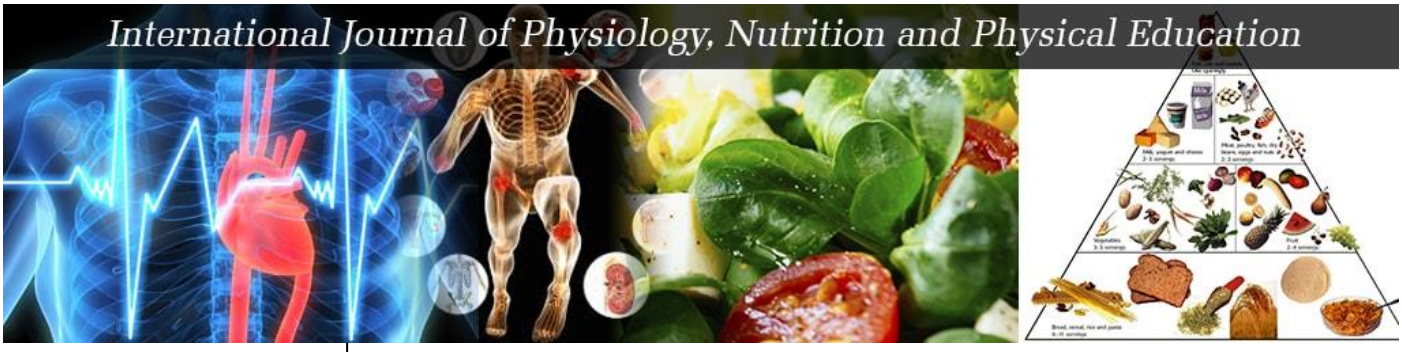

ISSN: 2456-0057
IJPNPE 2021; 6(1): 204-208

www.journalofsports.com
Received: 12-11-2020
Accepted: 16-12-2020

KSHMVWW Senevirathne
Department of Education, Faculty of Arts, University of Peradeniya, Sri Lanka

Corresponding Author:
KSHMVWW Senevirathne
Department of Education, Faculty of Arts, University of Peradeniya, Sri Lanka

Body mass index and cardiorespiratory fitness among secondary school children in Sri-Lanka

KSHMVWW Senevirathne

Abstract
The objectives of this study are to contribute to the available knowledge concerning the assessment identifying sex and age-related norms of Body mass Index (BMI) and cardio respiratory fitness of the secondary school children in Sri Lanka. A quantitative approach was used in this study. Physical fitness assessments were implemented to measure BMI and cardio respiratory of 1300 students (700 boys and 600 girls) which was a randomly selected sample in the Kandy District. Due to non-availability of equipment to administer 20m shuttle run to measure cardiorespiratory fitness. One Mile walk test. These tests were validated by scholars around the world in reputed standard test batteries All the data were computed and analyzed to formulate test norms as percentile values, stratified by chronological age groups separately for boys and girls. The Study revealed that norms of the BMI and I mile walk test are slightly different with the, Indian, USA and European norms. However, we cannot say 1mile walk test and BMI value level of Sri Lankan boys and girls are not in a satisfactory level compared to such as standards, because these figures are normative base values.

Keywords: body mass index, cardiorespiratory fitness

Introduction
There are a lot of scientific evidences to demonstrate that physical fitness reduces the risk of morbidity and mortality from a number of chronic diseases (Biddle *et al*, 2004). The recognition of the importance of physical fitness for optimal health has led to an increased interest in the study of different aspects of physical fitness. The overweight and obesity prevalence among children in Sri Lanka show different ranges with provincial and gender variations; among boys and girls between 8 and 10 years this was 4.3% and 3.1% respectively and obesity prevalence among primary schoolchildren in Colombo district is 5.1% in 2008 (Thilakarathne and Wijesinghe, 2011; Wickramasinghe *et al*., 2004; Medical Research Institute of Sri Lanka, 2002) [8, 12]. There were 3.8 million adolescents in Sri Lanka (2013) [5] accounting 19% of population. Associated risk behaviors not only influence morbidity and mortality of adolescents, but also have long –lasting impact in determining future health and fitness (Danansuriya *et al*., 201 [5]
Cardiovascular fitness is a health-related component of physical fitness that relates to ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity (USDHHS 1986). Cardiovascular fitness is also referred to as cardiovascular endurance, aerobic fitness and cardio respiratory fitness. A VO2 max test in the laboratory setting is considered to be the best measure of cardiovascular fitness. Commonly administered field tests include the One mile run/walk, the 12-minute run, the PACER run for children and various bicycle, step, and treadmill tests.
The reliability of the 1 mile walk test has been reported by Shafrit (1990), Baumgartner (1992). McSwegin *et al*. (1998) reported that the reliability of maximum volume of oxygen intake(VO_2 max) estimated from one mile walk test using the" Kline *et al*. (1987) [9] equation" was high. They reported an intra-class correlation of 0.91 for repeat measures on 21 boys and girls 14-18 years of age. Validity of the One mile walk test was reported by Shafrit, Hooper, Ehlert, Costa and Patterson (1988). One mile walk test standards were not developed for children under the age of 10 because of the concerns over reliability and validity of the test results.

Even with practice, it is difficult to assure that young children will pace themselves appropriately on a One-Mile Run, and give a maximal effort on the One-Mile Run and Progressive Aerobic Cardiovascular Endurance Run (PACER) tests (Cureton, Sharon A. Plowman, Matthew T. Mahar, 2012). This is reflected in the fact that the reliability and validity of the one-mile run, and the validity of the PACER for estimating VO2max in young children are not consistently good. Therefore, there is the danger that aerobic capacity will be inappropriately evaluated (underestimated) in a considerable number of children (Plowman & Meredith, 2013). By practicing these tests several years before actually being compared to standards, there is a greater probability that fewer misclassifications will occur. The One-Mile Walk test reduces these problems, although it still requires maintaining a focus on walking as fast as possible. However, it has less available studies which have been validated for young children. Although it has less studies, the researcher selected this one mile walk test to determine Aerobic Cardiovascular Endurance in this study.

Author came across two major conceptual frameworks which were relating to physical fitness concept namely Consensus Guidelines Model (Bouchard & Shephard (1994) [1] for Health related physical fitness and Institute of Medicine (IOM) Model (USA). These two models comprehensively discussed the relating factors to the Health Related physical Fitness (HRPF) concept and furthermore these models describe concept of HRPF under sub themes of morphological, muscular, motor, cardio respiratory, and metabolic fitness. Before 1994 there was no consensus among the sports scientists around the World on a concept of HRPF. To fulfill this need sports scientists and physical educationists gathered at Toronto, Canada in 1994 for landmark consensus conference on physical activity, fitness, and health led to the creation of a detailed conceptual framework for health-related fitness (Bouchard & Shephard, 1994) [1]. This model also named as a Toronto model because well reputed physical educationists and sports scientists agreed and develop this model at the world forum in Toronto, Canada in 1994. (Figure 01)

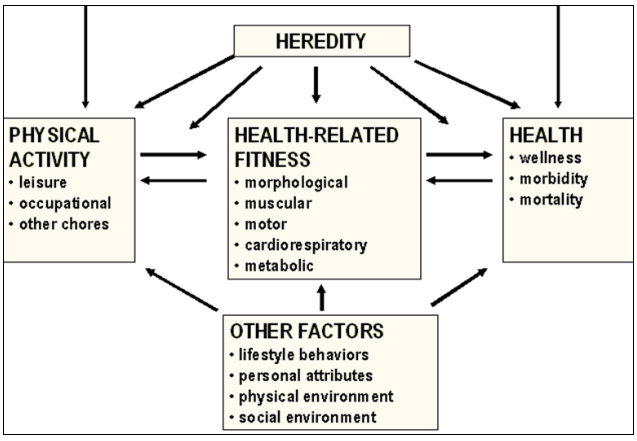

Fig 1: Consensus Guidelines Model (1994) [1] - (Bouchard & Shephard 1994) [1]

The above model considers the impact of heredity on HRPF and proposes different dimensions or components of physical fitness (morphological, muscular, motor, cardio respiratory, and metabolic).The model includes different dimensions than proposed by Caspersen *et al*. (1985), but this is because it takes a broader approach with regard to the concept of health-related fitness. This model was used as a theoretical framework of this study. The model also defines five main components of health related fitness:

1. A morphological component (body mass for height, body composition, subcutaneous fat distribution, abdominal visceral fat, bone density, flexibility);
2. A muscular component (muscular power, muscular strength, muscular endurance);
3. A motor component (agility, balance, coordination, speed of movement);
4. A cardiorespiratory component (submaximal exercise capacity, maximal aerobic
5. power, heart functions, lung functions, blood pressure); and
6. A metabolic component (glucose tolerance, insulin sensitivity, lipid and lipoprotein metabolism, substrate oxidation characteristics) (Bouchard and Sheppard, 1994; Pate, 1988) [1].

It was assessed by the recorded time in the 1- mile walk. The reliability of the 1 mile walk test has been reported by Shafrit (1990), Baumgartner (1992). McSwegin *et al*. (1998) reported that the reliability of maximum volume of oxygen intake (VO_2 max) estimated from one mile walk test using the" Kline *et al*. (1987) [9] equation" was high. They reported an intra-class correlation of 0.91 for repeat measures on 21 boys and girls 14-18 years of age. Validity of the One mile walk test was reported by Shafrit, Hooper, Ehlert, Costa and Patterson (1988). One mile walk test standards were not developed for children under the age of 10 because of the concerns over reliability and validity of the test results. Even with practice, it is difficult to assure that young children will pace themselves appropriately on a One-Mile Run, and give a maximal effort on the One-Mile Run and Progressive Aerobic Cardiovascular Endurance Run (PACER) tests (Cureton, Sharon A. Plowman, Matthew T. Mahar, 2012). This is reflected in the fact that the reliability and validity of the one-mile run, and the validity of the PACER for estimating VO2max in young children are not consistently good. Therefore, there is the danger that aerobic capacity will be inappropriately evaluated (underestimated) in a considerable number of children (Plowman & Meredith, 2013). By practicing these tests several years before actually being compared to standards, there is a greater probability that fewer misclassifications will occur. The One-Mile Walk test reduces these problems, although it still requires maintaining a focus on walking as fast as possible. However, it has less available studies which have been validated for young children. Although it has less studies, the researcher selected this one mile walk test to determine Aerobic Cardiovascular Endurance in this study. The 1-mile walk using the equation of Kline *et al*. 3 is a valid predictor of VO 2max in active duty Air Force males. To our knowledge, the 1-mile walk has not previously been validated in a military population, and previous studies were inconclusive as to whether this assessment was valid in other young adult populations. Dolenger *et al*. [5] and George *et al*. [6] reported signifi cant overestimation of VO 2max in college populations McSwegin *et al*. [10] and Greenhalgh *et al*. [11] concluded that the 1-mile walk is a valid predictor of VO 2max in high school and college students. Greenhalgh *et al*. [11] suggested the over prediction of VO 2max by Dolenger *et al*. 4 and George *et al*. 5 was likely due to using sample populations with lower fi tness levels. Although the mean age of subjects in this study is greater than that in previous studies, the current sample population has an overall higher fi tness level with a mean VO 2max of 50.31 ± 6.96 mL/kg/min.

2. Materials and Methods

A quantitative approach was used in this study. A cross sectional survey method was adopted to measure 1 mile walk test of 1300 students and BMI (700 boys and 600 girls) which was randomly selected sample in the Kandy District. A Multi-stage sampling method was adopted to select this student sample aged between 11 years and 17 years. To ensure standardization of data collection six physical education teachers thoroughly trained as data collectors through training workshop. Due to non-availability of equipment to administer 20m shuttle run to measure cardiorespiratory fitness by One Mile walk test. This was validated by scholars around the world.

Body composition –Anthropometric Measurement

To assess body composition, the body mass index (BMI) was calculated and to estimate central body fat, waist circumference was measured.

Body mass index (BMI)

To calculate the body mass index, weight and height of the subject were measured.

Height

To measure the height local "Stadiometer" was prepared by the researcher according to the measuring standards for this study. The child must stand on the platform of the Stadiometer on bare footed, feet placed slightly apart and the back of the head, shoulder blades, buttocks, calves and heals touching the vertical wall (board). Legs are kept straight and the feet flat. The tester positioned the child's head so that a horizontal line drawn from the ear canal to the lower edge of the eye socket runs parallel to the baseboard. The headboard pulled down to rest firmly on top of the head and compressed hair. Two measures of height were performed and the mean was retained. In measuring height the reading was taken to the last completed mm.

Weight

A beam Seca Alpha weighing scale (Model 1770) with a capacity of 200 kg and with a true zero balance was used to measure body mass to the last complete 0.1 kg

The child stood on the platform of the scale without support. The child stands still over the centre of the platform with the body weight evenly distributed between both feet. Light cloths were allowed to be worn, excluding shoes, long heavy trousers and sweaters.

Two measurement of body mass were performed and weight was recorded to the nearest 100 g.

G. Calculation of Body Mass Index (BMI)

Body Mass Index (BMI) was derived from the general equation,

$$BM\ I\ (kgm\text{-}^{2}) = body\ mass\ (kg) \div height\ ^{2}\ (m^{2})$$

That is mass (kg) divided by height^2 (m^2).

This formula was developed by Adolphe Queteler (1830 and 1850) and formula was adopted from Garabed Eknoyam (2008).

The result was scored in Seconds with one decimal. All the data were computed and analyzed to formulate test norms as percentile values, stratified by chronological age groups separately for boys and girls. All the calculations were performed using SPSS vs. 17 for windows.

3. Results

The normative values of 1 mile walk test and BMI values age categories from11 to 17 years for the Sri Lankan secondary school students, as it was done in age categories, it was classified according to sex and age expressed in percentiles from 5 to 95..

Figures 2 and 3 illustrate the performance of I mile walk test norms of boys and girls according to their age category

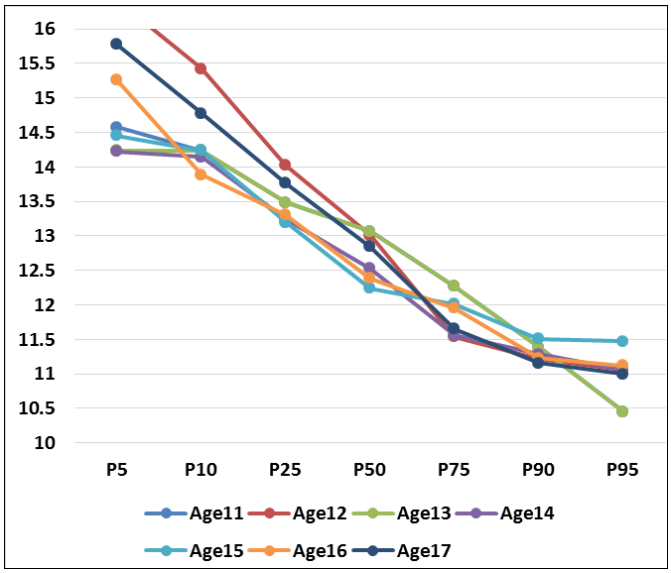

Fig 2: A Comparison of 1 mile walk test norms of boys

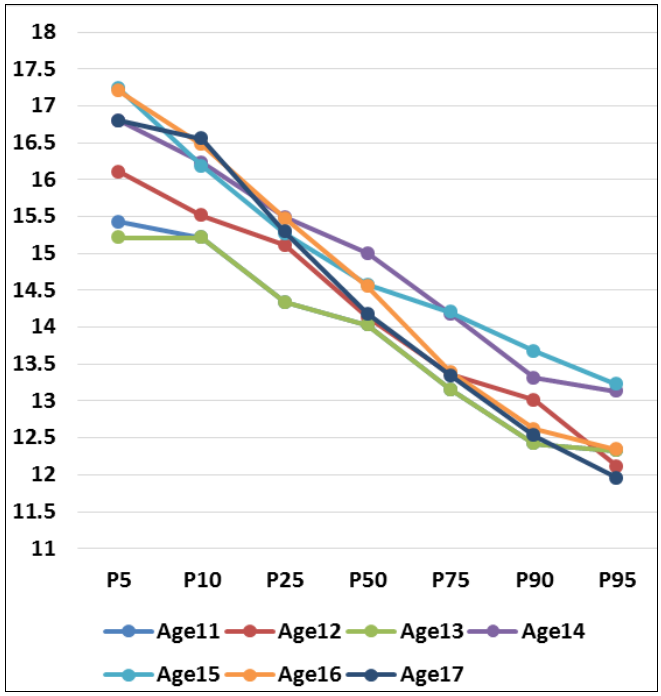

Fig 3: A Comparison of 1 mile walk test norms of girls

The lowest P5 of boy's One mile walk test performance is 14 minutes and the highest P5 performance is 13.2 minutes. Meanwhile, lowest P95 of boy's One mile walk test performance is 11.2 minutes and the highest P95 is 9.7 minutes. According to the graph 3

The lowest P5 of girl's One mile walk test performance is 17.2 minutes and the highest P5 is 15.2 minutes. Furthermore, lowest P95 of girls' One mile walk test performance is 13 minutes and the highest P95 is 11.5 minutes.

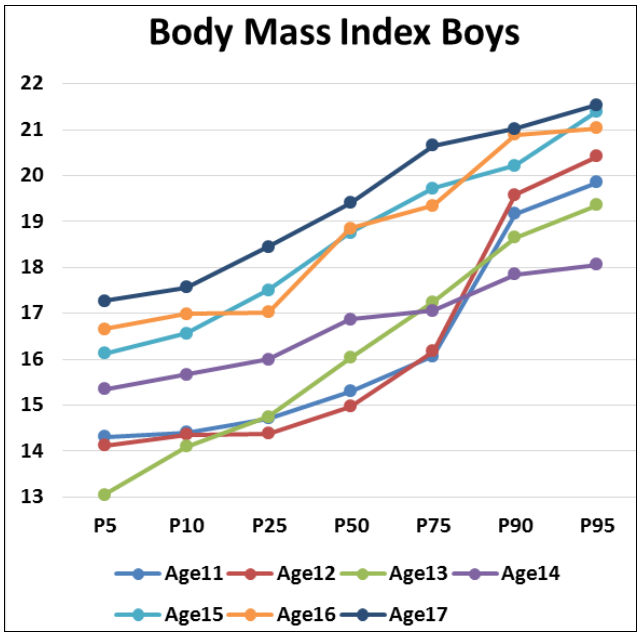

Fig 4: A Comparison of BMI boys

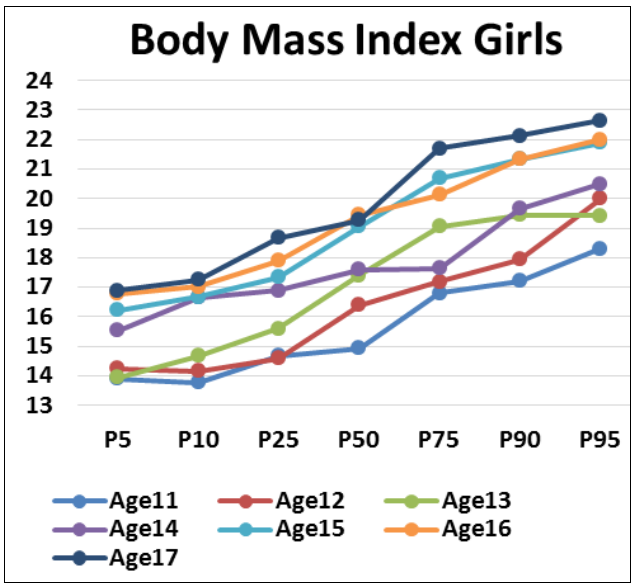

Fig 5: A Comparison of BMI test norms girls

The significant observation is that the BMI percentiles of P5, P10, P90 and P95 of the age groups 11, 12 and 13 of boys are greater than those of the age group14 years. Reasons may be due to changes occurred in adolescent period. Except this unusual pattern, it is revealed that BMI percentiles of the boys and girls gradually increase according to the age from 11 years age to 17 years. According to the Figure 4 the lowest P5 of boys BMI is approximately13 and the highest P5 is near 17 .4. Furthermore, lowest P95 of boys BMI is approximately 18 and the highest P95 is approximately 22 .6. According to the Figure 5 the lowest P5 of girls BMI is approximately 14 and the highest P5 is approximately 17. Furthermore, lowest P95 of girls BMI was found for year 18 range and the highest P95 found in 22.9 range.

4. Discussion

Finding of this 1mile walk test and BMI value references are constructed the school children lives in the Kandy distract of Sri Lanka. The other limitation of this study is the sample size consisted of 1300 (both boys and Girls).Therefore, to established Sri Lanka National Norms the sample size is not enough and it need a large sample. The findings of this study differ with similar studies especially in European Union studies. They converted one mile walk time into $\dot{V}O_2$max per kilogram. According to study done by Thomas Rowland, *et al*. (1999) [9] the average 1-mile run time of the boys in this study, 9:07, is comparable to, but somewhat greater than, the mean value of 8:22 reported in school fitness tests of 12-year-old boys in the United States. This difference may reflect the higher body fat content of our subjects, who had a mean skinfold sum of 21.2 mm compared with 17 mm in population studies of boys this age. The mean value of $\dot{V}O_2$max per kilogram of 47.2 mL/kg per minute is consistent with those previously described for boys in this age group [16]. Similarly, the average maximum cardiac index of 11.98 L/min per m falls at the upper range of normal values (9-12 L/min per m) reported in other pediatric studies [16]. The study population can therefore be considered representative of 12-year-old boys in average level of cardiovascular fitness.

Comparison of Body Mass Index (BMI) values of this study with Indian and USA norms *"FITNESSGRAM"* is a World famous physical fitness standards produced by Cooper Institute, USA. For each test area, the *FITNESSGRAM* uses the Healthy Fitness Zone (HFZ) to evaluate fitness performance. The performance goal for all test areas is to reach the HFZ which represents a level of fitness that offers protection against the diseases that result from sedentary living. If the performance goal is not met, the results are classified as Needs Improvement (NI) or, for Aerobic Capacity and Body Composition, Very Lean (Body Composition only) or Needs Improvement-Health Risk (NI-HR).The *FITNESSGRAM* and Healthy Fitness Zones (HFZ) are registered trademarks of The Cooper institute. Meanwhile, Ministry of Youth Affairs & Sports, Department of Sports, Government of India has developed a test battery and physical fitness standard performance for school children and youth in 2012. These two BMI standards and the BMI test norms developed at this study are compared in the following two tables.

(≥ the score is greater than or equal to the indicated value. ≤ the score is less than or equal to the indicated value.)

(Adapted data from *FITNESSGRAM* performance standards, The Cooper institute, USA and Government of India, Ministry of Youth Affairs & Sports, Department of Sports, 2012)

Table 1: Comparison of Body Mass Index (BMI) values of this study with Indian and USA norms of Boys

Age	FITNESSGRAM performance standards				Sri Lankan Standards	Indian Standards
	NI-HR	NI	HFZ	Very Lean		
11	≥23.7	≥20.6	20.5-14.9	≤14.8	14.0-19.0	14.0-18.0
12	≥24.7	≥21.4	21.3-15.3	≤14.8	14.5-20.5	15.0-19.0
13	≥25.6	≥22.3	22.2-15.8	≤15.7	13.0-19.0	15.5-21.0
14	≥26.6	≥23.1	23.0-16.4	≤16.3	15.0-18.0	16.0-21.5
15	≥27.2	≥23.8	23.7-16.9	≤16.8	16.0-21.5	16.5-21.5
16	≥27.9	≥24.6	24.4-17.5	≤17.4	16.5-21.0	17.0-22.0
17	≥28.6	≥25	24.9-18.1	≤18.0	17.0-21.5	17.5-22.5

Table 2: Comparison of Body Mass Index (BMI) values of this study with Indian and USA norms of Girls

Age	FITNESSGRAM performance standards				Sri Lankan Standards	Indian Standards
	NI-HR	NI	HFZ	Very Lean		
11	≥24.7	≥21.3	21.2-14.7	≤14.6	13.0-18.0	13.5-23.0
12	≥25.8	≥22.2	22.1-15.2	≤15.1	14.0-20.0	14.0-24.0
13	≥26.8	≥23.0	22.9-15.7	≤15.6	14.0-19.5	14.5-24.5
14	≥27.7	≥23.7	23.6-16.2	≤16.1	15.5-20.5	15.0-25.0
15	≥28.5	≥24.4	24.3-16.7	≤16.6	16.0-22.0	15.5-25.5
16	≥29.3	≥24.9	24.8-17.1	≤17.0	17.0-22.0	16.0-26.0
17	≥30.0	≥25.0	24.9-17.5	≤17.4	17.0-22.5	16.5-26.5

According to the Tables 1 and 2 it can be observed that although the BMI levels of Sri Lankan children (both boys and girls) are not in the range of 'Needs Improvement-Health Risk (NI-HR)' but in the range of 'Needs improvement'. They are in the margin of very lean level according to the USA norms. However, we cannot say BMI level of Sri Lanka boys and girls are not in a satisfactory level compared to USA standards. Because, these figures are normative base values. These norms are identical for some specific population. As the researcher has described in the theoretical background which is Consensus Guidelines Model (Bouchard & Shephard (1994) [1] of this study HRPF of children depends on various factors such as heredity, morphological factors leisure, wellness, life style behaviors and physical and social environment.

Conclusion

It can be concluded that although the cardio respiratory fitness and BMI values of Sri Lankan children (both boys and girls) are not in the range of poor range. They are slightly different with the USA and European norms. However, we cannot say level of Sri Lankan boys and girls are not in a satisfactory level compared to such as USA standards, because these figures are normative base values. These norms are identical for some specific population. It can be recommended that agility fitness can be objectively assessed by tests conducted in laboratory, but the need of expensive equipment limits its use in school environment. In this context, field tests might be an alternative for assessing fitness in school children, due to its low cost and its easy applicability, with the advantage that a big number of children can be assessed simultaneously.

References

1. Bouchard C, Shephard R. Physical activity, fitness and health: the model and key concepts. In: Bouchard C, Shephard R, Stephens T (Eds) Physical activity, fitness and health. International proceedings and consensus statement. Human Kinetics, Champaign, IL, 1994, 77-88.
2. Canadian Society for Exercise Physiology, Canadian physical activity, fitness and lifestyle approach (3rd Ed.). Ottowa: The Society, 2003.
3. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise and physical fitness: Definitions and distinctions for health-related research. Public Health Reports 1985;100:126-130.
4. Castro-Piñero J, Artero EG, España-Romero V, Ortega FB, Sjöström M, Suni J *et al*. Criterion-related validity of field-based fitness tests in youth: A systematic review. Br J Sports Med 2010;44(13):934-43.
5. Danansuriya MJ *et al*. Improving Adolescents Health in Sri Lanka. International Conference on Public Health Innovations, National Institute of Health Sciences, Sri Lanka 2013.
6. Institute of Medicine. Fitness measures and health outcomes in youth. Washington, DC: The National Academies Press 2012.
7. Ortega FB, Silventoinen K, Tynelius P, Rasmussen F. Muscular strength in male adolescents and premature death: cohort study of one million participants. British Medical Journal 2012;345:e7279.
8. Thilakarathne RMLR, Wijesinghe DGNG. Association between Nutritional Status and Life Style Practices of Primary School Children in the Colombo District: A Pilot Study. Tropical Agricultural Research 2011;22:392-401.
9. Thomas Rowland, Gregory Kline MD, PhD; Donna Goff, MS; *et al*. Leslie Martel, MED; Lisa Ferrone, MS One-Mile Run Performance and Cardiovascular Fitness in Children ,Arch Pediatr Adolesc Med 1999;153(8):845-849. doi:10.1001/archpedi.153.8.845
10. US Department of Health and Human Services. 1985 President's Council on Physical Fitness and Sports Youth Survey. Washington, DC: US Government Printing Office 1986.
11. Welk GJ, Meredith M. (Eds.) FITNESSGRAM® Reference Guide. Dallas, TX: The Cooper Institute 2008. Available at: http://www.cooperinst.org/reference-guide Accessed 7/15/2013
12. Wickramasinghe VP, Lamabadusuriya SP, Atapattu N, Sathyadas G, Karuparanantha S *et al*. Nutritional status of school children in an urban area of Sri Lanka. Ceylon Medical Journal 2004;49:4.