Elder Adult Body Composition and Stunting in Quetzaltenango, Guatemala

Measured Using Height, Weight, Knee-Height, Arm Span, Waist Circumference, and Full Length Photographs

Contents

Introduction

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Background

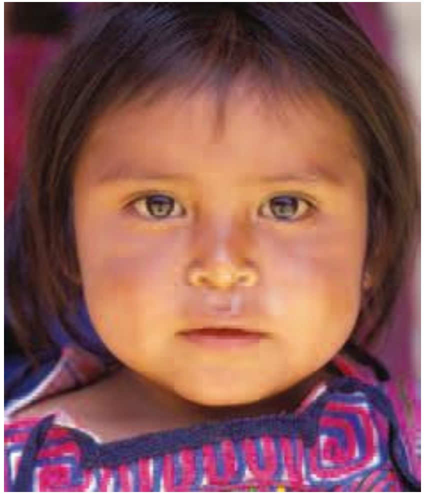
- Prevalence of stunting in Guatemalan children <5 is highest in Latin America (49%) [9], from 2nd to 4th highest in the world. [1, 4, 9]

- Especially worrying because according to The World Bank, Guatemala has higher rates of stunting than other nations in the region and in similar income status. [4]

- Currently not much evidence regarding prevalence of adults in Guatemalan population but it has been shown that childhood stunting is a direct cause of stunted adult height and furthermore is a risk factor diminished survival, childhood and adult health, learning capacity and productivity. [8]

Stunting

- Stunting as defined by the WHO is height for age < -2 SD of the WHO Child Growth Standards median decided in 2006. [6]
    - stunting in women is <145 cm and < 150 cm for men



- Definitions :

    - **Stunting** is low height for age
    - **Underweight** is low weight for age
    - **Wasting** is low weight for height.

- Recent literature promotes idea of first 1000 days of life beginning from conception as most vital time period affecting adequate growth. [7]

- Main causes include [8]:

    - intrauterine growth retardation

    - inadequate nutrition to support rapid development of infants/young children

    - repeated bouts of infections during first 1000 days

Manifestations of under-nutrition

- Weight is known to be a sensitive indicator of acute deficiencies

- Wasting is used as a way to identify severe acute malnutrition

- Height captures more chronic exposure to deficiencies and infections [8]

  - Subclinical infections, resulting from exposure to contaminated environments and poor hygiene, can contribute to stunting owing to nutrient malabsorption and reduced ability of the gut to function as a barrier against disease-causing organisms [53]

- Interventions targeting infections including immunization, improved hygiene and handwashing, sanitation and access to clean drinking water, use of improved oral rehydration salts and therapeutic zinc to treat diarrhoea, the prevention and treatment of malaria, and the treatment of pneumonia with antibiotics can lead to better growth and reduced mortality in children and infants [8]

Obesity in Guatemala

- As with other developing countries, overweight and obesity have been increasing rapidly over last 2 decades particularly among those living in urban areas. [1]
    - This is in large part due to the adoption of diets high in refined carbohydrates, saturated fats and sugars as well as a shift towards a more sedentary lifestyle

- As recently as 2009, an estimated 67% of Guatemalans aged 15 and above are overweight, of which 29% are obese. [4]
    - And the numbers are still increasing...

Double Burden of Malnutrition

- Guatemala is now facing a Double Burden of Malnutrition (DBM)

- DBM refers to the simultaneous existence of both under-nutrition in the form of stunting and over-nutrition in the form of obesity/overweight

- A study from 2000 showed that Guatemalan households had the highest prevalence of DBM in the world (16-18%)

    - This is referring to stunted children paired with overweight mothers pairs (SCOM). [1, 3]

How do you measure health??

- Traditionally BMI is used to analyze nutrition in individual and populations
    - It has been well proven as an indicator for chronic energy deficiency (CED) and as a lesser extent regarding overweight as well [44]

- The problem with BMI is it is not a perfect and reliable indicator of poor health as it isn’t able to differentiate between muscle and fat as well as adipose distribution throughout the body.

- Other methods indicators for health have been proposed as alternatives for indicating health risks (WC, WHR, WHtR, SHIB, etc.) but as of yet these measurements lack widely recognized techniques and cutoff points compared to BMI

Is BMI telling us the whole truth??

- BMI involves mass (kg)/ height squared (m) so what if one of these measurements is misleading?

- We know that as we age our bodies go through morphological changes including decreased height, a more central fat distribution as well as a loss of muscle mass (sarcopenia) [10]

- In the elderly population, measurements of height are particularly difficult to rely on with the shrinking due to IVD compression, changes in posture, and further complications including kyphoscoliosis or arthritis [11]

  - This process of decreasing height is thought to begin as early as 30 and accelerate with increasing age. [11]

Are there other ways to get height?

- Long bones in arms in legs do not change throughout age due to length/compression and therefore tend to maintain their maximal length throughout life [10]
    - Such surrogate measurements have been proposed to estimate height including knee height [12], arm span [13], demi-span [14], etc.
- The question is: do these alternative measurements indicate maximum or current height and furthermore, which one do we want to know??
    - Arm span is generally maximum due to the propensity of long bones to resist changes in length throughout life. [12]
    - Knee height on the other hand depends on the population for which the algorithm was calculated

Methodology

Literature Review

Field Work

- Recruitment
- Measurements
- Data Collection
- Returning results

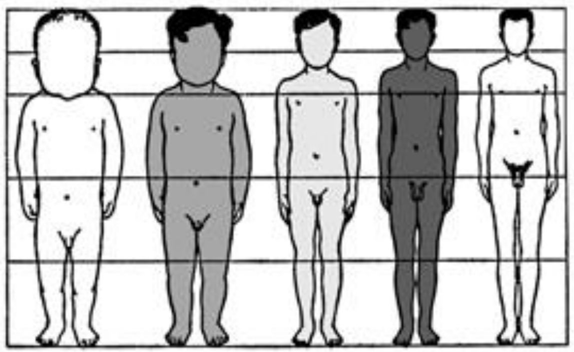
Analysis

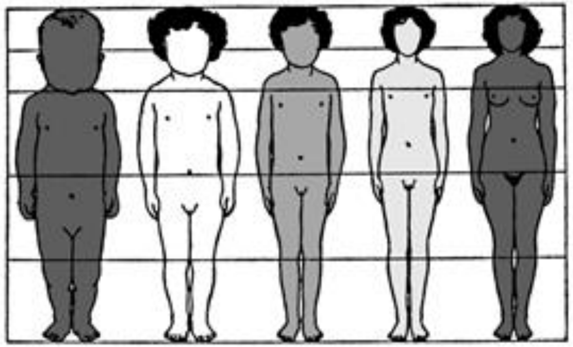
Literature Review

Leg Length, Body Proportion, and Health: A Review with a Note on Beauty.
Bogin, et al.

- A review on human anatomical biology
- Cephalocaudal gradient of growth and development in humans (like most other mammals) means that during prenatal development, the fastest growth occurs at the head.
- 87% newborn's resting metabolic rate (RMR) is allocated to brain growth or function (by 5 yrs changes to 44% then 20-25% as adult)
  - May show why human infants evolutionarily make tradeoffs in resource allocation (nutrients, etc) towards brain growth at the expense of other body parts
- The legs, especially the tibia, are growing faster relative to other body segments from birth to age 7 years

Cephalocaudal development





Climate relationships hypothesis

- Closely related mammalian species, such as bears, have greater mass in colder climates; as well as shorter limbs and tails in colder climates and longer in warmer climates (volume:surface area => heat loss)

- Different populations have distinct body proportions ranging from relatively long legs in Australian Aborigines (SHR = 47.3 men/ 48.1 women) to relatively short legs in Guatemalan Mayans (SHR = 54.6/ 55.8)

    - Estimated the contribution of geographic origin to the variance in the SHR to be 0.04

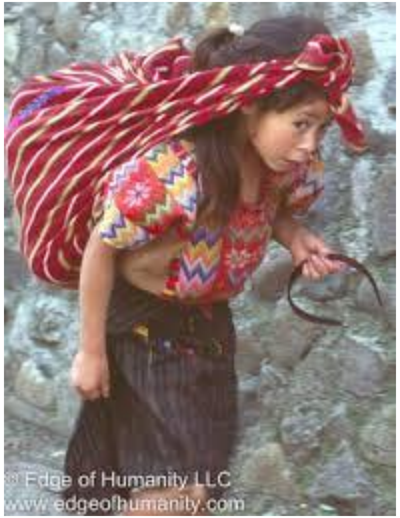
Influence of nutrition & lifestyle

- Also have to acknowledge nutrition can moderate the climate influence (i.e. modifications of diet and lifestyle, by introduction of western foods and behaviors)

- Guatemala Maya only consume on average 80% of total energy needed for optimal growth and an estimated 20% are also chronically iodine deficient

    - Iodine deficiency during infancy and childhood results in reduced leg length, especially the distal femur, the tibia and the foot

- Furthermore, the lifestyle of Guatemala Maya children and adults involving heavy labor, diverts energy from diet away from growth



Developmental plasticity

- Concept that the development of the phenotype of an organism is responsive to variations in the quality and quantity of environmental factors required for life
  - Those body parts growing fastest (leg length) will be most affected by a shortage of nutrients, infections, etc.
- Study found that Maya-American children were currently 11.54 cm taller and 6.83 cm longer-legged, on average, than Maya children living in Guatemala. The values indicate that about 60% of the increase in stature is due to longer legs.
  - Although Mayans in America tend to occupy lower SES and work physically demanding jobs, <u>they do have access to safe drinking water, copious food availability, public education, accessible healthcare, and relative safety</u>

Longitudinal Change in Height of Men and Women: Implications for Interpretation of the Body Mass Index: The Baltimore Longitudinal Study of Aging

John D. Sorkin, et al.

- Looked at 2,084 men and women aged 17-94 years enrolled from 1958 to 1993 in the Baltimore Longitudinal Study of Aging

- On average, men's height was measured nine times during 15 years and women's height five times during 9 years.

- Found that between 20-70 yrs of age there is an average accumulative loss of 3cm and 5cm for men and women respectively which accelerates after 80 to 5cm and 8cm.

Effect on BMI

- This degree of height loss would account for an **artificial increase in BMI** of approximately 0.7 kg/m2 for men and 1.6 kg/m2 for women by age 70 years that increases to 1.4 and 2.6 kg/m2, respectively, by age 80 years.

- True height loss with aging must be taken into account when height (or indexes based on height) is used in physiologic or clinical studies.

External validity?!

- “BLSA subjects generally are well educated, middle to upper-middle class, community dwelling, and in good health” (only 6% minority subjects)

- In poorer, less nourished populations where manual labor is very common, one might hypothesize <u>even more of a decrease in height and therefore more overestimation of BMI</u>

A comparison of three methods for estimating height in the acutely ill elderly population
M. Hickson, et al.

- Examined 3 surrogate methods to estimate height including half arm-span, demi-span and knee height
- 484 in-hospital patients in the United Kingdom over age of 65 (median age of 82)
- Half arm-span was simply doubled
- Demispan derived from a group of 35 y/o males and 34 y/o females when height would be expected to be at it’s maximum in life
- Knee height derived from elderly’s current height (60-80y/o)

Findings

- The correlation coefficients were high for all three estimates of height with the highest being for knee height,
    - r = 0.86 for demi-span, 0.87 for arm-span and 0.89 for knee height, and all were highly significant with $P < 0.0001$.

- However, the authors argued that this is a misleading interpretation of the accuracy of the height measurements as correlation demonstrates the linear association between two measurements, but perfect correlation may occur if the points lie along any straight line.

- They decided to use Bland & Altman agreement analysis which is recommended for comparing two different methods for measuring the same parameter, and shows how closely the two methods agree.

- Agreement is assessed by plotting the difference between the two measurements (in this case, standing height minus height calculated from a surrogate measure), against the mean of the two measurements, for each individual.

Implications

- The Bland-Altman analysis showed poor agreement between all three estimates of height, with very wide limits of agreement (the closest agreements were with the knee-height)

- Additionally demi-span and arm-span overestimate current height on average by approximately 4 and 7 cm, respectively, <u>which isn't surprising as they are designed to measure maximum height</u> (*with arm span overestimating height by as much as 17.55 cm*)

- Whereas knee measurement was much closer to actual height with a mean difference of -0.6cm (also not surprising as it was designed to measure existing height)

- Results indicate that one should be aware of what is being estimated and whether maximal or current height is required when deciding which method to use to estimate height

Intra/Interrater Reliability of Measurements On Body Posture Photographs

A J J . Zonnenberg, et al.

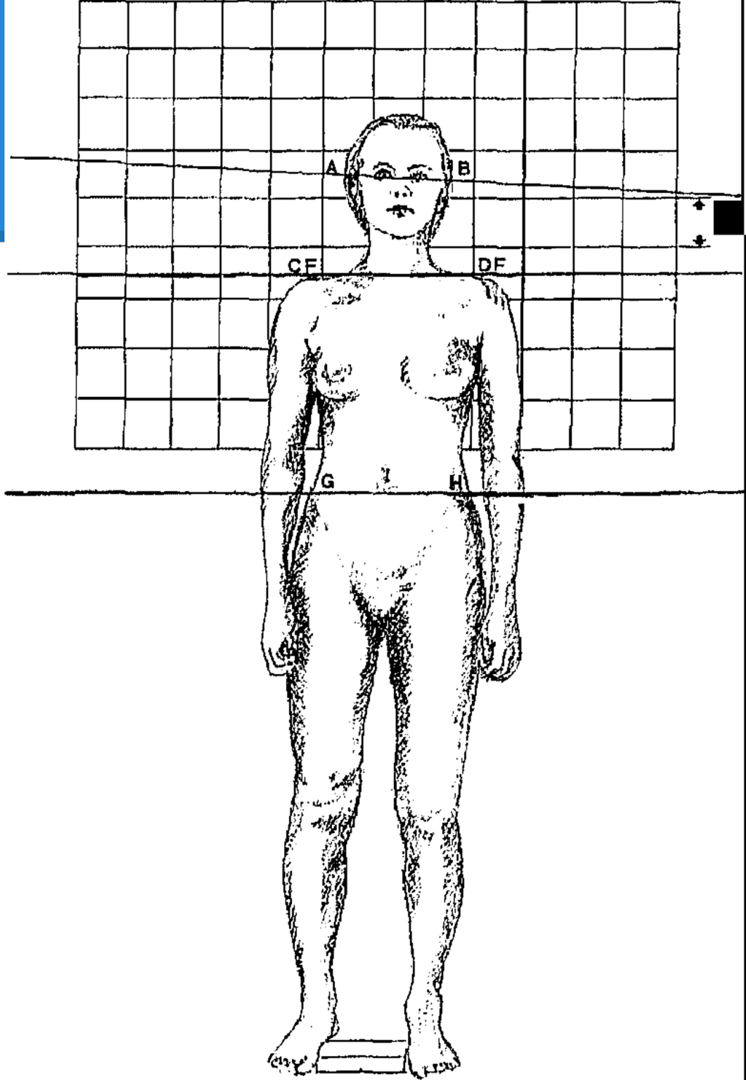
- Aimed to look at Intra/interrater's reliability of photographically measuring individuals based on ten anatomical landmarks using frontal and dorsal body posture photographs

- 18 subjects were photographed and measurements were conducted by two testers with an interval of seven days between each session.

- The repeated measurements of each examiner (intrarater) and the first and second measurement of both examiners (interrater) were assessed for reliability.

Findings

- Intraclass correlation coefficients (ICC) and Pearson Product-Moment correlation coefficients were used to assess reliability
- They found agreement in the number of observations with very few flaws in the intra-/interrater procedure
- Concluded that the use of body posture photographs as a measuring instrument for assessment of postural alignment is a reliable one



Waist circumference as a measure for indicating need for weight Management

Lean et al.

- Aim was to test the hypothesis that a single measurement, waist circumference (WC), might be used to identify people at health risk both from being overweight and from having a central fat distribution.
- Included 904 men and 1014 women in North Glasgow, aged 25 to 74 years
- Used widely accepted BMI action levels (≥25) and (≥30) as well as Waist:hip ratio (WHR) cutoffs of 0.95 for men and 0.8 for women (on the basis of consensus from previous studies)

Findings

- Calculated action levels regarding health risk::

- <u>Action level 1</u> (Waist circumference ≥ 94 cm for men and ≥ 80 cm for women) where individuals should refrain from gaining any more weight

- <u>Action level 2</u> (Waist circumference ≥ 102 cm for men and ≥ 88 cm for women) where individuals should lose weight

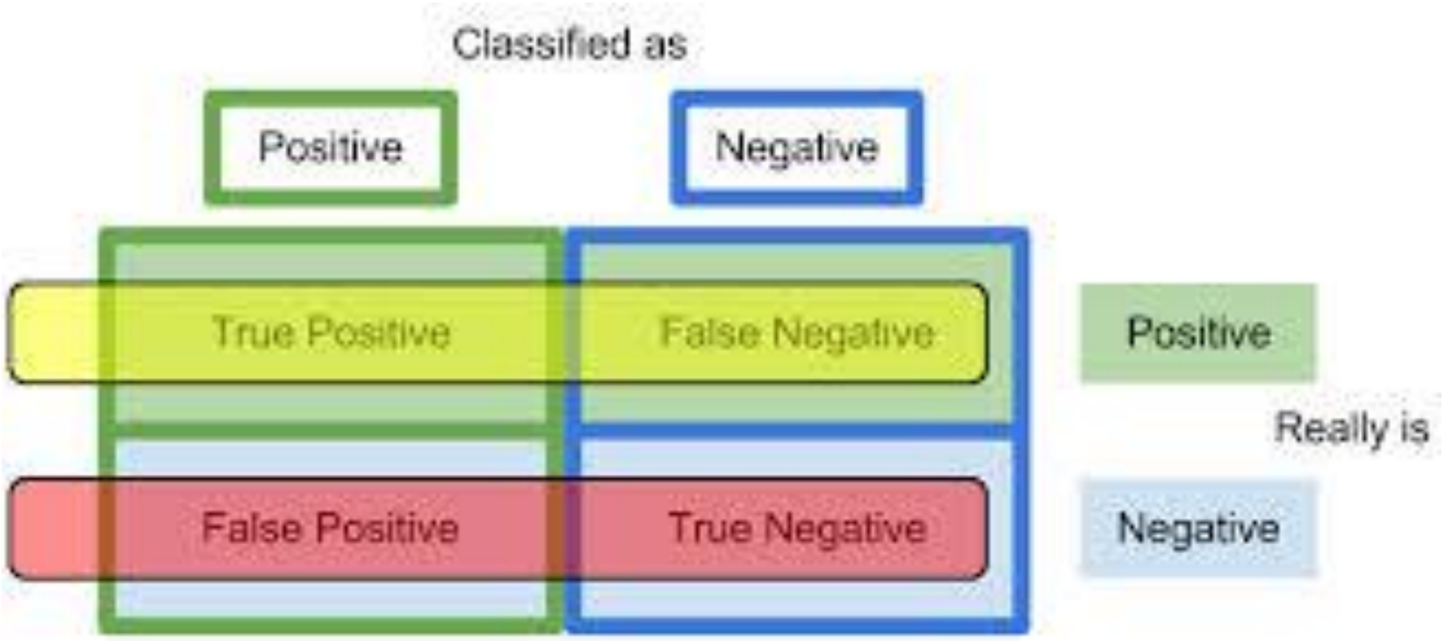
- In action level 1: sensitivity of > 96% and specificity >97 5% and action level 2: sensitivity of > 96% and specificity > 98%

    - Very good results!!!

Interesting point of contention

- Matrix to calculate Sensitivity and Specificity:
    - **"True positive" subjects were those with high BMI and those with lower BMI but high WHR**
    - **"True negative" subjects were those with low BMI and those with high BMI but low WHR**
    - "False positive" subjects were those with WC above the action level but with low BMI and WHR
    - "False negative" subjects were those with WC below the action level but with high BMI and WHR
- True positive and True negative are the same, and only labeled as such "post-hoc" after the test has been completed and WC had been been determined!!!

Sensitivity & Specificity



Varying Sensitivity of Waist Action Levels to Identify Subjects with Overweight or Obesity in 19 Populations of the WHO MONICA Project.

Molarius et al.

- They were skeptical of the techniques resulting in such high sensitivity and specificity of Lean et al’s study
- The second MONICA survey from 1987 to 1992 involved collaborating centers in 26 different countries totaling 32,978 subjects aged 25–64 years
- Calculated sensitivity/specitivity using same action levels and WHR cutoffs as Lean et al

Findings

- Waist action level 1: sensitivity varied between 40% and 80% in men and between 51% and 86% in women. Specificity was high (90%) in all populations.

- Waist action level 2, sensitivity varied from 22% to 64% in men and from 26% to 67% in women, whereas specificity was 95% in all populations.

- Based on the proposed waist action levels, very few people would unnecessarily be advised to have weight management, but a fairly large group of people in need of weight management would be missed if WC were adopted as a lone screening tool.

- Use with care...

Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis

M. Ashwell, et al.

- Systematic review of 31 papers (2 from south america) including a total of total of 123,231 men and 182,620 women

- Aim was to differentiate the screening potential of waist-to-height ratio (WHtR) and waist circumference (WC) for adult cardiometabolic risk in people of different nationalities and to compare both with body mass index (BMI)

- Looked at hypertension, type-2 diabetes, dyslipidemia, metabolic syndrome and general cardiovascular outcomes (CVD)

Findings

- Compared with BMI, WC improved discrimination of adverse outcomes by 3% ($P < 0.05$) and WHtR improved discrimination by 4–5% over BMI ($P < 0.01$).

- WHtR was found to be significantly better than WC for everything in both genders except for MS in men ($p=.6$).

- Most authors that suggested a proposed boundary value (the first cut-off level indicating risk) for WHtR was 0.5

- All in all it was found that WHtR>WC>BMI at indicating adverse cardiometabolic outcomes

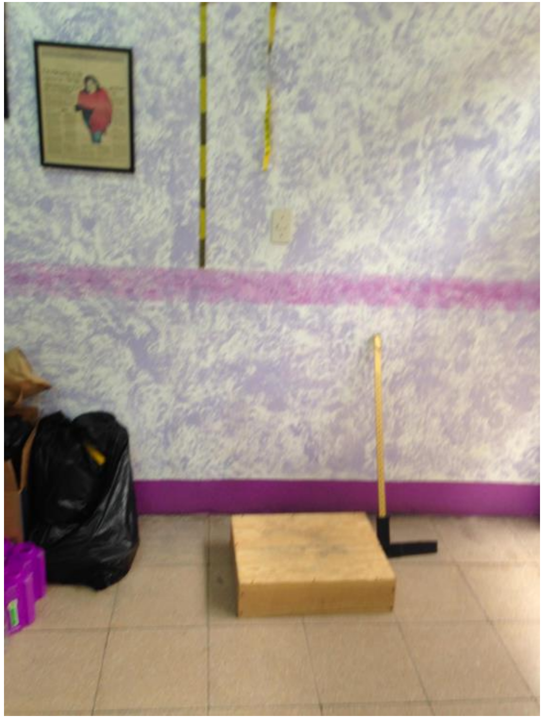
Field Work: Steps

- **Recruitment**: done by Marta prior to our arrival and during our stay.
  - Community Centers, Asilos, Health Clinics
- **Preparation**: Praticing the measurements, creating the ideal step-by-step work flow, and organizing our data collection processes
- **Data Collection:** Conducted at each site with all of those who showed up
- **Early analysis**: for BMI and Waist Circumference
- **Returning Results and references:** for BMI and Waist Circumference

Field Work: Measurements

1. Knee-Height
2. Weight
3. Armspan
4. Standing Height
5. Photographs (sagittal view)
    a. Measurements to be made after photo development
6. Waist Circumference

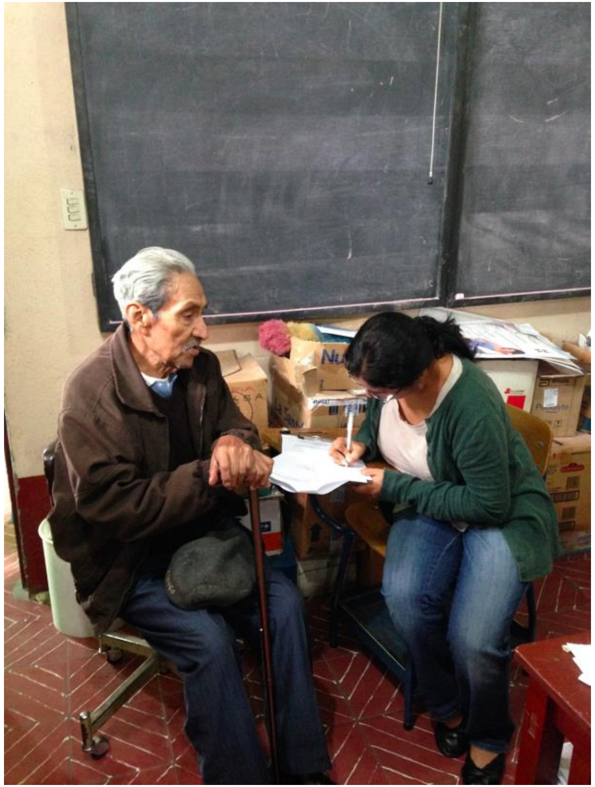
Field Work: Practicing measurements



Field Work: Procedure

Introduction: Marta (or Rosario/Alejandra) explains study procedure to participants

Field Work: Procedure



Consent: Eligible participants are consented to study. Inclusion criteria:

- Older than age 60
- Guatemalan living in Quetzaltenango

Field Work: Procedure

Participant orientation: Consented participants are asked to sit and remove the following:

- Shoes
- Sweater
- Jacket
- Belt
- Gorbacha
- Other accessories

Field Work: Procedure

Knee Height: Measured on the right leg with the thigh/leg and leg/foot at 90 degrees.

- Specialized Knee-Height was utilized
- Measured to the nearest tenth of a centimeter

Field Work: Procedure

Weight: Measured to the nearest tenth kilogram.

- Corrected for clothing in analysis

Field Work: Procedure

Armspan: Measured by both Brian and Jenny. Participant’s arms in plane of chest for measurement.

- Specialized meter stick was utilized
- Measured to the nearest tenth of a centimeter

Field Work: Procedure

Pictures: Jenny tagged the iliac crest, Brian then took 3 pictures of the participant.

- 2 from Sagittal view, during which participant instructed to gaze in the Frankfort Plane
- 1 from the front, for the participant

Field Work: Procedure

Standing Height: Measured against the wall.

- Participant instructed to put their heels together and against the wall
- Measured with Carpenter's Square tool to the nearest tenth of a centimeter

Field Work: Procedure

Waist Circumference: Measured at the “clinical waist,” halfway between iliac crest and lowest rib

- Measured using a flexible meter tape in a private area of the data collection site.
- Women instructed to remove faja
- Participants instructed to lift shirt/dress and lower pants/skirt

Field Work: Procedure

Returning Results: After preliminary analysis to calculate BMI, we returned results and photos to participants.

- **Obese Participants** and Participants with a **Level 3 Waist Circumference** were provided with a reference to a nutrionist at the Health Clinic

Field Work: Our sites

Site	Location	Date	Males	Females	Total
A	Asilo (Zona 10)	12/06/15	0	14	14
B	Zona 3	13/06/15	2	15	17
C	Zona 1 (Dia del Padre)	19/06/15	13	5	18
D	Zona 8 (Col El Bombero)	20/06/15	1	6	7
E	Asilo	24/06/15	7	0	7
F	La Casa de Mi Amigo	06/07/15	6	8	14
G	Asilo de Indigentes	07/07/15	5	1	6
H	Zona 9 (Clinica Salud)	08/07/15; 15/07/15	6	10	16
I	Zona 3 (Clinica Salud)	09/07/15	7	6	13
J	Zona 5	10/07/15	5	7	12
Total			**52**	**72**	**124**

Analysis: Height and BMI

- Height: 3 measurements
  - Standing height: directly from standing height measurement
  - Armspan height: directly from armspan measurement
  - Height from Knee-Height: Calculated
    - adjusted height in cm (males)=69.11+(1.86*knee height cm)-(0.03*age)
    - adjusted height in cm (females)=72.08+(1.84*knee height cm)-(0.131*age)

- BMI: 3 measurements
  - Calculated for all study participants from all heights
  - BMI = kg/(height in m)^2
  - BMI Categories: underweight, normal weight, overweight, obese

Analysis: Waist Circumference

- Measured at Clinical Waist
- Waist Circumference Categories (Lean, et al)
  - **Level 0:**
    - Males: less than 94cm
    - Females: less than 80cm
  - **Level 1:**
    - Males: between 94cm and 102cm
    - Females: between 80cm and 88cm
  - **Level 2:**
    - Males: greater than 102cm
    - Females: greater than 88cm
- Waist to Height Ratio

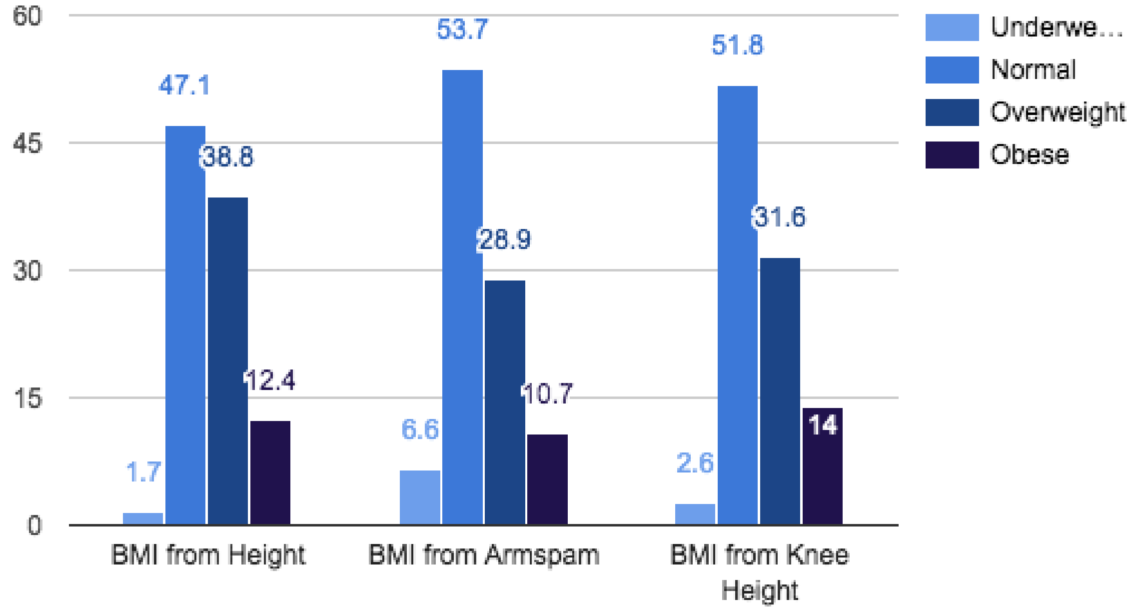
Analysis: Stunting

- Photographic Measurements
  - Total Height: from heel to top of head
  - Leg Length: from iliac crest (tape) to heel
  - Trunk length: calculated (total height - leg length)
  - Trunk/leg ratio: calculated (trunk length/leg length)
  - Examine relationship between Trunk/leg ratio and stunting
- Inter-rater reliability
  - Pearson’s Correlation used to measure reliability between 2 and 3 raters

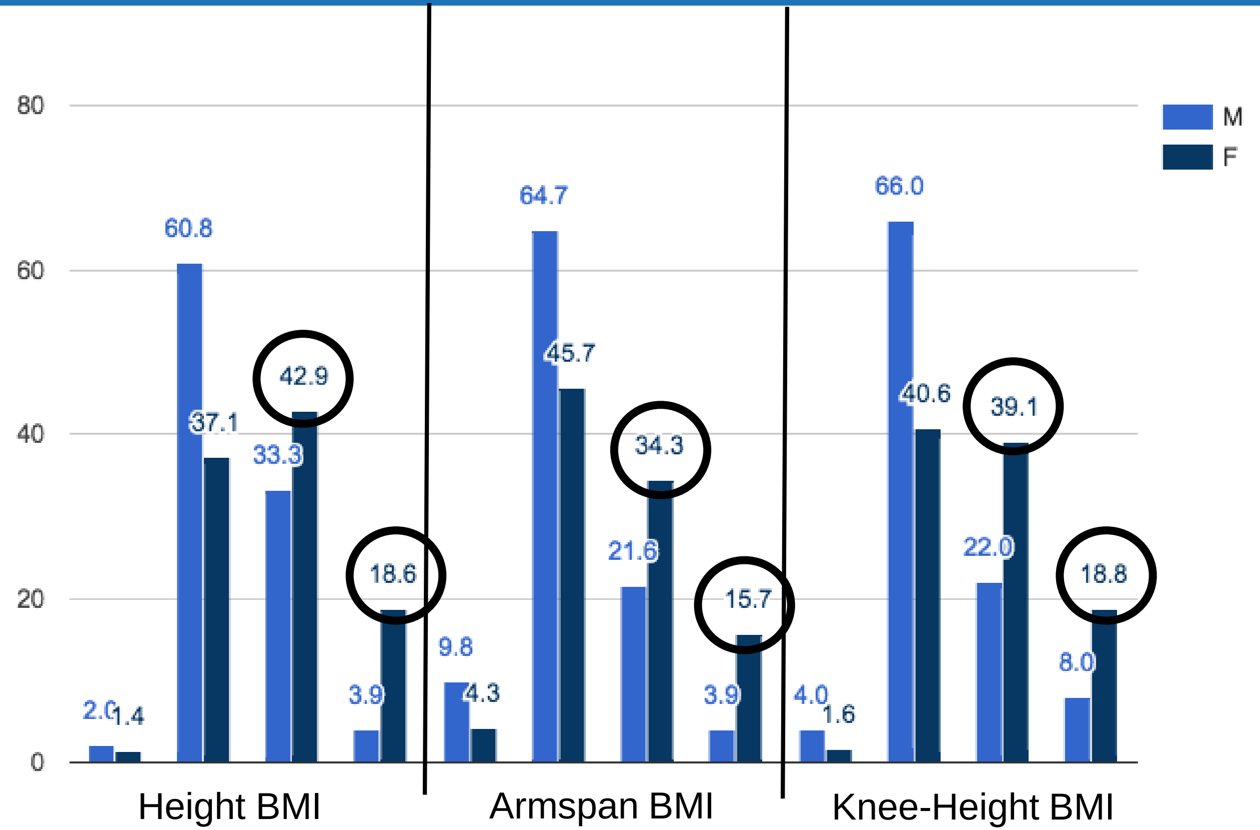
Anthropometric Measurements

Variable	Males(N=50) Mean±SD	Females (N=64) Mean±SD	p-value
Height (cm)	156.33±6.55	143.99±6.43	<.001
Armspan (cm)	159.88±8.14	146.31±7.60	<.001
Knee Height (cm)	48.70±2.30	44.40±2.10	<.001
Height from Knee Height (cm)	157.37±4.33	144.40±4.20	<.001
Weight (kg)	**58.37±10.72**	**55.17±13.15**	0.165
BMI from Height (kg/m²)	23.79±3.51	26.43±5.01	<.005
BMI from Armspan (kg/m²)	22.78±3.50	25.67±5.08	<.001
BMI from Knee Height (kg/m²)	23.48±3.66	26.29±5.24	<.005
Waist Circumference (cm)	**90.10±9.40**	**91.38±12.11**	0.529

BMI Category by Measurement



BMI Category by Measurement

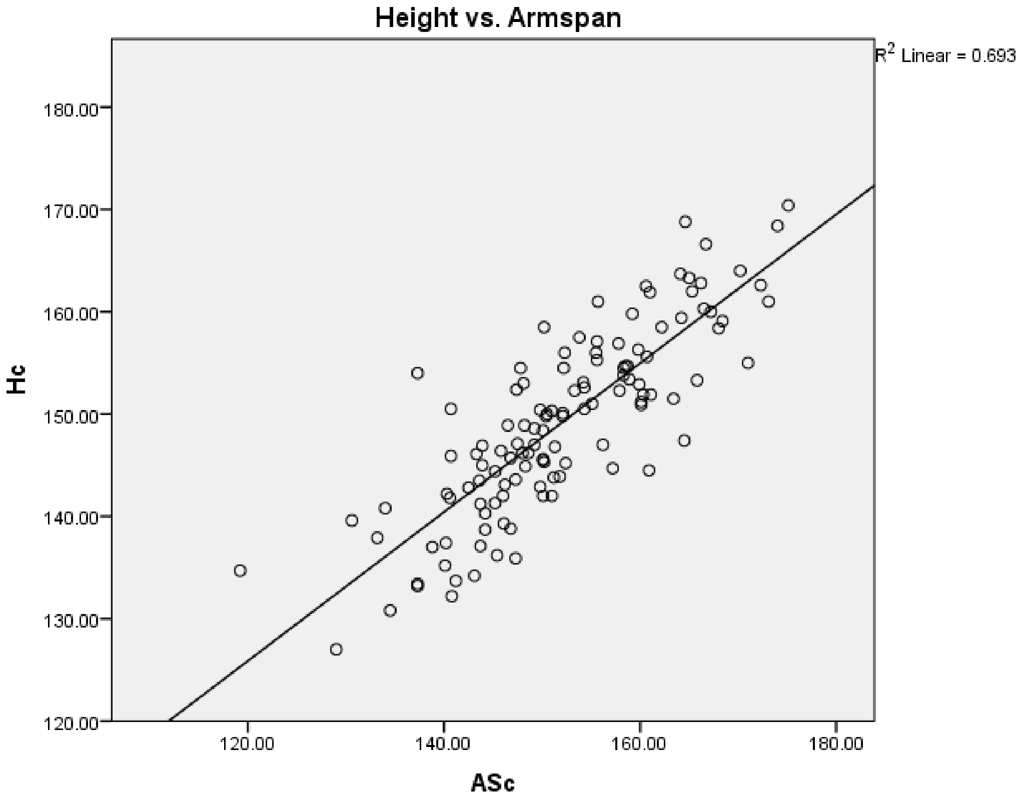


Height and BMI: Correlations

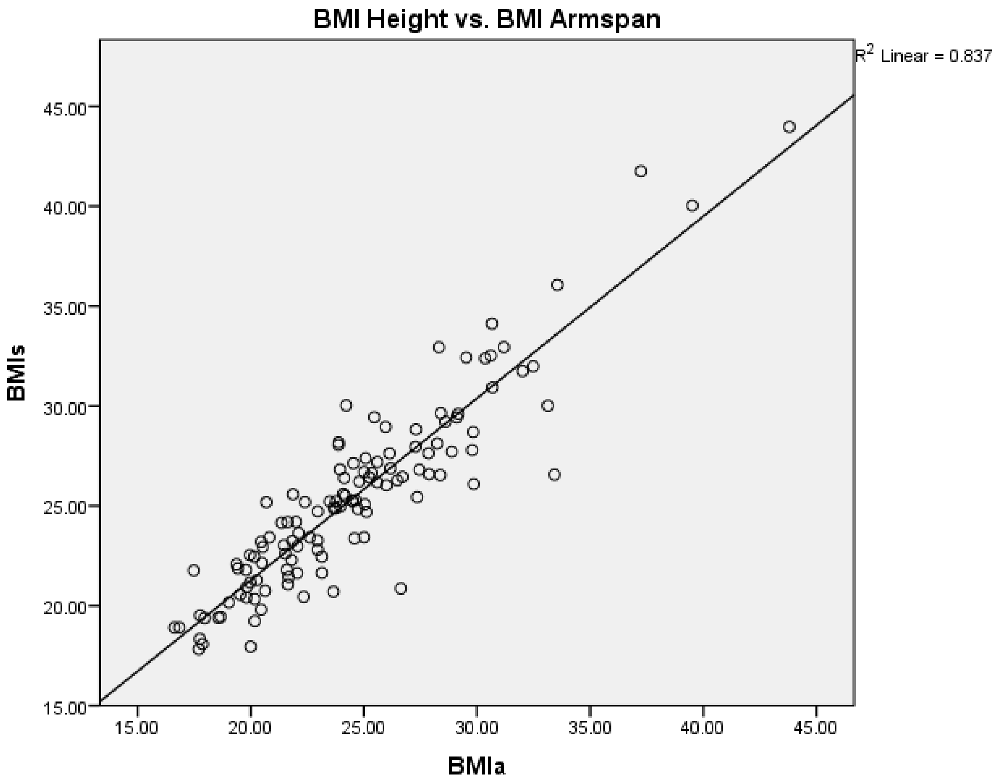
Variables	r	p-value
Height to Armspan	0.832	p<.001
Height to Knee-Height	0.898	p<.001
Armspan to Knee-Height	0.846	p<.001
BMI Height to BMI Armspan	0.915	p<.001
BMI Height to BMI Knee-Height	0.960	p<.001
BMI Armspan to BMI Knee-Height	0.918	p<.001

*Pearson Correlation used

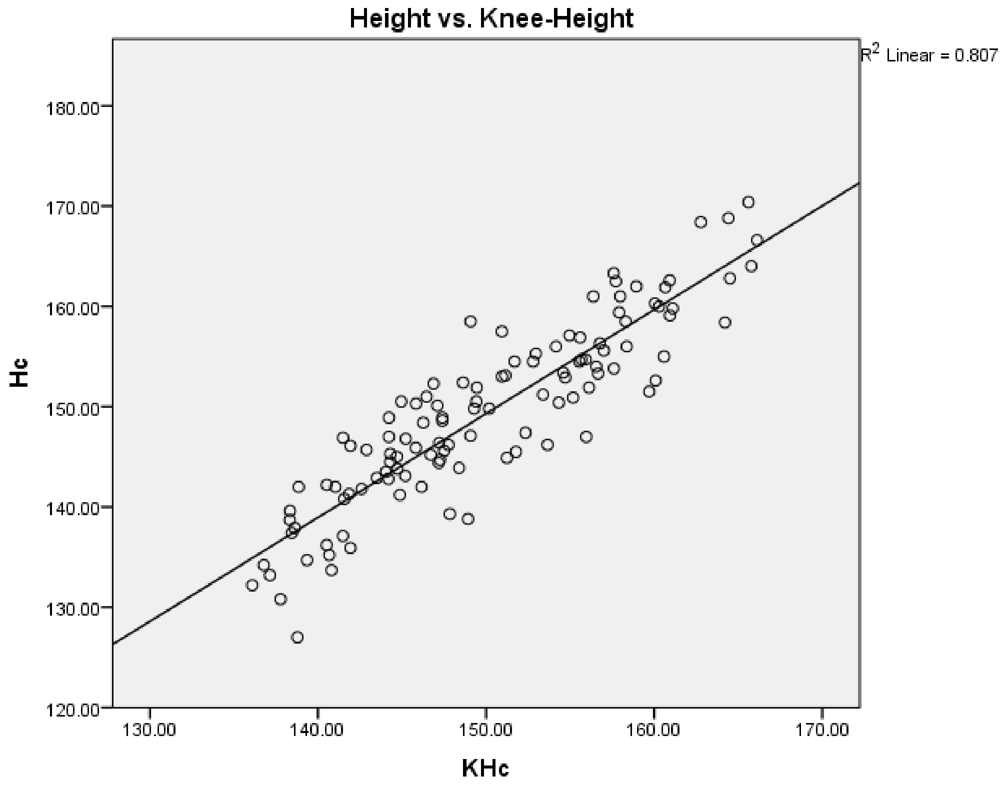
Height vs. Armspan



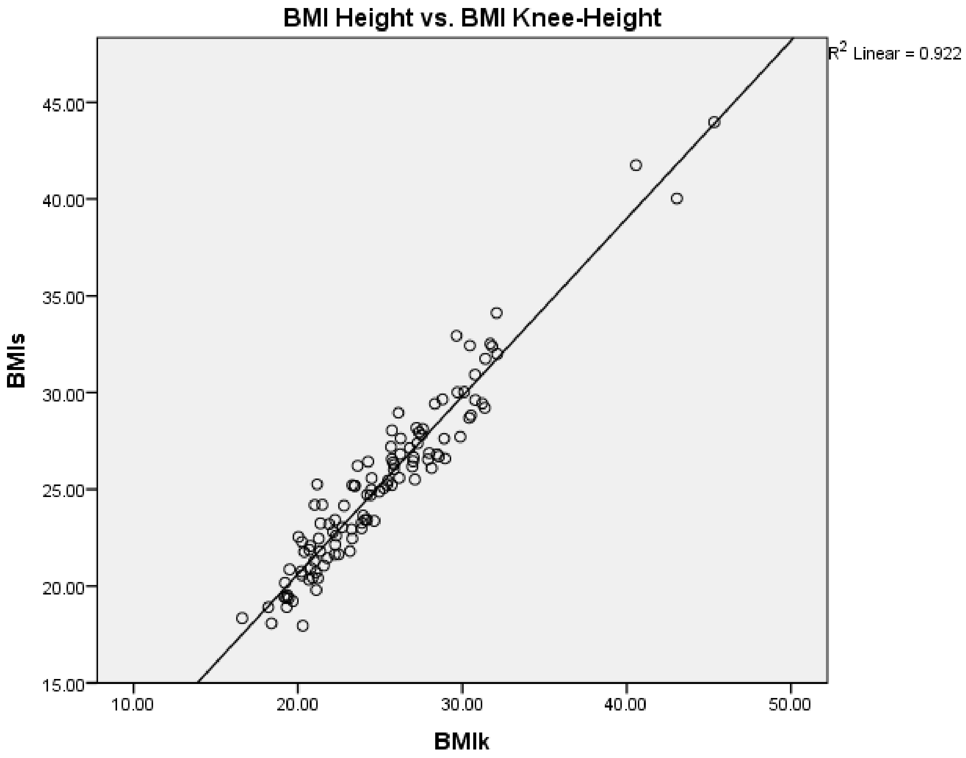
BMI using Height vs. BMI using Armspan



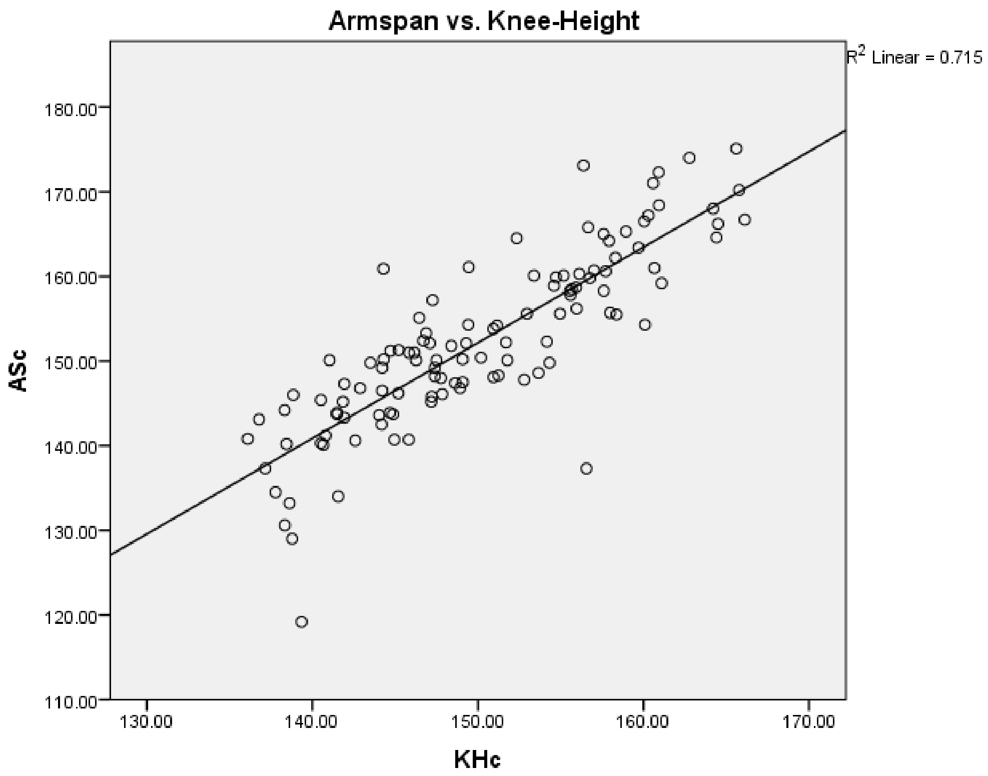
Height vs. Knee-Height



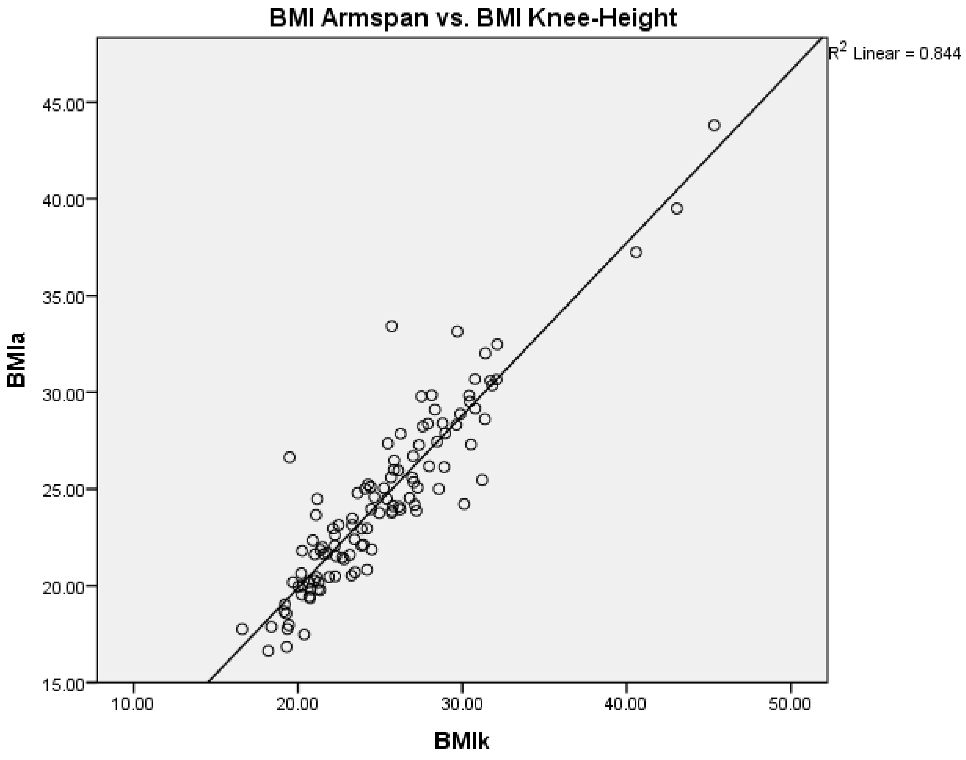
BMI using Height vs. BMI using Knee-Height



Armspan vs. Knee-Height



BMI using Armspan vs. BMI using Knee-Height



Sensitivity and Specificity

		BMI from Standing Height	
		Normal/Underweight	**Overweight/Obese**
BMI from Armspan	***Normal/Underweight***	56	17
	Overweight/Obese	3	45

Sensitivity = 72.6%; Specificity = 95.0%

		BMI from Standing Height	
		Normal/Underweight	**Overweight/Obese**
BMI from Knee-height	***Normal/Underweight***	55	7
	Overweight/Obese	0	52

Sensitivity = 88.1%; Specificity = 100%

Waist Circumference Risk Levels

	Waist Circumference (%)	
	M	**F**
Level 0	**68.6**	12.9
Level 1	17.6	31.4
Level 2	13.7	**55.7**

Level 0: Less than 94cm for Males; Less than 80cm for Females

Level 1: Between 94cm and 102cm for Males; Between 80cm and 88cm for Females

Level 2: Greater than 102cm for Males; Greater than 88cm for Females

Waist Circumference and BMI: Females

	Normal (n)	Overweight (n)	Obese (n)
Level 2	5	21	13
Level 1	15	7	0
Level 0	7	2	0

Percent Concordant = 27/70 = **38.57%**

Waist Circumference and BMI: Males

	Normal (n)	Overweight (n)	Obese (n)
Level 2	0	5	2
Level 1	1	8	0
Level 0	31	4	0

Percent Concordant = 41/51 = **80.39%**

Waist to Height Ratio

Variable	Males(N=50) Mean±SD	Females (N=64) Mean±SD	p-value
Waist:Height Ratio	**.57**±.06	**.64**±.08	<.001

	Frequency (n=121)	Percent (%)
WHtR below .50	8	6.6
WHtR .50 or above	113	**93.4**

Recall: The cutoff for risk is 0.5*

*Remember: this cutoff is not as widely accepted as BMI but a proposed point by the existing literature

Stunting

Female stunting: Height of less than 145cm
Male stunting: Height of less than 150cm

	Stunting Frequency	
	M (n=51)	F (n=70)
Not Stunted	44	33
Stunted	7	37

52.8% of females are stunted; 13.7% of males

Stunting

Variable	**Males(N=50)** Mean±SD	**Females (N=64)** Mean±SD	p-value
Torso:leg ratio	.63±.11	.62±.08	.865

Variable	**Stunted(N=7)** Mean±SD	**Non-stunted (N=44)** Mean±SD	p-value
***Males* Torso:leg ratio**	.61±.06	.61±.10	.998
***Females* Torso:leg ratio**	**.64±.06**	**.59±.05**	**.002**

Photographic Analysis: Inter-rater Reliability (Spring 2015)

	Rater 1 vs Rater 2		Rater 1 vs Rater 3		Rater 2 vs Rater 3	
	r	**p value**	**r**	**p value**	**r**	**p value**
Total Length	0.910	<.001	0.903	<.001	0.995	<.001
Leg length	0.945	<.001	0.943	<.001	0.989	<.001
Trunk:Leg ratio	0.829	<.001	0.711	<.001	0.852	<.001

*Pearson Correlation used

Photographic Analysis: Inter-rater Reliability (Summer 2015)

	Rater 1 vs Rater 2	
	r	**p value**
Total Length	0.999	<.001
Leg length	1.000	<.001
Trunk:Leg ratio	0.983	<.001

*Pearson Correlation used

Conclusions: BMI

- BMI from standing height, armspan, and knee-height are all significantly correlated with each other
    - BMI from Standing Height and BMI from Knee-Height were similar in this sample (males had a difference of .3; females .15)
- Female mean BMI was 3kg/m^2 greater than male mean BMI for all 3 measurements
- BMI from knee height is 88.1% sensitive and 100% specific
- BMI from armspan is 72.6% sensitive and 95.0% specific

Conclusions: Waist Circumference

- The majority of females (55.7%) are in Level 2; the majority of males (68.6%) are Level 0
- Females have a BMI-Waist Circumference concordance of 38.57%
- Males have a BMI-Waist Circumference concordance of 80.39%
- Both males and females have a mean WHtR greater than 0.5

Conclusions: Stunting

- 52.8% of females are stunted; 13.7% of males
- The measurements of all 3 raters (from Gabi’s photos) were significantly correlated
    - However, we are concerned about differences in the measurement methods used among these raters
- The measurements of the 2 raters (from our photos) were significantly correlated
- Stunted women had significantly greater torso:leg ratio than non-stunted women; there was no difference in men

Lessons Learned

- Recruitment
  - Many sites estimated a higher number of participants. Are there ways to get more people to come on the day of?
  - Good turn out during community party for El Dia de Padre. Should recruitment efforts focus on events such as these?
- Returning results
  - Not many participants come back for results. Is there a way to better coordinate this?
- Measurements: Difficult to find line to measure top of head because of hair
  - Use of a swim cap to reduce hair volume?

Next Steps

- Get a third rater for photographic measurements for this sample
- Do a Bland-Altman agreement analysis to determine level of agreement between measurements and height
- Consider our lessons learned for future studies
  - For photographic measurements procedures, give highly specific methods to follow
- More research regarding the validity of these measurements at indicating health risk factors
- Efforts to improve nutritional access at some of the sites we visited (CeSSIAM office in Xela)

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THANK YOU CeSSIAM!!!

Questions?