school boys is lower when compared to BMI (23.1±1.8) and PFI score (52.1±7.7) in residential school boys.

PFI score and PEFR comparison between the non-residential and residential school boys. It showed slight positive correlation but not significant. As PFI increases, PEFR parameter also increases. Mean value of PFI score (35.5±5.4) and PEFR (328±17.1) in non-residential school boys is lower when compared to PFI score (52.1±7.7) and PEFR (410±15.8) in residential school boys.

Subjects	**PFI Score(%)**		**FVC(L/sec)**	
	MEAN	**±SD**	**MEAN**	**±SD**
Non-residential	31.5	±5.4	2.3	±0.4
Residential	52.1	±7.7	3.0	±0.47

Comparison of PFI (Physical Fitness Index) and PFT (Pulmonary Function Tests) between Non-residential and Residential School Boys.

Subjects	**PFI Score(%)**		**FEV_1(L/sec)**	
	MEAN	**±SD**	**MEAN**	**±SD**
Non-residential	31.5	±5.4	2.1	±0.4
Residential	52.1	±7.7	2.7	±0.4

Comparison of PFI (Physical Fitness Index) and PFT (Pulmonary Function Tests) between Non-residential and Residential School Boys.

Table 3

PFI score and FVC comparison between the non-residential and residential school boys. It showed slight positive correlation but not significant. As PFI increases, FVC parameter also increases. Mean value of PFI score (52.1±7.7) and FVC (3.0±0.47) in residential school boys is higher than PFI score (35.5±5.4) and FVC (2.3± 0.4) in non-residential school boys.

PFI score and FEV_1 comparison between the non-residential and residential school boys. It showed positive correlation but not significant. As PFI increases, FEV_1 parameter also increases. Mean value of PFI score (52.1±7.7) and FEV_1 (2.7±0.4) and in residential school

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boys is significantly higher than PFI score (35.5± 5.4) and FVE_1 (2.1±0.4) in non-residential school boys.

PFI Grading	PFI Score(%)	FVC(L/sec)	FEV_1(L/sec)	PEFR(L/min)	FEV1/FVC(%)
Good	57.1	3.1	2.8	410	91.3
Average	45.2	2.9	2.6	368	91.8
Poor	29.8	2.6	2.3	278	92.2

Comparison of PFI (Physical Fitness Index) and PFT (Pulmonary Function Tests) in Residential School Boys

PFI Grading	PFI Score(%)	FVC(L/sec)	FEV_1(L/sec)	PEFR(L/min)	FEV1/FVC(%)
Good	51.2	3.1	2.8	378	91.1
Average	36.2	2.3	2.1	316	91.8
Poor	27.2	2.1	1.9	289	92.6

Comparison of PFI (Physical Fitness Index) and PFT (Pulmonary Function Tests) in Non-residential School Boys

Table 4

Grading of PFI score and PFT parameters comparison in the residential school boys. It showed positive correlation. As PFI increases, PFT parameters also increase. With the increase in PFI score from poor PFI grade to average PFI grade to good PFI grade, the mean value of FVC, FEV_1 and PEFR increased and is more in good PFI score grade than average PFI score grade and poor PFI grade in residential school boys.

Grading of PFI score and PFT parameters comparison in the residential school boys. It showed positive correlation. As PFI increases, PFT parameters also increase. With the increase in PFI score from poor PFI grade to average PFI grade to good PFI grade, the mean value of FVC, FEV_1 and PEFR increased and is more in good PFI score grade than average PFI score grade and poor PFI grade in non-residential school boys.

Discussion

Effect of Regular Physical Activity on Anthropometric Parameters

Physical anthropometry of residential and non-residential school boys.

It shows that the mean values of height, weight, BMI and BSA of residential school boys were significantly higher when compared to non-residential school boys. Similar findings are seen in Chowdhuriet al.[8] studies. Increase in anthropometric parameters indicates significance of regular physical exercise given to them. Regular physical exercise during growing period increases the plasma somatotropin level which is essential for the proper growth of an individual. Also, nutritious food may be one of the contributing factors in attainment of such growth. Thus, variation in anthropometric parameters is related to physical exercise and nutritious food.[17]

Effect of Regular Physical Activity on Physiological Parameters

There was statistically significant increase in SBP and statistically significant decrease in resting pulse rate and respiratory rate in residential school boys when compared to non-residential school boys. We found DBP, PP and MAP though not statistically significant, but were increased in residential school boys than non-residential school boys. Similar findings is seen in Choudhuri et al.,[18] Khodnapur J P et al.[19] studies.

SBP, DBP and MAP are increased in residential school children due to increase in the cardiovascular endurance. This is because of regular exercise which brings changes on

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myocardium, cardiac output, coronary circulation, increased efficiency of blood flow and bradycardia.[20,21,22,23]

Effect of Regular Physical Activity on PFI Score

100 school going children performed the Modified Harvard step test and PFI score was recorded. Statistically significant increase in PFI score in residential school boys (52.1±7.7) when compared to non-residential school boys (31.5±5.4) was observed indicating residential school boys are more physically fit than non-residential school boys. The mean PFI score of similar findings is seen in Chatterji et al.,[24] Choudhuri et al.,[18] Das et al.,[25]Khodnapur et al.[19] studies.

Physical fitness index of a person represents cardiovascular fitness. Regular physical exercise increases PFI by increasing oxygen consumption. Also nutritious food under guidance improves the growth and physical fitness. The poor physical fitness of non-residential school boys is due to poor physical composition, improper nutritional status and lack of physical activity in them.

Effect of Regular Physical Activity on PFT Parameters

100 school going children performed the PFT using Helios 401 Medspiror satisfactorily. The following parameters were recorded: FVC, FEV_1, FEV_1/FVC ratio and PEFR.

The actual volumes of FVC, FEV_1 and PEFR were significantly ($p<0.001$) higher in residential school boys than non-residential school boys. Mean values are as follows of FVC in residential (3.0±0.47) and non-residential (2.3±0.4), FEV_1 in residential (2.7±0.4) and non-residential (2.1±0.4) and PEFR in residential (410±15.8) and non-residential (328± 17.1) school boys. FEV_1/FVC ratio was slightly higher in non-residential school boys than residential but was not significant. Similar findings were observed in Reza Farid et al.[10] and Chaitra B et al.[26] studies.

The pulmonary function tests (PFT) recorded in % PREDICTED between residential and non-residential school boys. FVC, FEV_1 and PEFR were significantly ($p <0.001$) higher in residential school boys than non-residential school boys. Mean values of FVC are as follows in residential (102± 16.5) and non-residential (88.1±18.8), FEV_1 in residential (101.8±17.9) and non-residential (84.2±17.4) and PEFR in residential (84.9± 15.8) and non-residential (73.7±17.1) school boys. FEV_1/FVC ratio was slightly higher in non-residential school boys than residential but was not significant.

The increase in the pulmonary function tests in residential school children could be explained due to better strengthening of respiratory muscles as a result of physical training. Skeletal muscle controls, many crucial elements of aerobic conditioning including lung ventilation. There might be increase in the maximal shortening of the inspiratory muscles as an effect of training, which has been shown to improve the lung function parameters.[14] In the Amsterdam Growth and Heart study, physical activity was observed to be positively correlated to changes in FVC between ages 13-27 years over a period of 15 years. This confirms that regular exercise has a facilitatory effect on the lungs. The possible explanation for this could be that regular forceful inhalation and deflation of the lungs for prolonged periods leads to strengthening of respiratory muscles. This helps lung to inflate and deflate maximally. This maximal inflation and deflation is the most important physiological stimulus for the release of surfactant and prostaglandins increasing the alveolar spaces and thereby increasing the lung compliance and decreasing the bronchial smooth muscle tone.[27,28]

The physical training must have helped in developing reduced resistance to respiration and greater endurance in respiratory muscles, accounting for increased FVC, FEV_1 and PEFR. This is advantageous for physical work capacity in them. The flow rates have also shown to have higher values in group Ib. These flow rates are effort dependent. During training, there

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is adaptation to frequently higher ventilatory load which might bring about some structural changes that may lead to less compression of airways at lower lung volumes.[26]

Vital capacity and pulmonary reserve are increased through physical training as studied by Gould and Aye, because of training there is proportional expansion of both coronary and pulmonary vessels. Trained individuals have greater capacity adjustments. These increased dimension of circulatory and pulmonary system lead to a greater economy of work at all levels of physical work.

The pulmonary function tests also depend upon anthropometric measurements like height, weight and sex of the individual. PFT shows positive correlation with height and weight. With the increase in height, weight and thereby increase in BMI, Pulmonary function tests also increases. This also explains increase inFVC, FEV_1 and PEFR in residential school children who have better BMI and PFI.[28]

PFI score and BMI comparison between the residential and non-residential school boys.

It showed positive correlation. As BMI increases, PFI score increases. The normal BMI group students presented the highest PFI. Data from Linear regression analysis revealed that PFI was significantly positively correlated with BMI, while negatively associated with BMI square, which indicated that PFI was the quadratic function of BMI. When BMI was increasing, PFI showed a parabolic curvilinear.

PFI score and PFT parameters comparison between the residential and non-residential school boys.

It showed positive correlation. As PFI increases, PFT parameters also increases. Similar findings were observed in Sandeep et al.[28] studies.

The present study agrees with the study done by DipayanChaudhuri et al.[18] that Physical fitness index score is more in residential school children when compared to non-residential school children and Jyoti P Khodnapur et al.stated that the status of respiratory performance in residential children is good compared to non-residential school children.

The results of our study showed the beneficial effects of regular exercise and nutrition on VO_2 max and physiological parameters among growing children. Regular physical exercise and physical activity contributes to the primary and secondary prevention of several chronic diseases and is associated with reduced risk of premature death.[29]

Conclusion

The anthropometric measurements like height, weight, CC, BMI and BSA are increased in residential school boys indicating the significance of regular physical exercise and balanced diet provided under guidance compared to non-residential school boys. The physiological parameters like SBP is increased in residential school boys due to increase in cardiovascular endurance and PR and RR are decreased due to increased parasympathetic discharge to heart and increased compliance of respiratory muscles due to training respectively. The PFI score is more in residential school boys as regular exercise increases PFI by increasing the oxygen consumption compared to non-residential school boys. This study shows the positive correlation of BMI on PFI. The actual values and % predicted values of FVC, FEV_1 and PEFR are increased in residential school boys due to increase in respiratory muscle strength and low resistance to respiration as compared to non-residential school boys positive correlation of PFI on PFT is shown. Regular physical exercise and a nutritious balanced diet show beneficial effect on health. So, regular physical exercise can be included as a part of curriculum to gift physically fit youth of the country.

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