ORIGINAL ARTICLE

PHYSICAL MEASUREMENT PROFILE AT GILGEL GIBE FIELD RESEARCH CENTER, SOUTHWEST ETHIOPIA

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ABSTRACT

***BACKGROUND:** Physical measurement reference values are helpful to manage patients, conduct surveillances and monitor and evaluate interventional activities. Such valuable data at a community level however, are almost non-existent in Ethiopia. The objective of this study was to determine anthropometrics and blood pressure in "apparently healthy individuals" in community settings.*
***METHODS:** A population-based cross-sectional survey was conducted from September 2008 to January 2009 at Gilgel Gibe Field Research Center, Southwest Ethiopia. Blood pressure, height and weight were measured using Automatic Blood Pressure monitor, stadiometers and digital weight scales respectively. Waist and hip circumferences were measured using measuring tapes. BMI was computed as weight in kg divided by square of height in meter of individual (kg/m^2). Waist to hip circumference ratio (WHR) was calculated by dividing the waist circumference to hip in centimeter. Data were entered into Epidata and analyzed using SPSS for Windows version 16.0 and STATA 11.*
***RESULTS:** The mean systolic/diastolic blood pressures for men and women were 115.8/73.4 and 112.6/72.9 mmHg respectively. The mean BP values showed increasing trend with age for both sexes. The mean heart rate for men and women were 78.6 and 84.7 beats per minute, respectively. The mean weight and height values in all age groups, waist circumference value in 35 years and above were significantly higher ($p < 0.001$) for men, while the mean values for hip circumference in under 35 years and body mass index in under 45 year age groups were significantly higher ($p < 0.025$) for women. The mean body mass index for age group 15-24 (18.1 kg/m^2) was significantly lower ($p < 0.001$) than the other age groups in men; whereas in women those 55+ years had significantly ($p < 0.001$) lower mean body mass index compared to the other age groups. The Waist to Hip circumference (WHC) ratio increased from 0.87 for age 15-24 years to 0.92 for those age 55 years and above. Comparison with findings in other parts of the world showed that Ethiopians (both sex) had low mean weight, waist and hip circumferences, but high body mass index.*
***CONCLUSION:** The study showed that the physical measurement values are different from the other regions of the world. The use of other reference values in evidence based practices may result in under detection of risk groups.*

***KEYWORDS:** Blood pressure, anthropometric measurements, GGFRC, Community based survey*

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INTRODUCTION

Non-communicable chronic diseases are increasing in prevalence and seriously threaten developing nations' ability to improve the health of their populations. World Health Organization (WHO) projected increases in deaths and illness due to non-communicable chronic diseases in low- and middle-income countries up to 2030 (1, 2). The Global Burden of Disease Study, conducted in 2001, showed that 20% of deaths in sub-Saharan Africa were caused by non-communicable diseases (3, 4). These increases appear across a wide range of developing countries, but with substantial variation among those countries in the prevalence levels and rates of increase. A more nuanced understanding of who is affected by non-communicable chronic diseases is gained by examining the presence of their various risk factors. Physical measurements are one means of assessing the risk factors for the development of these diseases, which are amenable for intervention and modifications.

Different anthropometric measurements like body mass index (BMI), waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio as well as BP measurements are vital for screening high risk groups for non-communicable diseases (5). Those Physical measurements are also used by health professionals to manage patients, screen high risk groups for different diseases, conduct surveillance and monitor and evaluate interventional activities.

Level of blood pressure and pulse rate are vital physical signs that determine the degree of risks to cardiovascular disorders. Many studies attempted to show the distribution of blood pressure and pulse rate values among people of different geographic settings. Studies conducted in the USA revealed that young black adults had higher mean blood pressure but lower pulse rate than young white adults (6, 7). On a systematic review of 14 studies, 10 studies showed higher mean systolic blood pressures whereas 11 reported higher mean diastolic blood pressures in African descent men compared to white men. In women, 10 of 12 studies reported higher systolic and diastolic blood pressures (8).

Difference in blood pressure and pulse rate among different population segments was also found in studies conducted in Africa and Asia. A study in Malawi showed that urban dwellers had higher blood pressures and significantly lower pulse rate than rural (9). In Turkish study blood pressure was found to be higher in men than in women (5).

Anthropometric measurements provide information on body muscle mass and fat reserves. The most practical and commonly used anthropometric measurements are body weight, height, and mid-upper arm circumference (MUAC). Nowadays, waist and hip circumferences are being utilized to assess central obesity or abdominal fat reserve. Body weight is one of the most useful nutritional parameters to follow patients who are acutely or chronically ill. Body mass index (BMI) is used since it provides an estimate of body fat and is related to risk of diseases (10). Excess abdominal fat, assessed by measurement of waist circumference (WC) or waist-to-hip ratio (WHR) is independently associated with higher risk for diabetes mellitus and cardiovascular diseases. Cut-off points that define higher risk for men and women based on race have been proposed by the International Diabetes Federation. As there are no data for South and Central America, Middle East and Africa, it was recommended to utilize the European reference for African and Middle East while for South and Central America to use the Asian reference values (11).

However, health professionals and policy makers are confronted by a remarkable heterogeneity among their patients as well as their general population as age, race, gender and environment may influence some values of blood pressure, pulse rate and anthropometrics (12, 13). It has been recommended that every population should determine their best physical measurement values in order to screen their population to identify risk factors, thus suggesting that the development of reference values for the Ethiopian population is imperative to improve quality of health care. Such valuable data at a community level are scanty in the Ethiopian situation.

Therefore, this study was conducted to determine anthropometrics, blood pressure and pulse rate in "apparently healthy individuals" in community settings which can help for generating reference values in the future providing evidence for decision making, and evidence-based practices. Moreover, this study will serve as baseline information for further studies at national level.

SUBJECTS, MATERIALS AND METHODS

This population-based cross-sectional survey was conducted from late September 2008 to the end of January 2009 at Gilgel Gibe Field Research Center (GGFRC) of Jimma University located 55 kilometers Northeast of Jimma City. The center comprises of eight rural and two urban kebeles (the lowest administrative unit in Ethiopia) found within 10 kilometers distance from the periphery of the water body of the Gilgel Gibe Dam. This study was part of the survey for determination of magnitude of Chronic Non Communicable Diseases (CNCDs), risk factors of CNCDs and biochemical, immunological and hematological value determination for the community at GGFRC. Detailed information on methods is described in article (1) of this special issue.

The sample size was determined based on the WHO STEPS guideline stratifying the population by sex, age and residence (14). Taking 10% non-response rate, the total sample size was 5,500 individuals. To select the study participants, the 2008 updated census list of the population and households of the ten kebeles was used as sampling frame. Then the sample was distributed to each kebele proportional to their population size. Using the age and sex stratified sampling frame obtained from the census list, individuals were selected randomly.

Six data collectors who completed at least high school and fluent in local languages (Amharic and Afan Oromo) were recruited and trained on how to obtain consent, use equipments and how to perform and record the physical measurements. Different training methods were employed, including practice of measurement and role playing. They were also provided with manuals that cover the standard physical measuring procedures. Recording formats were adapted from WHO guidelines to measure blood pressure, pulse rate, weight, height, waist and hip circumference (14). Pre-test was conducted in similar urban and rural communities outside of the study setting with the aim of testing the functionality of the equipments and checking the competencies of data collectors. Upon completion of the pre-test, discussion was made on the experiences gained in the field work and based on feedbacks a re-training was conducted.

Physical measurements were done on sampled individuals' age 15 to 64 years of both sexes residing in the 10 Kebeles. After the interview for CNCDs survey, all respondents were given appointment to come to nearby health post, health station, health centre, school, Kebele offices or other convenient sites for measurements. On the next morning physical measurements including blood pressure, pulse rate, weight, height, and waist and hip circumferences were measured following standard procedures.

Three blood pressure (BP) readings were taken at a minimum of three minutes interval after the participant rested for 30 minutes. BP was measured in sitting position with the arm placed at the level of the heart mostly on right upper arm in mild flexion using the WHO recommended automatic BP monitor (Omron$^{(R)}$ HEM-711DLX intelliSense Bannockburn, Illinois, USA). Values of the three BP and pulse rate readings were recorded on respective recording formats. Individuals who had elevated BP or having indication of any of the CNCDs during the survey were referred to the nearest health centre or hospital for further investigation and management.

Height was measured using a Stadiometer (INVICTA Plastics Limited, England, Model 2007246) to the nearest 0.1cms while the participant stood still bare footed. Weight was measured to the nearest 0.1 kg with a calibrated portable digital weight scale (model 770; Seca, Germany) while the participant lightly clothed and shoes off. Waist and hip circumferences were measured to the nearest 0.1cms using measuring tapes. Waist circumference was measured in centimeters at the midpoint between the bottom of the ribs and the top of the iliac crest. Hip circumference was also measured in centimeters at the largest posterior extension of the buttocks.

There was daily supervision in the field during data collection period at all levels by field supervisors and the investigators. The physical measuring equipments were calibrated daily. Double data entry was done by trained data clerks. Incomplete and inconsistent data found during supervision and data entry were returned to data collectors for rectification. Moreover, data were checked for completeness, inconsistency and outliers by looking at their distribution.

Data were entered into Epi database, EpiData Entry 2, and analyzed using SPSS for window version 16.0 and STATA version 11. The mean of the three readings for systolic and diastolic pressures were determined and thus the mean of the three readings were accepted as BP of the individual. BMI was calculated as weight in kg divided by square of height in meter of individual (kg/m2). Waist to hip circumference ratio (WHR) was calculated by dividing the waist to hip in centimeters. Frequencies, summary values and measures of dispersion were determined when appropriate and necessary.

The proposal was approved by Jimma University ethical review committee. Support letter to the Jimma Zonal and to the four Woredas administrations was obtained from the university. Written consent was obtained for voluntary participation. Preliminary finding was communicated to the local authorities and Jimma University community.

RESULTS

Blood Pressure and Pulse Rate

Blood pressure and pulse rate was measured on 2,466 (1,225 men and 1,241 women) individuals. The mean SBP (95% CI) for men ranged from 112.4 (110.8-114.0) in the age group 15-24 to 123.4 (121.1-125.7) mm Hg among those 55 years and above ($p < 0.001$). The corresponding value for women ranged from 108.5 mm Hg (95% CI; 106.9-110.1) for age 15-24 years to 121.1 mm Hg (95% CI; 118.9-123.3) for those age 55 years and above ($p < 0.001$). Similarly, gradual increment in mean DBP was demonstrated with increasing age for both men and women. Both the mean SBP and DBP in different age strata were slightly higher for men than women except the mean DBP for age group 15-24 years. The mean pulse rate was higher for women than men in all age groups; however, there was slight decline on mean pulse rate as age increases. The mean (95% CI) pulse rate for men were 79.0 (77.3- 80.7) beat per minute (bpm) and 78.9 (77.5-80.3) bpm for age groups 15-24 and 55 years and above, respectively. The corresponding values for women age 15-24 and 55 years and above were 87.6 (85.9-89.3) bpm and 83.2 (81.9-84.5) bpm, respectively (Table 1).

Table 1: Mean systolic and diastolic blood pressure and pulse rate by age and sex, GGFRC, Sept 2008-Jan 2009.

Age group in years	*Sex*	*Systolic Blood Pressure (mmHg)*	*Diastolic Blood Pressure (mmHg)*	*Pulse Rate (per minute)*
		Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
15-24	Men (n=245)	112.3 (110.7-113.9)	70.2 (69.1-71.3)	79.0 (77.3-80.7)
	Women(n=249)	108.5 (107.0-110.1)	70.5 (69.4-71.7)	87.6 (85.9-89.3)
25-34	Men (n=245)	113.0 (111.5-114.4)	72.2 (71.2-73.1)	78.0 (76.6-79.5)
	Women(n=249)	108.6 (107.3-110.0)	71.8 (70.8-72.7)	85.7 (84.4-87.0)
35-44	Men (n=245)	113.2 (111.6-114.8)	73.2 (72.1-74.2)	78.2 (76.8-79.6)
	Women(n=249)	109.6 (108.0-111.3)	72.7 (71.7-73.7)	84.2 (83.0-85.4)
45-54	Men (n=245)	115.4 (113.5-117.3)	74.0 (72.8-75.2)	78.9 (77.6-80.2)
	Women(n=249)	114.5 (112.5-116.5)	73.5 (72.2-74.7)	83.8 (82.4-85.1)
≥ 55	Men (n=245)	123.4 (121.1-125.7)	76.3 (75.1-77.5)	78.9 (77.5-80.3)
	Women(n=245)	121.1 (118.9-123.3)	75.5 (74.4-76.7)	83.2 (81.9-84.5)
Total	Men (n=1225)	115.8 (115.0-116.7)	73.4 (72.9-73.9)	78.6 (78.0-79.3)
	Women(n=1241)	112.6 (111.8-113.5)	72.9 (72.4-73.4)	84.7 (84.1-85.3)

mmHg= Millimeter of Mercury

Anthropometrics

Anthropometric measurements taken from 3228 (1544 men and 1684 women) individuals were described. The mean age for men and women was similar within different age strata. While the mean weight, height, waist to hip circumference values were higher for men, the mean values for hip circumference and body mass index were higher for women of all age strata. However, no difference was seen in mean waist circumference. The mean weight and BMI (95% CI) for men increased from 51.4 kg (50.5-52.3) and 18.1 (17.9-18.4) for age group 15-24 years to 53.9 Kg (53.1-54.7) and 19.0 (18.8-19.2) for 44-54 years, respectively; however, such changes were not seen on women. The mean height in different age strata was similar within sex group (Table 2).

Table 2: Mean anthropometric values by age and sex, GGFRC, Sept 2008-Jan 2009.

Age group in years	*Sex*	*Age (years)* Mean (95% CI)	*Weight (Kg)* Mean (95% CI)	*Height (Cm)* Mean (95% CI)	*Body Mass index(kg/m^2)* Mean (95% CI)
15-24	Men (n=245)	19.0 (18.7-19.3)	51.4 (50.5-52.3)	168.2 (167.3-169.1)	18.1 (17.9-18.4)
	Women(n=250)	19.7 (19.4-20.1)	48.3 (47.5-49.0)	157.4 (156.6-158.3)	19.5 (19.2-19.8)
25-34	Men (n=277)	28.8 (28.5-29.1)	53.1 (52.3-54.0)	168.5 (167.6-169.3)	18.7 (18.5-18.9)
	Women(n=356)	28.2 (28.0-28.5)	48.9 (48.2-49.7)	157.2 (156.5-157.8)	19.8 (19.5-20.1)
35-44	Men (n=319)	38.7 (38.4-39.0)	53.9 (53.1-54.8)	169.0 (168.2-169.9)	18.8 (18.6-19.1)
	Women(n=385)	38.3 (38.0-38.6)	46.9 (46.1-47.6)	156.0 (155.4-156.6)	19.3 (19.0-19.6)
45-54	Men (n=340)	48.6 (48.3-48.9)	53.9 (53.1-54.7)	168.3 (167.6-169.0)	19.0 (18.8-19.2)
	Women(n=345)	49.0 (48.7-49.3)	46.1 (45.3-46.9)	155.8 (155.1-156.6)	19.0 (18.7-19.3)
≥ 55	Men (n=363)	62.0 (61.3-62.6)	52.4 (51.6-53.3)	167.1 (166.4-167.9)	18.7 (18.5-19.0)
	Women(n=348)	60.2 (59.7-60.6)	45.7 (44.9-46.6)	155.6 (154.9-156.3)	18.8 (18.6-19.1)
Total	Men (n=1544)	40.6 (40.0-41.3)	53.0 (52.6-53.4)	168.1 (167.8-168.5)	18.7 (18.6-18.8)
	Women(n=1684)	40.1 (39.5-40.7)	47.1 (46.7-47.5)	156.3 (156.0-156.6)	19.3 (19.1-19.4)

Table 3: Mean anthropometric values by age and sex, GGFRC, Sept 2008-Jan 2009.

Age group in years	*Sex*	*Age (years)* *Mean (95% CI)*	*Waist Circumference(cm)* Mean (95% CI)	*Hip Circumference(cm)* Mean (95% CI)	*Waist to Hip Ratio* Mean (95% CI)
15-24	Men (n=245)	19.0 (18.7-19.3)	71.55 (70.54-72.56)	82.50 (81.73-83.27)	0.87 (0.86-0.88)
	Women(n=250)	19.7 (19.4-20.1)	71.51 (70.65-72.37)	85.28 (84.56-86.00)	0.84 (0.83-0.85)
25-34	Men (n=277)	28.8 (28.5-29.1)	73.84 (73.14-74.54)	84.08 (83.15-85.00)	0.88 (0.87-0.89)
	Women(n=356)	28.2 (28.0-28.5)	74.53 (73.74-75.32)	85.60 (84.92-86.28)	0.87 (0.86-0.88)
35-44	Men (n=319)	38.7 (38.4-39.0)	76.03 (74.93-77.13)	84.49 (83.89-85.09)	0.90 (0.89-0.91)
	Women(n=385)	38.3 (38.0-38.6)	73.85 (73.15-74.55)	84.54 (83.87-85.20)	0.87 (0.87-0.88)
45-54	Men (n=340)	48.6 (48.3-48.9)	76.40 (75.53-77.28)	84.35 (83.72-84.98)	0.91 (0.90-0.91)
	Women(n=345)	49.0 (48.7-49.3)	73.63 (72.85-74.41)	84.12 (83.42-84.82)	0.88 (0.87-0.88)
≥ 55	Men (n=363)	62.0 (61.3-62.6)	76.78 (75.93-77.63)	83.78 (83.06-84.50)	0.92 (0.91-0.92)
	Women(n=348)	60.2 (59.7-60.6)	74.61 (73.87-75.35)	84.85 (84.09-85.61)	0.88 (0.87-0.89)
Total	Men (n=1544)	40.6 (40.0-41.3)	75.2 (74.8- 75.6)	83.9 (83.6-84.2)	0.90 (0.89-0.90)
	Women(n=1684)	40.1 (39.5-40.7)	73.8 (73.4- 74.1)	84.9 (84.5-85.2)	0.87 (0.87-0.87)

The mean waist circumference and WH ratio (95% CI) rose from 71.55 (70.54-72.56) cm and 0.87 (0.86-0.88) for age 15-24 years to 76.78 (75.93-77.63) cm and 0.92 (0.91-0.92) for age 55 years and above. However, the above trend was not seen on women (Table 3).

DISCUSSION

The present study was undertaken to determine reference values of blood pressure, heart rate, weight, height, BMI, Hip and waist circumferences and Waist to hip circumference ratio for “apparently healthy population”. Physical measurements of these types of population are extremely useful in understanding the medical and public health ramifications of the association between physical reference values and non-communicable diseases (10). The main finding of these physical measurements showed our study populations’ physical measurements were lower than other population values. Thus, these measurements could be used in the locality, in Ethiopia as well in Sub-Saharan African countries of similar setting for developing reference values to identify modifiable risk factors for non-communicable diseases that would help in patient management and policy formulation for control and prevention of these diseases.

The mean SBP and DBP measurements showed increasing trend with age for both sexes. The result is consistent with a finding reported from the study conducted among adult population 25-64 years age in Addis Ababa (15). Another study conducted in three Demographic surveillance sites (DSS); in Ethiopia, Vietnam and Indonesia (16) also showed that both SBP and DBP were significantly and positively correlated with age in both male and female subjects across the three countries. The distribution is higher among men as compared to women for both SBP and DBP. This observation is consistent with other studies (17, 18, 19). Systolic blood pressures were reported to be consistently higher in males than females (18, 19, 20), which is also true for this study. A study conducted in rural population in Ghana, however, reported that the mean systolic pressure was higher for women than men while mean diastolic was higher for men (21**)**. The mean systolic and diastolic blood pressures of both sexes at different age strata in this study are much lower than that reported from the USA (6, 7) and Ghana (21). This difference could possibly be explained by the effect of environment and life style. The same studies showed that mean heart rates of black participants were lower than mean heart rates of white participants (6, 7) in the contrary our study showed faster heart rate than the whites. The mean pulse rate was higher among women than men in all age categories in agreement with other studies (6, 7, 22).

When we see the anthropometric measurements, the mean weight, height, waist to hip circumference ratio values were higher for men than women while values for hip circumference and body mass index were higher for women in all age strata. Similarly the mean waist circumference was higher for men beyond the age of 35 years; but the pattern in the younger age groups was not consistent. Compared to a study conducted in Butajira, this population was less heavy, shorter, and with lower BMI (16). The same study documented lower weight and height and higher BMI for Vietnamese population and lower height, higher weight and higher BMI for Indonesians (16). Similarly, all anthropometric parameters of this population except the WHR in women were lower than that reported in a Turkish study (5) and lower mean BMI as compared to Ghanan study (21). Anthropometric measurements of different countries shown in the table 4 also clearly depicts that all the parameters except height in this study population are lower than the West Africans, Caribbeans and Asians (23, 24). A much higher BMI, waist and hip circumference measures are also reported from studies conducted in Canada (25, 26, 27). However, the Ethiopian men in the current study were heavier, taller and with higher BMI compared to the Indians (28).

The limitations of the study should be considered in understanding our results. Firstly, the social distribution of our study population does not exactly match the national distribution. For the smaller towns: Assendabo, Dimtu and Deneba included in this study cannot be taken to represent urban population in its strict sense, majority of our study populations were subsistence farmers who involved in more strenuous activities compared with urban populations. This strongly implicates differences in lifestyle as an explanatory factor such as increased fat intake and engaging in jobs with minimal physical activity of urban

Table 4. Anthropometric profile (mean±SD) of study participants as compared with different studies

Site	n	Age in years	Height (cm)	Weight (Kg)	Waist(cm)	Hip (cm)	WHR	BMI(Kg/m^2)	SBP(mmHg)	DBP (mmHg)	Pulse rate per minute)
Men											
Ethiopia	1544		168.1±0.35	53.0±0.4	75.2±0.4	83.9±0.3	0.90±0.01	18.7±0.1	115.8±0.85	73.4±0.5	78.6±0.65
Nigeria	1197	41.7±13.6	163.1±9.5	61.3±10.9	77.7±9.3	88.5±9.9	0.88±0.05	22.6±4.5	121.5±19.7	73.3±13.0	
Cameroon	1360	41.2±11.3	171.1±7.2	71.0±11.6	81.7±8.2	93.4±7.9	0.88±0.05	24.2±3.4			
Jamaica	603	46.2±14.3	172.0±6.9	70.5±13.9	80.8±12.0	95.7±8.3	0.84±0.07	23.8±4.4	123.2+20.8	71.2±14.7	
St. Lucia	494	44.6±13.5	173.4±7.5	72.9±11.4	82.6±9.6	95.3±7.4	0.87±0.06	24.3±3.7	126.8±18.9	75.9±13.7	
Barbados	329	46.3±14.5	171.9±7.4	76.4±13.2	86.2±11.3	97.8±7.7	0.88±0.07	25.9±4.3	125.5±17.0	77.0±10.9	
USA(Maywood) (30)	708	-	176.5+7.3	84.5+18.0	92.4+14.0	103.4+10.7	0.89+0.07	27.1±5.5	125.3+19.5	73.9+13.4	
Singapore:											
Chinese	*108	40.7(Sd=13.6)	169±(Sd=5.2)	65±(Sd=10.8)				22.8(Sd=3.5)			
Malays	*76	41.4(Sd=12.3)	166(Sd=6.4)	69.0(Sd=12.4)				25.0(Sd=3.7)			
Indians	*107	43.4(Sd=12.8)	170(Sd=6.9)	69.8(Sd=11.9)				24.2(Sd=3.6)			
Women											
Ethiopia	1684		156.3±0.3	47.1±0.4	73.8±0.35	84.9±0.35	0.87±0.00	19.3±0.15	112.6±0.85	72.9±0.5	84.7±0.6
Nigeria	1377	40.0±12.2	157.4±7.5	57.6±12.2	75.9±10.1	92.1±11.2	0.83±0.07	22.8±5.1	119.1±21.8	72.1±12.8	
Cameroon	1472	40.5±10.1	161.4±6.2	68.9±13.8	81.8±9.6	97.7±11.4	0.84±0.07	25.3±4.8			
Jamaica	835	46.0±13.5	160.7±6.4	72.1±17.4	83.2±12.7	102.2±12.9	0.79±0.06	27.9±6.5	122.3±21.6	70.9±14.1	
St. Lucia	596	44.9±13.9	162.8±6.8	72.3±17.0	85.5±13.4	103.7±13.1	0.82±0.07	27.3±6.2	122.7±22.5	73.4±14.6	
Barbados	483	47.6±14.4	160.1±6.3	75.2±16.3	87.1±12.6	106.7±12.8	0.82±0.07	29.4±6.4	122.0+19.9	73.5±11.5	
USA(Maywood) (30)	810		163.4+6.4	82.4+20.9	91.4+15.4	111.8+15.0	0.82+0.08	30.8+7.7	122.4+19.6	72.7+11.8	
Singapore:											
Chinese	*108	36.3(Sd=12.8)	157±(Sd=5.9)	54.7(Sd=11.1)				22.1(Sd=4.8)			
Malays	*76	35.6(Sd=13.9)	154(Sd=6.1)	58.1(Sd=11.5)				24.5(Sd=4.8)			
Indians	*107	36.6(Sd=10.1)	157(Sd=6.0)	61.2(Sd=13.9)				24.9(Sd=5.2)			

* Population represents both sexes, WHR=waist for Hip ratio, SBP=Systolic blood pressure, DBP= Diastolic blood pressure, mmHg= millimeters of mercury

populations (29). Thus, resulting in lower values of these physical measurements values in rural populations compared to urban, thus impacting our ability to extrapolate to the general population of the country. Secondly, although we followed the WHO STEPs Guideline and also removed the white-coat effect by using non-medical personnel for the B/P measurement and the measurement was carried out in the subjects' own environment, it is impossible to avoid the interobserver variation in the measurements. Thirdly, this study is cross sectional in nature and hence temporality and causality cannot be determined. A longitudinal study is in process in order to determine the impact of these physical reference values as risk factors for non-communicable diseases.

In conclusion, this study documented the distribution of physical measurements in community settings of "apparently healthy populations". The findings of this study showed that the anthropometric parameters are different from the other parts of the world. The use of western reference values for clinical and public health practice may result in misclassification and hence this calls for the establishment of age, sex, social as well as country specific reference values. It is also believed that nationally representative multi-center research should be conducted.

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