VALIDITY OF RANDOM UPPER ARM CIRCUMFERENCE FOR SCREENING WASTING AMONG UNDER FIVE CHILDREN IN HADERO TUNTO ZURIA WOREDA, KEMBATA TEMBARO ZONE, SOUTHERN ETHIOPIA,2019.

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THESIS SUBMITTED TO JIMMA UNIERSITY, INSTITUTEOF HEALTH, FACULTY OF PUBLIC HEALTH, DEPARTMENT NUTRITION AND DIETETICS IN PARTIAL FULFILLMENT FOR THE REQUIREMENT FOR MASTERS OF SCIENCE IN HUMAN NUTRITION

June, 2019 G.C
JIMMA, ETHIOPIA

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ABSTRACT

Background: Undernutrition is widely recognized as a major health problem in developing countries. For practical purposes, anthropometric measurements are the most useful tool for assessing the nutritional status of children. Random upper arm circumference has been proposed as an alternative to mid upper arm circumference as a measurement of wasting because of its ease of performance particularly for rapid field assessments of nutritional status in circumstances where resources and trained personnel were limited. Although mid upper arm circumference (MUAC) has been widely used for screening wasting, finding the mid-point is a cumbersome procedure that needs intensive training and educated and skilled personnel. To identify these cases early, simple and valid tool is needed. No research was done to validate whether random upper arm circumference(RUAC) measurement is a useful tool for rapid screening of children as compared to mid upper arm circumference measurement.

Objective: The objective of this study was to validate random upper arm circumference against mid-upper arm circumference in screening wasting among under-five children.

Methods and Materials: A community based cross sectional study was conducted from March 1st to 15, 2019 in Hadero Tunto Zuria woreda, Southern Ethiopia, among in a total of 412 under-five children. Study participants were selected using systematic sampling technique. Interviewer-administered questionnaire was used to collect the data and a tape meter was used for anthropometric measurement. The data were analyzed using SPSS windows version 20. Receiver operating characteristic curve analysis was used to calculate sensitivity and specificity of random upper arm circumference and mid upper arm circumference. Pearson Correlation coefficient(r) was used to evaluate the correlation between random upper arm circumference and mid upper arm circumference. Kappa coefficient statistic (K) and Bland-Altman plot was used to compare the agreement between random upper arm circumference versus mid upper arm circumference. Multivariable Linear regression model was used to generate coefficients of RUAC in predicting MUAC. A *p*-value of < 0.05 was considered statistically significant.

Results and discussion: The sensitivity of RUAC in detecting wasting was found to be around 89% in our study whereas the specificity was 94.8%, the positive predictive value and negative predictive value was 68% and 98.6% respectively. Area under the curve in this study using receiver operating characteristic curve analysis was high (0.919[95% CI: 0.864, 0.973]). The agreement of the two measurements by using the Kappa coefficient was substantial (K=0.739) agreement for moderate wasting. The correlation between random upper arm circumference and mid upper arm circumference in this study was strong (r=0.972).Bland-Altman plot also showed strong agreement between the two measurements.

Conclusion and recommendation: RUAC has excellent sensitivity and specificity compared to MUAC. The findings imply that random upper arm circumference could be used for screening wasting among 6-59 month aged children as it identifies more children with wasting.

Keywords: Random upper arm circumference, mid-upper arm circumference, severe acute malnutrition, wasting, validity, Kembata Tembaro, Southern Ethiopia.

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ACRONYMS AND ABBREVIATIONS

CBN	Community Based Nutrition
CHWs	Community Health Workers
CHIS	Community Health Information System
CI	Confidence Interval
CMAM	Community based Management of Acute Malnutrition
CTC	Community based -Therapeutic Care
EDHS	Ethiopian Demographic and Health Survey
FMOH	Federal Ministry of Health
GAM	Global Acute Malnutrition
GMP	Growth monitoring and promotion
HAD	Health Development Army
HEP	Health Extension Programme
HEWS	Health Extension Workers
IMNCI	Integrated management of neonatal and childhood illness
IYCF	Infant and young child feeding
IRB	Institutional Review Board
IQ	Intellectual quotient
MAM	Moderate Acute Malnutrition
MUAC	Mid-Upper Arm circumference
NCHS	National Centre for Health Statistics
OTP	Outpatient therapeutic programme
PPS	Population proportion to size
ROC	Receiver Operating Characteristic Curve
RUAC	Random Upper Arm circumference
SAM	Severe Acute Malnutrition
SC	Stabilization Center
SNNPR	Southern Nation Nationalities People Region
SPSS	Statistical Package for Social Science
SRS	Systematic Random Sampling
WFH	Weight for Height
WHO	World Health Organization

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Chapter 1. Introduction

1.1 Back ground

Undernutrition is a broad umbrella term associated with multiple conditions. According to the United Nations these are: Stunting, Wasting and underweight [1]. It is caused by long-term and short term insufficient nutrient intake and frequent infections. Wasting and stunting are mostly prevalent in developing countries [1].

Anthropometry refers to measurement of body size and proportions. Anthropometric indices compare a child's size to mean values using standard deviations or Z-score [2].

Mid-upper arm circumference (MUAC) and Weight-for-height Z-score (WHZ) are two independent anthropometric indicators for diagnosing and admitting children with severe acute malnutrition (SAM) for treatment. While severely wasted children are at high risk of mortality, MUAC and WHZ do not always identify the same population of children as having SAM. In this regard MUAC is better. MUAC < 115 mm and WHZ < -3 were used to define severe wasting as per the World Health Organization (WHO) classification [3].

Both MUAC and WHZ measurements show an indirect reflection of fat and lean muscle catabolism that was obvious in SAM and are therefore the anthropometric measurements of choice in assessing the magnitude of malnutrition [4]. However, WHZ requires the measuring of weight and height, as well as a reference table, while using MUAC requires only the use of a tape measure with a fixed cut off [5]. MUAC is regarded as a useful screening tool in community interventions and a better predictor of mortality in children [6]. MUAC and WHZ z-scores have been shown to identify different child populations with SAM, with only a small level of overlap [7].

1.2 Statement of the problem

Nutrition transition being experienced in low and middle-income countries (LMICs) undergoing rapid economic transition and urbanization is a major driving force behind the increase in levels of obesity in LMICs, despite persistence of undernutrition [8, 9].Currently the world suffering from double burden of malnutrition. Fifty (50) million children were affected by wasting. Forty two (42) million children under the age of five were overweight or obese but 156 million were affected by stunting [10].

Globally 6.3 million children under five years of age die every year. Nearly half of these deaths are attributable to undernutrition [11].The consequences of undernutrition among children are delay in physical growth, lower intellectual quotient (IQ), greater behavioral problems, and deficiency in social skills and susceptibility to contracting diseases [12, 13]. These negative outcomes of undernutrition is more in MAM cases than SAM [14] because they did not get considerations. Undernutrition is still a major health problem in developing countries and particularly in sub-Saharan Africa. Undernutrition includes stunting, wasting and underweight [15]. An estimated 160 million children are affected by stunting in Africa, particularly in West, Central and Eastern Africa [16, 17].

Ethiopia is one of East African countries and according to the 2016 EDHS, 38 percent of children are stunted and 23 percent of children are underweight 10 percent are wasted. In SNNPRG stunting, wasting & underweight were 38.6%, 6% and 21.1% respectively. The health system applied various intervention activities like growth monitoring and promotion (GMP), community based nutrition (CBN), promoting exclusive breast feeding and infant and young child feeding (IYCF) practices and integrated management of neonatal and childhood illness(IMNCI) through health extension program(HEP) to minimize this alarming number of wasting, stunting and underweight. But the prevalence is still high and currently used anthropometric measurements or index need intensive training, skilled man-power, reference table, measuring board and weighing scale, exposed to measurement errors. Especially in the study woreda, there is year round admission of cases on OTP and SC in health facilities. The woreda is one of the hot spot woreda for undernutrition in the region and additionally the prevalence of wasting is not known in the woreda. So to early identify these cases, simple and valid tool is needed. No research was done to close this

gap in the woreda. The utilization of simple, valid anthropometric measurement is essential to minimize morbidity and mortality related to wasting. In this regard MUAC better identify stunted and younger children compared to WFH [18-20]. Studies showed that in Ethiopia from 1973 SAM subjects WHZ and MUAC identified 43.4% and 41 % respectively [21]. This study shows that there is slight difference in identifying cases. Also studies show that, MUAC has a better sensitivity and specificity than WFH [22] but the validity of RUAC is unknown. Therefore, the reasons for promoting RUAC against MUAC is that, it easy to use in the community [23]**,** it minimizes the waiting time of the mothers or care takers at screening site, does not need mid-point between acromion and olecranon, one can screen many children in short period of time, not need much training and can be done by CHWs /HDA leaders. To identify the discrepancies and promote RUAC as the best anthropometric measurement, researches are not done in Ethiopia and on selected district for this study.

The aim of this study is to compare the validity of RUAC against MUAC in screening wasting among under-five children in Hadero Tunto Zuria woreda.

1.3 Significance of the study

Although acute malnutrition (wasting) has not declined for the last 20 years, there is no any study that came up with a simple and effective tool for assessing wasting among under five children at the community level. Development of a simple and a fast tool will facilitate early detection and referral of children with wasting even by mothers or care takers themselves.

The findings of the study will influence the development of valid, simple and easy anthropometric measurement. May serve as a baseline for farther study as a reference. As the results of this study simple indices will be designed with the view of reduction on morbidity and mortality related to wasting in under-five children. By providing empirical evidence the result of this study will also contribute to the growing body of knowledge about new indices to screen wasting in under-five children. Finally, the findings from current study will facilitate shifting of the task of screening children to community level actors (health development army or even mothers themselves) which is expected to enhance coverage and early referral children with wasting at community level.

Chapter 2. Literature review

Acute malnutrition (SAM) contributes to almost three-fifths of (87,500) of under-five global deaths each year [24].If identified and properly managed, it is possible to prevent these deaths [25]. Previously, the World Health Organization (WHO) guideline for SAM management was restricted to inpatient management of SAM [26].

Currently, the recommended standard management for all children with SAM is Community Management of Severe Acute Malnutrition (CMAM) [27, 28].To prevents this morbidity and mortality the best anthropometric index and measurements for early screening should be suited.

MUAC in contrast to WHZ is a simple and low-cost method [27] that can be applied easily by one person after minimum training and is less susceptible to measurement error than WHZ [29]. This problem was solved by also introducing MUAC as an alternative criterion for both referral and admission to OTP [30, 31]. A longitudinal study in Senegal shows the relationship between anthropometry MUAC identifies high-risk children better than WHZ. They concluded that to identify high-risk malnourished children, there is no benefit in using both WHZ and MUAC, and that using MUAC alone is preferable [31].

The use of MUAC for screening and admission can also be defended by its greater ability to predict the risk of mortality than WHZ [32-34]. Current guidelines recommend the use of MUAC < 115 mm or WHZ < - 3 independently for the identification of severe wasting in children aged 6–59 months [7, 35].

The study from five surveys in Cambodia, in children under 5 years, the sensitivity of MUAC ranged from 6.5% to 32.9% in children with acute malnutrition. Sensitivity of the new WHO 2013 cut-offs is higher for acute malnutrition than for severe acute malnutrition [36].

A systematic review study shows in Belgium, MUAC-based and WHZ-based malnutrition diagnosis correlates poorly, a puzzling observation for two indicators of severe wasting [37].

Another study reported that among 34,937 children between the ages of 6 and 59 months, from 39 nutritional surveys, 75% of the children with a WHZ <- 3 SD was not identified by a MUAC <115 mm [38].

A systematic review of evidence reported that, MUAC could be used adequately as a stand-alone criterion for admitting to and discharging from nutritional rehabilitation SAM children [39].

Anonymous data collected from 1832 anthropometric surveys from 47 different countries had measured children aged from 6 to 59 months and at least 75 malnourished subjects screened[20]. They concluded that MUAC was less sensitive than WFH**.**

A cross-sectional weighted survey of households in South Africa shows, of the 572 child participants, 38 children (6.6%) using MUAC were malnourished in comparison to 44 were malnourished (7.7%) using W/H measurements [40].

The descriptive cross-sectional study in Nigeria shows, the sensitivity of MUAC using weight for height as gold standard is 20%, and the specificity is 95.3%. A receiver operating curve was plotted to determine the optimal cut off and sensitivity and specificity for the MUAC was found to be a sensitivity of 80% and specificity of 53.5% [41].

A population based survey was conducted in Wolayita zone showed; the two indicators of SAM classified children as severely wasted in a significantly different way. MUAC categorized more children as severely wasted (1.6% vs. 1.0%) compared with WHZ. MUAC categorized a larger proportion of girls as severely wasted compared with WHZ [3].

The secondary analysis in Cambodian children showed, that there is no benefit of using WHZ in addition to MUAC as specificity of MUAC is higher than WHZ to predict subsequent death [42].

In the above studies, the validity of MUAC was well known against WFH index but still the validity of RUAC was not known. So that, the current study aimed to assess validity of RUAC against MUAC to promote best suited simple anthropometric measurement to identify children with wasting.

Chapter 3. Objective

3.1 General objective

To determine the validity of RUAC in screening wasting among 6-59 months age of children in Hadero Tunto Zuria woreda, Kembata Tembaro Zone, South Ethiopia,2019.

3.2 Specific objective

To compare the validity of RUAC against MUAC in screening wasting among 6-59 months age of children in Hadero Tunto Zuria woreda, Kembata Tembaro Zone, South Ethiopia,2019.

Chapter 4. Methods and materials

4.1 Study area and period

Hadero Tunto Zuria Woreda is one of the seven districts in Kembata Tembaro Zone, which is found in Southern Natation's Nationalities and People Regional Government. It is one of the woredas in which a total of 107,644 populations lived (Based on 2015 census estimation).Of the total population, 52,746 males and 54,898 were female population. Its main town is Hadero. There are a total of 15,358 under-five children (6-59 months of age) in the woreda. It is far from Addis Ababa, Hawassa and Durame 342km, 165 kms, and 40 kms, respectively. It is bordered: by North Hadiya Zone, West Tembaro District, North East Kacha-bira District, and South East Wolaita Zone. In Hadero Tunto Zuria Woreda there are 13 rural and 2 semi-urban kebeles; three health centers, twenty health posts, and seven private health facilities are found. The overall potential health coverage of the district is 80%. The woreda is one of the hot spot woreda for undernutrition in region. The study period was from March 1st to 15, 2019.

4.2 Study design

Community based cross-sectional study was conducted to determine and compare the validity of RUAC against MUAC in screening wasting among 6-59 months age children.

4.3 Population

4.3.1 Source population

All under-five children aged 6-59 months in Hadero Tunto Zuria Woreda (district).

4.3.2 Study population

All sampled children 6-59 months of age in the selected kebeles of Hadero Tunto Zuria Woreda.

4.3.3 Study unit

Individual child in the household who fulfill the eligibility criteria from whom data was collected.

4.4 Inclusion and exclusion criteria

4.4.1 Inclusion criteria

Children and infants without congenital malformation of upper limb in selected age group

4.4.2 Exclusion criteria

Children or infants who are seriously ill during data collection.

Children with skin infection of the upper limb like scabies, dermatitis, and ulcer.

Children or infants with bilateral pitting oedema.

4.5 Sample size determination and sampling technique

4.5.1 Sample size

Sample size was calculated using sensitivity estimation formula [43] taking prevalence of wasting 37% by MUAC<125 mm among under-five children in SNNPR [21] margin of error of 5%, a confidence level of 95% and an anticipated sensitivity (SN) of 90%.

$$n = \frac{(Z\acute{\alpha}/2)^2 \, SN \, (1-SN)}{d^2 \, (p)}$$

$$n = \frac{(1.96)^2 \, 0.9(0.1)}{(0.05)^2(0.37)}$$

$$n = 373.7 \sim \underline{374}$$

Where;
n= sample size
Zά/2= confidence level (95%)
SN= anticipated sensitivity (90%)
1-Sn = specificity
d=margin of error (5%)
p= prevalence from previous studies (37%)
The final sample was **412** by adding 5% non-respondent rate.

4.5.2 Sampling Technique

From fifteen kebeles in the Woreda, 30 % of the kebele was selected by using lottery method and four kebeles was selected one from semi-urban and three from rural kebeles namely, Lesho Town, Mendoye, second Tunto and Ajora. Then the number of study participants were allocated for each Kebele by proportional allocation of sample size. Community based demographic and health related information from family folder of community health information system (CHIS) in the health post updated by health extension workers used as a sampling frame. A systematic sampling method was employed to select the required households. To select individual households K-value was determined (interval). So, k=N/n » 2921/412 = 8. The starting household was randomly selected from 1-8 by using lottery method. Number three was selected. Data were collected from every 8^{th} household starting from third house. This procedure was applied for all selected kebeles. If there were more than one child in the house, one child selected by lottery method.

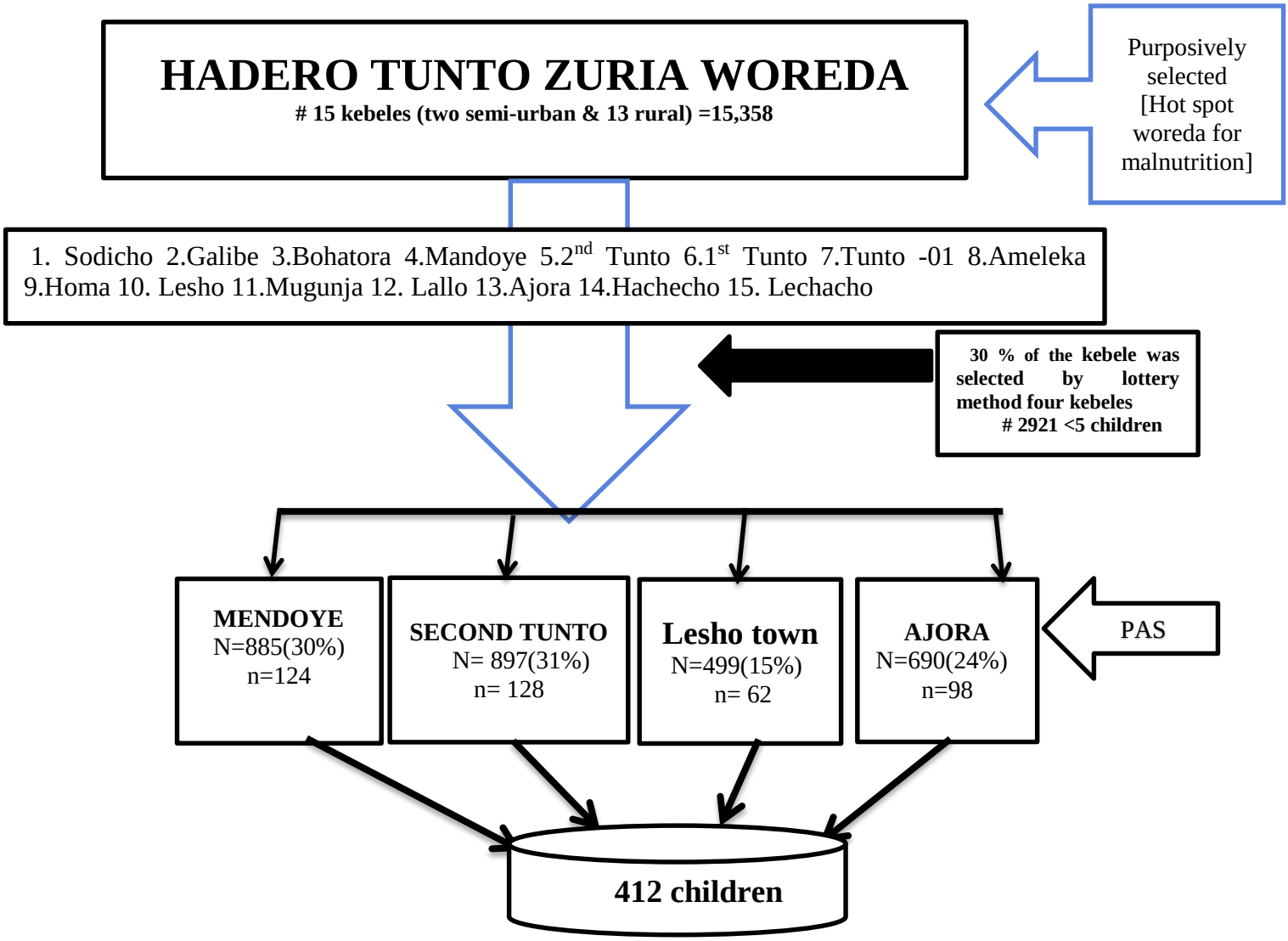

Figure 1: schematic presentation of sampling procedure

4.6 Study variables

Validity of random upper arm circumference against mid upper arm circumference in screening wasting among 6-59 months age children.

4.7 Operational and standard definitions

Wasting - reflects impaired weight gain in reference to an individual's height [1] or Mid Upper Arm Circumference (MUAC) of < 12.5 cm in children age 6–59 months [7].

Mid upper arm circumference (MUAC) - measurement of left upper arm circumference at the mid-point between acromion and olecranon process [7].

Sensitivity-defined as the percentage of true positive for wasting that was identified when the MUAC/RUAC below the given threshold.

Specificity - defined as the percentage of true negative for wasting that was defined when the MUAC/RUAC above the given threshold using ROC curve.

Random upper arm circumference (RUAC)-measurement of left upper arm circumference without searching by the guess of the eye between acromion and olecranon process [7].

Severe acute malnutrition (SAM): SAM is defined as a WHZ < -3 SD or Mid Upper Arm Circumference (MUAC) of < 11.5 cm in children age 6–59 months [7].

Undernutrition -is the result of inadequate intake of food in terms of either quantity or quality, poor utilization of nutrients due to infections or other illnesses and it manifests itself through wasting, stunting and micronutrient deficiencies[53].

4.8 Data collection tool and procedures

Interviewer administered questionnaire was used and English version first translated in to Amharic by reviewing different literatures and consulting the experts and data such as sex, age, RUAC and MUAC of each child was collected. WHO-recommended non -stretchable color banded MUAC tape was used to measure MUAC and RUAC. The child's left arm was flexed to 90 degrees at the elbow. The midpoint of the arm (between the lateral acromion and distal olecranon process) was identified and marked. The arm then hanging freely by the side with elbow extended and palm towards the thigh, and the tape encircled around the arm at the marked midpoint, so that it lay flat around the arm without compressing the skin or underlying tissue. The procedure to measure RUAC was telling the purpose of measurement for the parents or caregivers, let the child's left arm hang freely by side, take the measurement between elbow and tip of shoulder by the guess of eye without searching for mid-point. When the child's hand was naturally left handed, the right hand of the child was measured.Then the measurement was taken and recorded to the nearest 0.1 cm. Interviewers were trained in RUAC and MUAC measurement techniques. Socio-demographic factors of the family were collected. Age was determined (calculated in the nearest months) by asking of both the child's age by referring major events like public holidays Meskel, Christmas and Easter and date of birth by using immunization cards. The data were collected by the three trained diploma nurses and one supervisor was recruited for supervision.

4.9 Data quality management

The data quality was ensured during data collection, entry and analysis. One day intensive training was given for the data collectors. Strong supervision was conducted by supervisors on field work during data collection period. The principal investigator checked and reviewed all the completed questionnaires to ensure completeness and consistency of collected information on daily base. RUAC and MUAC were taken by using the WHO-recommended non -stretchable color banded tape. The data collectors were took RUAC first then MUAC followed. Pre-test was done on 5 % of sample size in Kachebira woreda.

4.10 Data analysis procedure

Data was entered in to Epidata software version 3.1 and exported and analyzed by using SPSS version-20. Pearson Correlation coefficient(r) was used to evaluate the correlation between RUAC and MUAC. Kappa coefficient statistic (K) and Bland-Altman plot analysis were used to compare the agreement between RUAC versus MUAC. Multivariable linear regression model was done to predict MUAC using RUAC, age and sex. A *p*-value of < 0.05 was considered statistically significant.

4.11 **Ethical consideration**

Ethical approval letter for the study was sought from the Institutional Review Board of the Jimma University. The letter was brought to the Hadero Tunto Zuria woreda Health office. Written informed consent was obtained from the mothers who could read in Amharic and a verbal informed consent in local language for mothers who could not read and write.

Those children identified as SAM in this study were linked to the health posts in order to get therapeutic food according to National SAM guideline protocol and for the family counseling was given on how to feed and care their children.

4.12 Dissemination plan

The findings of this study was disseminated to the Nutrition and Dietetics Department as partial fulfillment of a master's science in human nutrition. Besides this at woreda health sector annual review meeting/ symposium the finding will be discussed for stake holders. Finally attempts will be made for publication in national/regional scientific journals.

Chapter 5. Results

Socio-demographic characteristics of care givers (respondents)

In total, 412 households were interviewed with a response rate of 100%. Of those interviewed care givers, 172 (41.7%) were males, while the mean age of the participants was 30.63 ±5.48 SD. Of the total of 412 households 351(85.2%) were male headed. The majority of the caregivers were married 407(98.8%).With regard to their religion majority of the caregivers (respondents), 360(87.4%) were protestant. Concerning parental educational status 233 (56.6%) and 252 (61.2%) of the fathers and mothers attended primary school respectively. Greater than one-fourth of the respondents were Donga by ethnicity 111(26.9%). The majority of the respondents 169 (41.0%) were housewife (Table-1).

Table 1:Shows Socio-demographic characteristics of care givers among 6-59 months age children in Hadero Tunto Zuria woreda, from March 1st to 15, 2019.

Variables	Characteristics	Response	
		Frequency	Percent
Sex of the caregivers	Male	172	41.7
	Female	240	58.3
Marital status	Married	407	98.8
	Separated	5	1.2
Religion	Protestant	360	87.4
	Others(Orthodox, Catholic, Muslim)	52	12.5
Educational level of Father	Unable to read and write	43	10.4
	read and write	42	10.2
	Primary	233	56.6
	Secondary	64	15.5
	Preparatory	6	1.5
	Diploma and above	24	5.8
Educational level of Mother	Unable to read and write	56	13.6
	read and write	33	8.0
	Primary	252	61.2
	Secondary	52	12.6
	Preparatory, diploma and above	19	4.6
Ethnicity	Kembata	94	22.8
	Donga	111	26.9
	Dawuro	5	1.2
	Hadiya	101	24.5
	Tembaro	33	8.0
	Amhara	25	6.1
	Wolayita	30	7.3
	Others	13	3.2
Occupational status	government employee	18	4.4
	Farmer	99	24.0
	Merchant	110	26.7
	house wife	169	41.0
	daily laborer and student	16	3.9
Respondent's position in the household	Husband	172	41.7
	house wife	240	58.20

Socio-demographic Characteristics of the Children

Concerning sex of study participants 200(48.5%) of the participants were males and regarding the age of the children's most of the children are in the age category of 6-23 month with the mean age of 28.06 months ±13.74 SD (Figure 2).

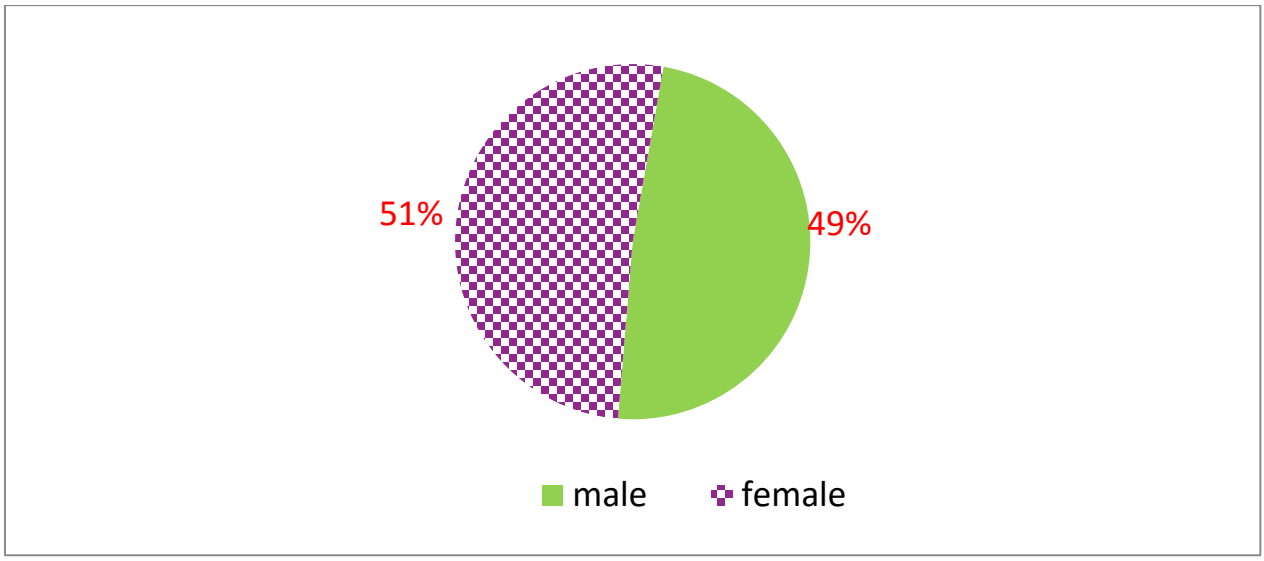

Figure 2: Shows participants' sex category in the study area.

Validity of RUAC against MUAC in screening wasting among 6-59 months age of children

From a total of 412 under-five children , RUAC identified 59(14.3 %) both SAM (RUAC <11.5 cm)and MAM (RUAC>=11.5cm and <12.5cm) whereas MUAC identified 45 (10.9%) as SAM (MUAC <11.5 cm) and MAM(MUAC> = 11.5 and <12.5cm) children and the rest were well-nourished(MUAC >= 12.5 cm). This result shows RUAC better identified wasted children than MUAC (Table 2).

Table 2: Comparison between RUAC and MUAC in wasting case identification in Hadero Tunto zuria woreda, March, 2019

Wasting	RUAC		MUAC	
	Number	%	Number	%
Yes	59	14.3	45	10.9
No	353	85.7	367	89.1
Total	412	100.0	412	100.0

Wasting yes includes both SAM and MAM.

Table 3: Comparison of wasting in under- five children by sex using RUAC and MUAC-WHO cut-off in Hadero Tunto zuria woreda, March, 2019.

Wasting	RUAC			MUAC		
	Females	**Males**	**Total**	**Females**	**Males**	**Total**
Total SAM and MAM	33(8%)	26(6.3%)	59(14.3%)	25(6.1%)	20(4.8%)	45(10.9%)
Total	212	200	412	212	200	412

**For both RUAC and MUAC the cut-off point for SAM was < 11.5cm and for MAM ≥11.5cm and <12.5cm

From the above table we can conclude that more female children were wasted than male counterparts when both RUAC and MUAC used as screening tool in under-five children in the study area.

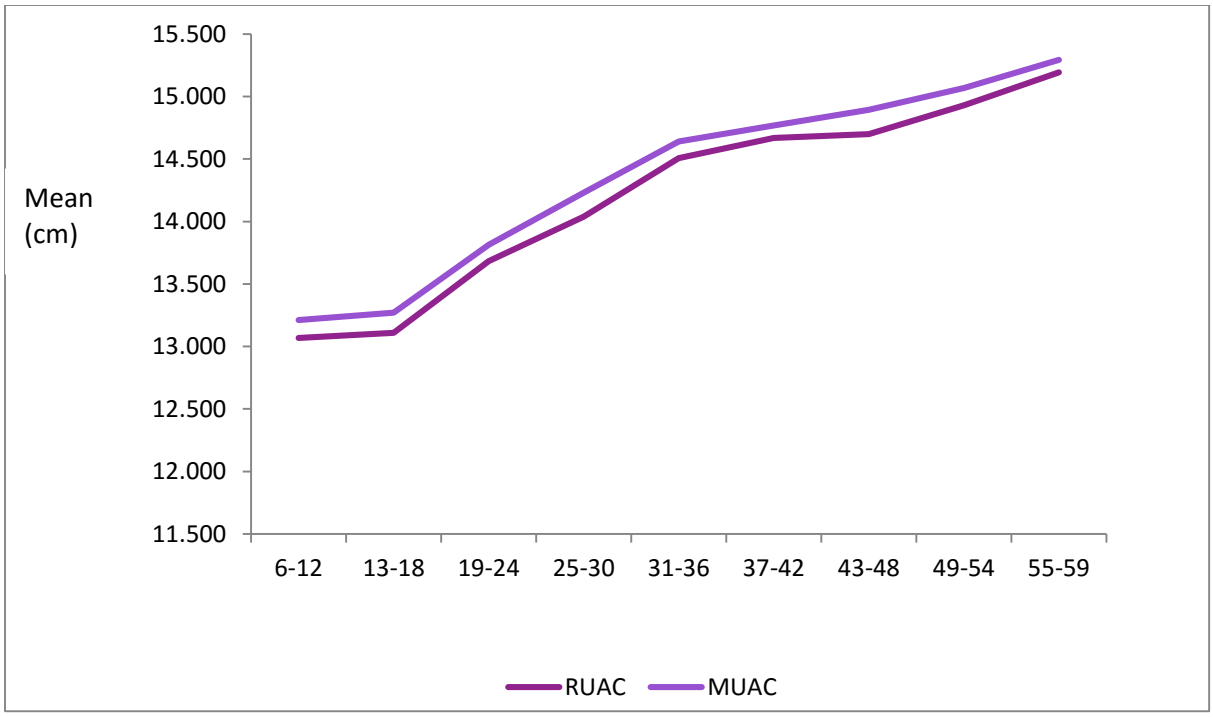

Figure 3: Show MUAC and RUAC have a similar trend of increase with age

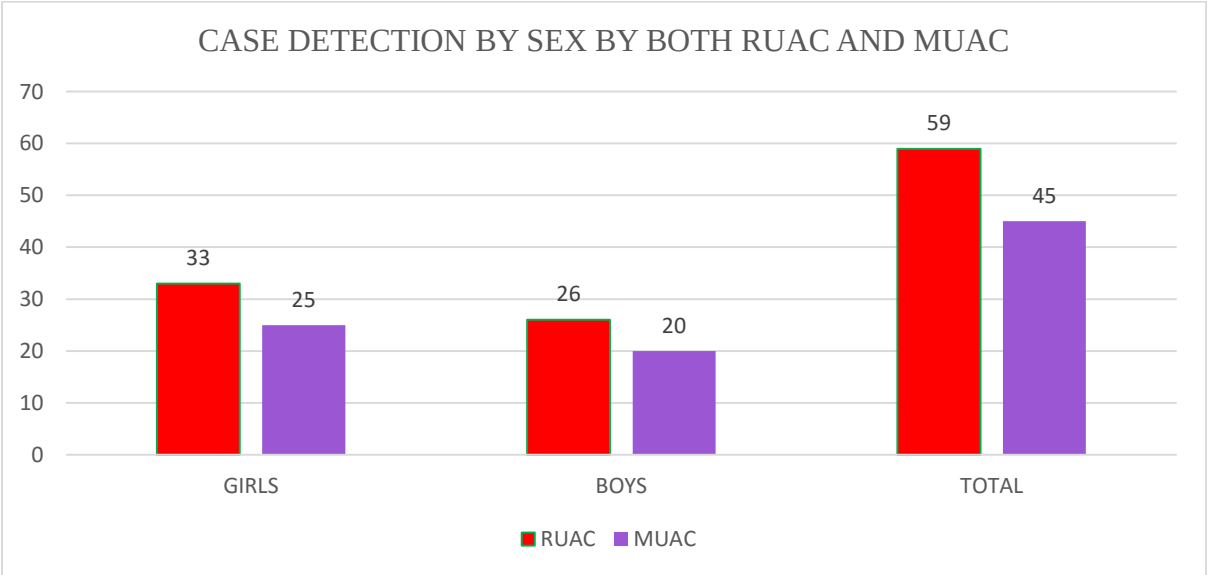

Figure 4: Bar graph shows cumulative number of wasting by sex using both RUAC and MUAC

Area under the curve (AUC) for RUAC in this study was (0. 919[95 % CI: 0.864, 0.973]) which shows that RUAC has better sensitivity 89% and specificity 94.8% compared with MUAC in screening moderate wasting in under-five children as shown below Figure 5.

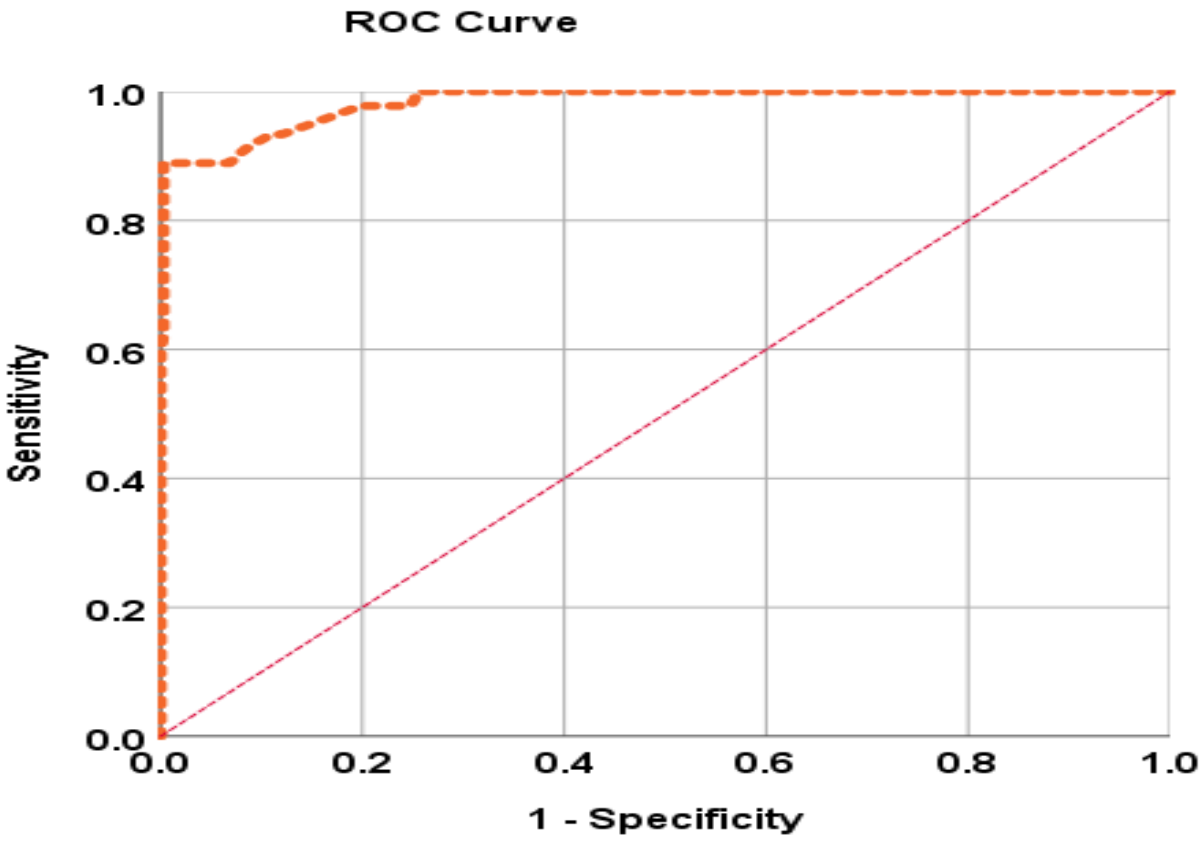

Figure 5: ROC curve shows the AUC for Moderate wasting by using RUAC

As shown in figure 6 and Table 4, the area under the curve for diagnosing severe wasting was 0.917 (95% CI: 0.820, 1.00), showing an excellent performance.

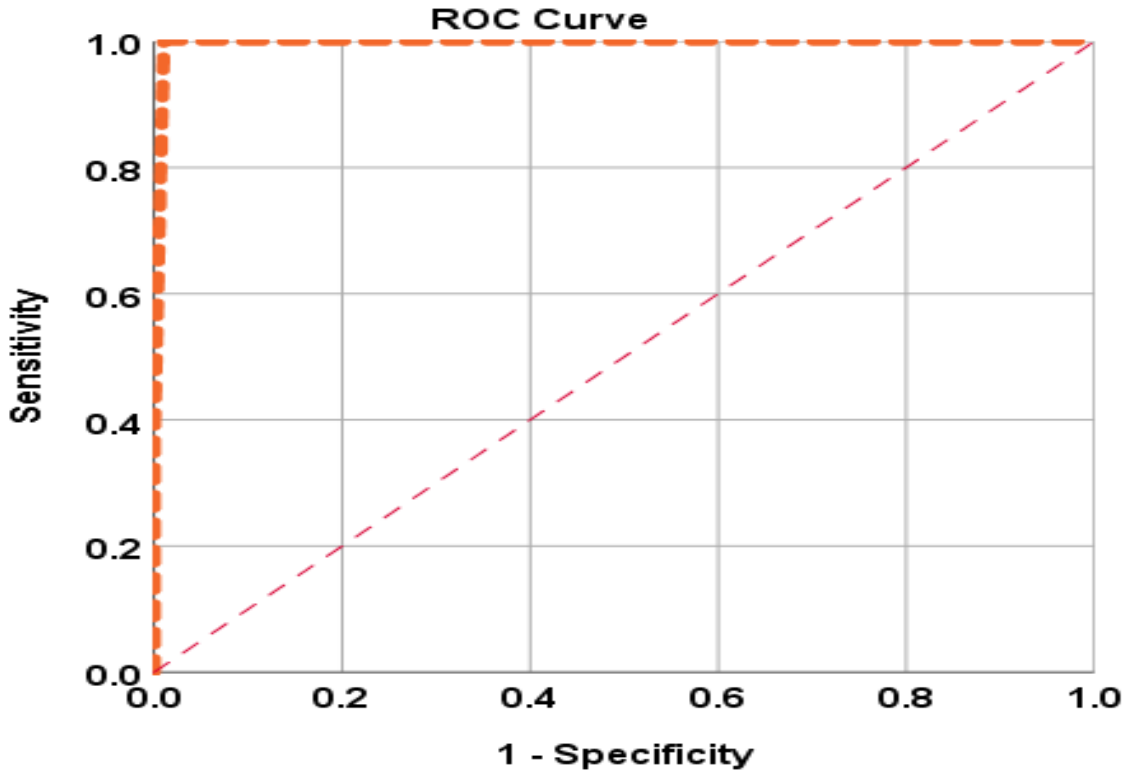

Figure 6: ROC curve shows AUC and severe wasting by using RUAC

Table 4: Area under the Curve (AUC) which shows the sensitivity of RUAC for severe wasting

			95% CI	
Area	Std. Error	P	Lower Bound	Upper Bound
.917	.049	.000	0 .820	1.00

Table 5: Sensitivity and specificity of diagnostic test (RUAC) in screening wasted children in under-five children in Hadero Tunto zuria woreda, March, 2019.

		MUAC wasting		
		SAM and MAM	WELL NOURISHED	TOTAL
RUAC wasting	SAM and MAM	40	19	59
	WELL NOURISHED	5	348	353
TOTAL		45	367	412

*Key:**sensitivity=a/a+c=40/45*100=89%,specificity=d/b+d*100=348/367*100=94.8%,PPV(precision)=a/a+b*100=40/59*100=68%andNPV=d/d+c*100=348/353*100=98.6%prevalence=14.3%,Accuracy=a+d/p+N*100=40+348/14.3+412*100=91%,FPR=b/b+d*100=19/367*100=5.2%,FNR=c/a+c*100=5/45*100=11.1%***

The sensitivity of RUAC in detecting moderate wasting (MAM) was found to be around 89% in my study whereas the specificity was 94.8%, the positive predictive value (PPV) and negative predictive value (NPV) was 68% and 98.6% respectively. The cut-off value for MAM using RUAC in this study was 12.55 cm at the sensitivity of 88.9% and at the specificity of 94.8% (table 6).

The cut-off value for severe wasting (SAM) using RUAC in this study was 11.45 cm at the sensitivity of 84.2 % and specificity of 99.2% (table 7).

Table 6: Sensitivity and specificity of RUAC in diagnosing MAM among under five children in Hadero Tunto Woreda, 2019.

RUAC	Sensitivity	Specificity	Youden index
8.000	0.000	1.000	0.000
10.000	0.022	1.000	0.022
11.050	0.133	1.000	0.133
11.150	0.156	1.000	0.156
11.250	0.244	1.000	0.244
11.350	0.333	1.000	0.333
11.450	0.422	1.000	0.422
11.550	0.511	1.000	0.511
11.650	0.578	1.000	0.578
11.850	0.600	1.000	0.600
12.050	0.622	0.997	0.619
12.150	0.644	0.997	0.642
12.250	0.756	0.997	0.753
12.350	0.844	0.997	0.842
12.450	0.889	0.997	0.886
12.550*	0.889*	0.948*	0.837
12.650	0.889	0.932	0.821
12.750	0.911	0.916	0.827

SPSS output **Cut-off point for MAM using RUAC in current study is 12.55 at the sensitivity of 89% and specificity of 94.8%

Table 7:Cut-off point for severe wasting (SAM) using RUAC in current study

RUAC	Sensitivity	Septicity	Youden Index
8.000	0.000	1.000	0.000
10.000	0.053	1.000	0.053
11.050	0.316	1.000	0.316
11.150	0.368	1.000	0.368
11.250	0.526	0.997	0.524
11.350	0.684	0.995	0.679
11.450*	0.842*	0.992*	0.834
11.550	1.000	0.990	0.990
11.650	1.000	0.982	0.982
11.850	1.000	0.980	0.980
12.050	1.000	0.975	0.975

SPSS output *Cut-off point for SAM using RUAC in current study is 11.45 at the sensitivity of 84.2% and specificity of 99.2%.

Bland-Altman plot showed that the agreement between RUAC and MUAC as shown below in figure-7**,** there was more than 95% agreement between RUAC and MUAC because majority of the measurements fall in between the upper limit (0.77) and lower limit(-0.498) of agreement. The formula used to calculate the upper and lower limit of agreement was SD square and plus or minus mean of both RUAC and MUAC.

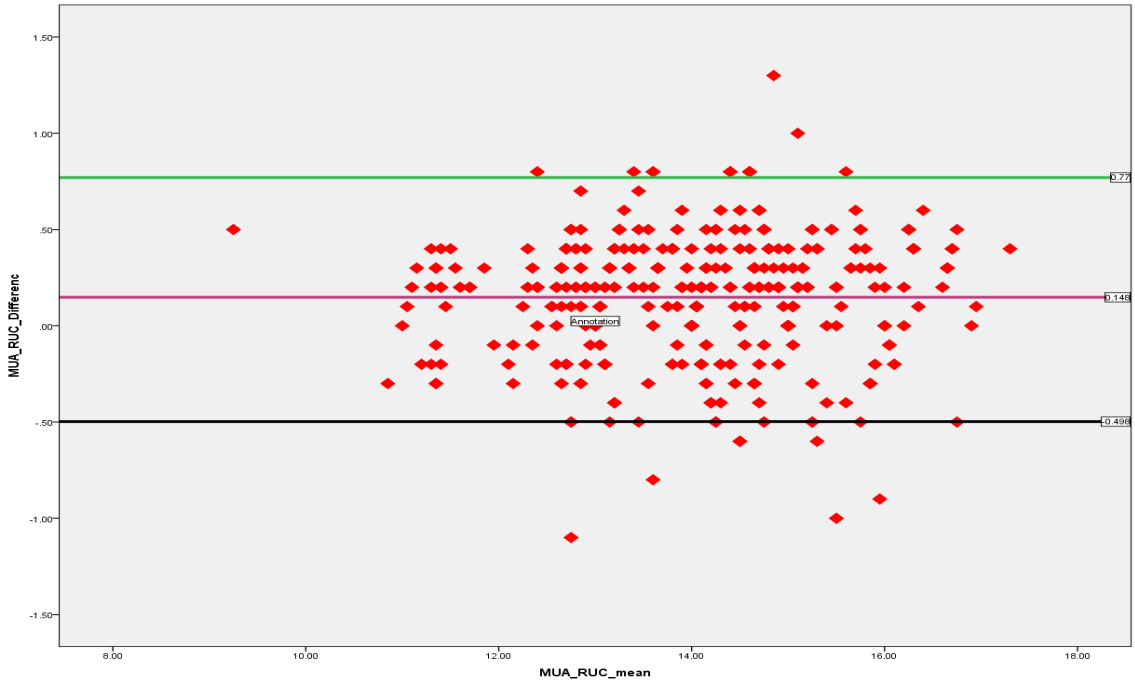

Figure 7: Bland-Altman plot agreement of RUAC and MUAC measurement among under-five children in Hadero Tunto Zuria Woreda, March 2019.

Table 8: Shows the correlation between RUAC and MUAC

The Pearson correlation coefficient(r) in this study was =0.972 for both RUAC and MUAC and the correlation was significant at (p<0.001). This showed that there is strong positive linear correlation between the two measurements as shown below figure 8**.**

		RUAC	MUAC
RUAC	Pearson Correlation	1	.972**
	p.value		.000
MUAC	Pearson Correlation	.972**	1
	p.value	.000	
	N	412	412

**. Correlation between RUAC and MUAC is significant at p< 0.001

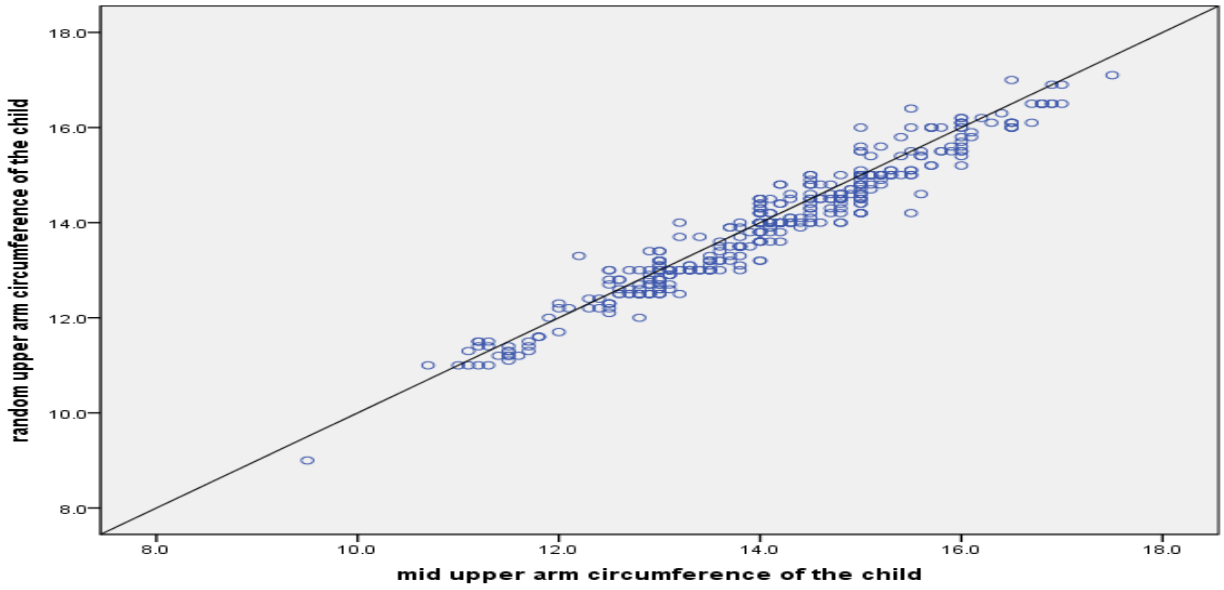

Figure 8: Scatter plot shows strong positive linear correlation between RUAC and MUAC in <5yrs children in Hadero Tunto zuria woreda, March, 2019

In this study measure of agreement between the two measurements RUAC and MUAC by using Kappa coefficient was (k= 0.739) and significant at (p<0.001) which is substantial agreement as to diagnose severe wasting among children aged 6–59 months.

Table 9: Shows the agreement between RUAC and MUAC by kappa coefficient

		K-Value	P
Measure of Agreement	Kappa	0.739	.000
N of children			412

As shown in table 10, on multivariable linear regression model, after adjusting for age and sex, for 1cm increase in RUAC, MUAC increased by 0.968 cm(==1cm) (β=0.968, P <0.001).

Table 10: Multivariable linear regression model Predicting MUAC using RUAC, age and sex

Model	Unstandardized Coefficients		P.	95.0% CI	
	B	Std. Error		Lower Bound	Upper Bound
(Constant)	.506	.191	.008	.131	.881
RUAC	.968	.014	.000	.941	.996
age of the child	.001	.001	.314	-.001	.004
sex of the child	.027	.031	.380	-.034	.089

**Maximum VIF is 1.44 and adjusted R^2 is 94%

Equation $y=\acute{\alpha}+ß_1x_1+ß_2x_{2+}\ ß_3x_3 + \varepsilon$

MUAC= 0.506+ 0.968(RUAC) + ε

Interpretation = for one cm increase in RUAC, MUAC increases by 0.968 cm===1cm).

Chapter- 6 Discussion

The early, rapid, and accurate diagnosis of SAM is crucial in prevention of deaths of SAM cases in the community. Based on the current findings RUAC was a valid, simple and rapid screening measurement for wasting in children between the ages of 6-59 months. The advantage of RUAC over MUAC in diagnosing SAM is its simple, rapid, accurate as well as easy to measure with minimal training at the community level and has great advantage over taking mid-point of the arm circumference in circumstances where emergency and many children screened at a time in scarce man power and resource-poor settings.

For definition of wasting, there was substantial agreement using kappa statistic coefficient (k=0.739) between RUAC and MUAC. The Pearson's correlation coefficient test which was used to assess the correlation between RUAC and MUAC in this study was strong (r=0.972). The correlation had a significant association with their RUAC and MUAC ($p<0.001$) and had strong positive correlation between the two measurements.

In the current study, RUAC categorized a large proportion of children as wasted and identified children that differed according to age and sex as severely wasted compared with MUAC. Generally, more children were screened as wasted in age category of less than two years 43/59 (73%) than the rest of age category which is the critical age for undernutrition and suggesting that interventions in first 1,000 days could still be effective. Poor nutrition during the first 1,000 days, from pregnancy through a child's second year of birth, can cause life-long and irreversible damage, with consequences at the individual, community, and national level [51, 52].

Area under the curve (AUC) in this study using ROC curve analysis was high. This showed that the sensitivity of RUAC in our study was higher than the study conducted in Nigeria (89 % versus 80 %) [41] and much higher than the study conducted from five surveys in Cambodia ranged 6.5% to 32.9%, respectively [36]. This difference might be due to the place of residence being urban and rural setting and socio-economic status of the countries.

The Bland-Altman plot analysis showed that there is high degree of agreement between RUAC and MUAC. Because 95% of the measurements fall in between the upper limit and lower limit of agreement.

This study screened low number of undernourished subjects 59 versus 75 as compared with anonymous data collected from 1832 anthropometric surveys from 47 countries in the age group of children 6-59 months [20].This discrepancy might be due to the difference in sample size, racial, geographical variations and socio-economic level of the countries.

The current study screened more children as wasted by RUAC only 59(14.3%) children as compared with 38(6.6%) than the study conducted in South Africa by using MUAC [40]. Moreover, study done in Senegal showed that, MUAC has better sensitivity than WFH [31] but current study further identified that, RUAC was even better sensitive than MUAC. RUAC could be used adequately as stand-alone criteria for screening, admitting to and discharging from nutritional rehabilitation of severe acute malnutrition [39] so that based on the current findings, RUAC was better to reduce risk of mortality due to wasting.

Even if both anthropometric measurements were sensitive in screening wasting in community level, RUAC is better than MUAC by its ease of performance, less error in measurement particularly for rapid field assessments of nutritional status in nutritional emergency circumstances where resources and trained personnel were limited. The results have a wider practical implication in developing countries like Ethiopia where the majority of the population is residing in widely scattered rural setting, the coverage of screening children for wasting is very low. Shifting the task of early detection and referral to the low level community actors could be considered as an option. However the tools used for diagnosing severe acute malnutrition including MUAC have cumbersome and time consuming procedure, which deters such an endeavor. The fact that RUAC performed very well in terms of picking children with SAM and its simplicity in measuring would pose arguments to initiate screening of children by health development army or even by the mothers or care takers themselves. This needs to be explored by future research.

Strength of the study

The study was new in its nature because no similar study was done in validity of RUAC in screening wasting among under-five children. The results are validated using different validation measures.

Chapter-7 Conclusion and recommendations

7.1 Conclusion

The sensitivity of RUAC in screening wasting among under-five children was high and can be used as an alternative tool with MUAC. The result showed that RUAC is a valid measure for rapid diagnosis of wasting in a community setting, and can be applied for early detection of children with wasting to close capacity gap and enhance coverage of screening. There is strong correlation between RUAC and MUAC , so RUAC can be used as a screening tool as an alternative to MUA in community settings.

7.2 Recommendations

7.2.1 For policy makers

RUAC should be promoted as simplest, easiest and valid anthropometric measurement tool to screen wasting among under-five children in community level because of its high sensitivity.

7.2.2 For researchers

Future research should investigate the coverage and effectiveness of using RUAC applied by community level actors in improving coverage of screening and reduction of wasting in the community set up.

7.2.3 The Hadero Tunto Zuria Woreda Health Office

RUAC should be promoted as simplest, easiest and valid anthropometric measurement tool to screen wasting among under-five children in community level because of its high sensitivity.

References

1. Access to global nutrition index; 2018.
2. Kramer, C. V. Malnutrition in developing countries', *Paediatrics and Child Health*; 2015, 25(9), pp. 422–427.
3. Tadesse, A. W. Identification and Community Management of Severe Acute Malnutrition Empirical evidence in rural Southern Ethiopia; 2018.
4. Dale NM, Myatt M, Prudhon C, et al. Using mid-upper arm circumference to end treatment of severe acute malnutrition leads to higher weight gains in the most malnourished children.,2013.
5. Goossens S, Bekele Y, Yun O, et al. Mid-upper arm circumference based nutrition programming: *evidence* for a new approach in regions with high burden of acute malnutrition,2012; 7(11)
6. Cichon B.MUAC versus weight-for-height debate in the Philippines [Internet]. [Cited 2016 March 20]. Available from: http://fex. Ennonline.net/42; 2012.
7. World Health Organization (WHO). Updates on the management of severe acute malnutrition in infants and children. Geneva: WHO; 2013.
8. Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. Nutr Rev 2012; 70: 3-21.
9. Popkin B. The nutrition transition in the developing world. Dev Policy Rev 2003; 21: 581-97.
10. WHO, Joint child malnutrition estimates –Levels and trends; 2015.
11. You D, Hug L, Chen Y. Levels and trends in child mortality report 2014. Estimates developed by the UN inter-agency Group for Child Mortality Estimation. New York: United Nations Children's Fund; 2014.
12. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet. 2003; 361(9376):2226–34.
13. Waber DP, Bryce CP, Girard JM, et al. Impaired IQ and academic skills in adults who experienced moderate to severe infantile malnutrition: A 40-year study. Nutr Neurosci. 2014; 17(2):58–64.
14. Ezzati M, Lopez AD, Rodgers A, et al. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva: WHO; 2004.
15. Chesire EJ, Orago AS, Oteba LP, et al. Determinants of under nutrition among school age children in a Nairobi peri-urban slum. East Afr Med J. 2008; 85(10):471–9.
16. World Bank. International monetary fund. Global Monitoring Report: Food Prices, Nutrition and the Millennium Development Goals; 2012.
17. UNICEF, WHO, World Bank Group. Levels and trends in child malnutrition. New York. The World Bank Joint Child Malnutrition Estimates; 2015**.**

18. Berkley J, Mwangi I, Griffiths K, Ahmed I, Mithwani S, English M, et al. Assessment of severe malnutrition among hospitalized children in rural Kenya: comparison of weight for height and mid upper arm circumference.JAMA. 2005; 294(5):591–7.
19. ENN, SCUK, ACF, UNHCR. Mid Upper Arm Circumference and Weight-for- Height Z-score as indicators of severe acute malnutrition: a consultation of operational agencies and academic specialists to understand the evidence, identify knowledge gaps and to inform operational guidance. Final review paper 2012.(Accessed 3 Feb 2016)
20. Roberfroid D, Hammami N, Lachat C, Prinzo ZW, Sibson V, Guesdon B, et al. Utilization of a Mid-Upper Arm Circumference Versus Weight-for-Height in Nutritional Rehabilitation Programmes: A Systematic Review of Evidence. Geneva: World Health Organization; 2013.Accessed 3 Feb 2016**.**
21. Grellety, E., & Golden, M. H. Circumference should be used independently to diagnose acute malnutrition : policy implications. *BMC Nutrition*.(2016) 2:10 DOI 10.1186/s40795-016-0049-7
22. Briend A, Maire B, Fontaine O, Garenne M. Mid-upper arm circumference and weight-for-height to identify high-risk malnourished under-five children. Maternal & Child Nutrition. 2012; 8(1):130–3.
23. Isanaka S, Guesdon B, Labar AS, Hanson K, Langendorf C, Grais RF. Comparison of Clinical Characteristics and Treatment Outcomes of Children Selected for Treatment of Severe Acute Malnutrition Using Mid Upper Arm Circumference and/or Weight-for-Height Z-Score. PLoS One. 2015;10 (9)
24. Black, R.E.; Victora, C.G.; Walker, S.P.; Bhutta, Z.A.; Christian, P.; de Onis, M.; Ezzati, M.;Grantham-McGregor, S.; Katz, J.; Martorell, R.; et al.(2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013, 382, 427–451.
25. Bhutta, Z.A.; Das, J.K.; Rizvi, A.; Gaffey, M.F.; Walker, N.; Horton, S.; Webb, P.; Lartey, A.; Black, R.E. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? Lancet 2013, 382, 452–477.
26. World Health Organization. Management of Severe Malnutrition: A Manual for Physicians and Other Senior Health Workers; World Health Organization: Geneva, Switzerland, 1999.
27. Collins, S.; Sadler, K.; Dent, N.; Khara, T.; Guerrero, S.; Myatt, M.; Saboya, M.;Walsh, A. Key issues in the success of community based management of severe malnutrition. Food Nutr. Bull. 2006, 27, 49–82.
28. World Health Organization; World Food Programme; United Nations System Standing Committee on Nutrition; United Nations Children's Fund. Community-Based Management of Severe Acute Malnutrition: A Joint Statement by the World Health Organization, the World Food Programme, the United Nations System Standing Committee on Nutrition and the United Nations Children's Fund; World Health Organization: Geneva, Switzerland, 2007. (Accessed on 31 August 2015).

29. Myatt, M.; Khara, T.; Collins, S. A review of methods to detect cases of severely malnourished children in the community for their admission into community-based therapeutic care programs. Food Nutr. Bull. 2006, 27, S7–S23.
30. Mwangome, M.K.; Fegan, G.; Mbunya, R.; Prentice, A.M.; Berkley, J.A. Reliability and accuracy of anthropometry performed by community health workers among infants under 6 months in rural Kenya.Trop. Med. Int. Health 2012, 17, 622–629.
31. World Health Organization; United Nations Children's Fund; Standing Committee on Nutrition. SCN Nutrition Policy Paper No. 21: WHO, UNICEF, and SCN Informal Consultation on Community-Based Management of Severe Malnutrition in Children. Accessed on 5 August 2015.
32. Briend, A.; Maire, B.; Fontaine, O.; Garenne, M. Mid-upper arm circumference and weight-for-height to identify high-risk malnourished under-five children. Matern. Child Nutr. 2012, 8, 130–133.
33. Briend, A.; Garenne, M.; Maire, B.; Fontaine, O.; Dieng, K. Nutritional status, age and survival: The muscle mass hypothesis. Eur. J. Clin. Nutr. 1989, 43, 715–726.
34. Vella, V.; Tomkins, A.; Ndiku, J.; Marshal, T.; Cortinovis, I. Anthropometry as a predictor for mortality among Ugandan children, allowing for socio-economic variables. Eur. J. Clin. Nutr. 1994, 48, 189–197.
35. World Health Organization; United Nations Children's Fund. WHO Child Growth Standards and Identification of Severe Acute Malnutrition in Infants and Children: A Joint statement by the World Health Organization and the United Nations Children's Fund; World Health Organization Press: Geneva, Switzerland, 2009. (Accessed on 20 September 2015).
36. Fiorentino, M., Sophonneary, P., Laillou, A., Whitney, S., & De, R. Current MUAC Cut-Offs to Screen for Acute Malnutrition Need to Be Adapted to Gender and Age : The Example of Cambodia.2016, 1–11.
37. A Joint Statement by the World Health Organization and the United Nations Children's Fund. WHO child growth standards and the identification of severe acute malnutrition in infants and children. Geneva, WHO/UNICEF, 2009.
38. Fernandez MA, Delchevalerie P, Van HM. Accuracy of MUAC in the detection of severe wasting with the new WHO growth standards. *Pediatrics*, 2010, 126(1)
39. Roberfroid, D., Hammami, N., Lachat, C., Prinzo, Z. W., Sibson, V., & Guesdon, B. Utilization of mid-upper arm circumference versus weight-for-height in nutritional rehabilitation programmes : a systematic review of evidence; 2013, 1–23.
40. Dukhi, N., Sartorius, B., & Taylor, M. Mid-upper arm circumference (MUAC) performance versus weight for height in South African children (0 – 59 months) with acute malnutrition, (May 2018).

41. M. D. Dairo, Modupeoluwa E. Fatokun, and Modupeoluwa Kuti. Reliability of the Mid Upper Arm Circumference for the Assessment of Wasting among Children Aged 12-59 Months in Urban Ibadan, Nigeria; 2012.
42. Groot, D., Oeurn, S., Amma, M., Frank, T., Laillou, A., Prak, S.Conkle, J. Optimal Screening of Children with Acute Malnutrition Requires a Change in Current WHO Guidelines as MUAC and WHZ Identify Different Patient Groups;2018, *9*(2014).
43. Hajian-Tilaki K. Sample size estimation in diagnostic test studies of biomedical informatics. J Biomed Inform. 2014; 48:193–204
44. Watson, P.F.; Petrie, A. Method agreement analysis: A review of correct methodology. Theriogenology 2010, 73, 1167–1179.
45. Park K. Park's Text book of Preventive and Social Medicine. 22nd ed. Jabalpur: M/s Banarasidas Bhanot Publishers; 2013; 508,130.
46. Kummar R, Indrawn A. Receiver operating characteristic (ROC) curve for medical researchers. Indian Pediatr 2011; 48:277–89.
47. Linnet K. Comparison of quantitative diagnostic tests: type I error, power, and sample size. Stat Med 1987; 6:147–58.
48. Hanley JA, McNeil BJ. The meaning and use of the area under a receiver operating characteristic (ROC) curve. Radiology 1982; 143:29–36.
49. Hanley JA, McNeil BJ. A method of comparing the area under receiver operating characteristic curves derived from the same cases. Radiology1983; 148:839–43.
50. De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. Bulletin of the World Health Organization. 2007; 85(9):660-7.
51. Maternal and Child Undernutrition .The Lancet (2008) Special Series, 371.
52. Child Survival. The Lancet(2003)Special Series,36
53. The global hunger index, 2018

Appendix

Annex I: Administrators Information Sheet:

My name is Mesele Tadewos; I want to collect data for the study being conducted in your kebele /households, I am studying my master's degree in Human Nutrition, Jimma University, and Institute of Health. I kindly request you to give me your attention to explain about the study and your child selected as the study participant.

The Study Title: Validity of Random Upper Arm Circumference for Screening wasting among Under Five Children in Hadero Tunto Zuria Woreda, Kembata Tembaro Zone, Southern Ethiopia,2019

Purpose of the study: The aim of this study is to write a thesis as a partial requirement for the fulfillment of a Master's program in Human Nutrition for the principal investigator. Moreover, the findings of this study can be of a paramount importance for your child to plan intervention programs.

Procedure and Duration: I will collect data from your child by using check list to provide me with pertinent data that is helpful for the study. There are 19 questions to be checked where there will be filled on the check list. The data collection will take about 15 days, so I kindly request you to cooperate during data collection.

Risk and Benefits: The risk of being selected in this study has very minimal or no risk for your child and for you. But the findings from this research or any finding will be advised to review in regular basis with key performance indicators and may reveal important information for the health bureau planners.

Confidentiality: The information collected from your child will be confidential. There will be no information that will identify children in particular, to do so; all child information will have a code. The findings of the study will be general for the study population and will not reflect anything particular of individual child. The check list will be coded to exclude showing names. **Rights:** This study will be done if you are voluntary on the behalf of your child. You have the right to declare to allow or not for this study. If you choose to be done the study, you have the right to stop the study at any time.

Contact address: If you have any questions about the study please ask me now. If you have questions later, want additional information, or wish to withdraw call the researcher conducting the study.

Address of the Principal Investigator
Name: Mesele Tadewos:

Mobile phone: 0913270816/0961352672

Email address: meselemisha@gmail.com

Declaration of parents /caretaker Information Sheet:

I have read the participant information sheet. I have clearly understood the purpose of the research, the procedures, the risks and benefits, issues to confidentiality, the rights of participating and contact address for any queries. I have been given the opportunity to ask questions for things that may have been unclear. Stop when any justified problem occurs. I am also informed that the family has the right to stop this study from being conducted if any misdeeds and unethical procedures are observed during data collection procedures from the children. Therefore, I declare my voluntary consent on the behalf of my child to allow this study to be conducted with my initials (signature)

Name & Signature of parents /caretaker ……..Date ……

Name & Signature of data collector …….Date ……

Name & Signature of supervisor…… Date……

Annex II: English version

Questionnaire

Part I: - Background information

1. Identification number: _____
2. House No_____
3. Name of kebele _____
4. Gote _____
5. Head of the house hold 1. Male 2.female
6. Respondent position in the house holds
   A. Husband
   B. House wife
   C. Relatives
   D. Care taker
7. Age of respondent (in years)_____

Part II: Socio-demographic data

Q 8	**Q 9**	**Q 10**	**Q 11**	**Q 12**	**Q 13**	**Q 14**
Sex of respondents	**Religion**	**Ethnicity**	**Educational status father**	**Educational status mother**	**Marital status**	**Occupational status**
1.Male	1.Protestant	1.Kembata	1.unable to read write	1.Unable to read and write	1.Single	1. Governmental worker
2.Female	2.Orthodox	2.Donga	2.Read & write only	2.Read & write only	2.Separated	2.Farmer
	3.Catholic	3.Dawuro	3. Primary 1-8	3.primary (1-8)	3.Married	3.Merchant
	4.Muslim	4.Hadiya	4.Secondary (9-10)	4.Secondary (9-10)	4.Divorced	4.House wife
	5.Other specify	5.Tembaro	5.preparatory(11-12	5.preparatory(11-12)	5.Widowed	5.Daily labor
		6.Amhara	6. Diploma and above	6. Diploma and above		6.Student
		7.Wolaita				7.NGO worker
		8. other				8.Unemployed
						9.other specify

Part III. Characteristics of the child

	Questions	**Response**	Remark
Q15	**Date of birth of the child**	**dd/mm/yy……./……/……**	
Q16	What is the age of the child?	…….in months	
Q17	What is the sex of the child?	1.Male 2.Female	
Part IV. Anthropometry			

Q18	RUAC of the child	_____cm	
Q19	MUAC of the child	_____cm	

Annex III-Amharic version

ክፍል 1፡ የወላጅ /ቤተሰብ መረጃ

ተ.ቁ	መለያ ቁጥር	
1	የቀበሌው ስም	
2	የቤተሰቡ ሃላፊ	1.አባት 2.እናት
3	ተጠየቂው በቤተሰቡ ያለው ሃላፊነት	1. አባወራ 3. ዘመድ 2. እማወራ 4. ጠባቂ/ ተንከባካቢ
4	የተጠየቂው ዕድሜ	በዓመት……
5	የተጠየቂው ጾታ	1. ወንድ 2. ሴት
6	የተጠየቂው ሃይማኖት	1.ፕሮቴስታንት 3. ካቶሊክ 2. ኦሮቶዶክስ 4. እስላምና 5.ሌላ ካሆነ ይጠቀስ…….
7	የተጠየቂው ብሔር	1. ካምባታ 3. ዳውሮ 2. ዶንጋ 4. ሃዲያ 5.ጠምባሮ 6. አማራ 7. ወላይታ 8. ሌላ ካለ ይጠቀስ
8	የአባት ትምህርት ደረጃ	1መጻፍና ማንበብ የማይችል 2. መጻፍና ማንበብ የሚችል 3. የመጀመሪያ ደረጃ (1-8) 4. ሁለተኛ ደረጃ (9-10) 5. መሰናዶ (11-12) 6. ዲፕሎማና ከዚያ በላይ

9	የእናት ትምህርት ደረጃ	1. መጻፍና ማንበብ የማትችል 2. መጻፍና ማንበብ የሚትችል 3. የመጀመሪያ ደረጃ (1-8) 4. ሁለተኛ ደረጃ (9-10) 5. መሰናዶ (11-12) 6. ዲፕሎማና ከዚያ በላይ
10	የጋቢቻ ሁኔታ	1. ያላገባ/ች 3. ተለያይተው የሚኖሩ 2. ያገባ/ች 4. የተፋቱ 5. ባል ወይም ሚስት የሞተባት/በት
11	ሥራ	1.መንግስት ሠረተኛ 3. ነጋዴ 2. አርሶ አደር 4. የቤት እማቤት 5. የቀን ሠረተኛ 6. ተማሪ 7. መንግስታዊ ያልሆነ ድርጅት ሠረተኛ 8. ያልተቀጠራ

ክፍል 2. የህፃኑ መረጃ		
1	ህፃኑ/ኗ የተወለደት/ችበት ቀን/ወር/ ዓ.ም	……/……/……
2	የህፃኑ/ ኗ ዕድሜ በወር	……
3	የህፃኑ ጾታ	1. ወንድ 2. ሴት
4	የህፃኑ የላይኛው ግራ ክንድ ዙሪያ ልኬት……...ሴ.ሜ (RUAC)	
5	የህፃኑ የላይኛው ግራ ክንድ ዙሪያ መሃል ልኬት ……...ሴ.ሜ (MUAC)	

Annex IV: Declaration

I, undersigned, declare that this thesis is my original work and has not been presented for a Degree in this or any other University, and all source of materials used for this thesis have been fully acknowledged.

Name: Mesele Tadewos Hochiso

Signature_____ Date ……

Place: Jimma University

Date of Submission_____

This thesis has been submitted with my approval as the University Advisor.

Name of the First Advisor: _____

Date_____ Signature_____

Name of Second Advisor: _____

Date_____ Signature_____