ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

SPATIAL DISTRIBUTION OF UNDER IMMUNIZATION AMONG CHILDREN 12-23 MONTHS OLD IN BUTAJIRA, SOUTHERN ETHIOPIA

A RESEARCH PAPER SUBMITTED TO SCHOOL OF PUBLIC HEALTH, ADDIS ABABA UNIVERSITY IN PARTIAL FULFILLMENT FOR THE REQUIREMENTS OF MASTERS OF PUBLIC HEALTH (MPH) DEGREE IN EPIDEMIOLOGY.

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JUNE, 2016

APPROVED BY THE BOARD OF EXAMINERS

This thesis by Admassu Ketsela is accepted in its present form by the board of examiners as fulfilling thesis requirement for the degree of Master of Public Health in Epidemiology.

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ACKNOWLEDGEMENT

First of all I would like to thank my advisors Mr. Seifu Hagos and Dr.Wakgari Deressa for helping me in the refinement of this research topic and for their continuous support and guidance in the conduct of this research paper.

Also I would like to extend My Heartfelt gratitude to the staffs of Butajira Rural Health Project, without whose continued effort this research would have been impossible to conduct.

Finally I would like to extend my gratitude to the School of Public Health, Addis Ababa University for providing me with this wonderful opportunity to conduct this research work.

ACRONYMS

ANC----------Antenatal care

AOR----------Adjusted Odds Ratio

BCG----------Bacille Calmette-Guérin (vaccine)

CDC----------Centers for Disease Control and Prevention

COR----------Crude Odds Ratio

DPT----------Diphtheria, Pertusis and Tetanus vaccine

EDHS----------Ethiopian Demographic and Health Survey

EPI----------Expanded Programme on Immunization

FMOH----------Federal Ministry of Health

HDSS----------Health and Demographic Surveillance Site

HepB----------Hepatitis B

Hib----------Haemophilus Influenzae B

TT----------Tetanus Toxoid

WHO----------World Health Organization

ABSTRACT

Introduction

According to WHO, Immunization helps to prevent between 2 and 3 million deaths globally each year and it is widely accepted that it is one of the most cost-effective health interventions. Despite all its advantages immunization in Ethiopia fell short of achieving the target set by the UN MDGs to achieve overall immunization rate of 90 % for all developing countries by the year 2015 evidenced by immunization rate of only 24 % as to the recent 2011 EDHS.

Objectives

The objective of this study was to evaluate the spatial distribution of under immunization in 12 to 23 months old children and determinants of under immunization clustering in Butajira HDSS.

Methodology

A cross sectional survey was done from March, 2016 up to April, 2016 in Butajira HDSS. Data on immunization status was collected by going to Households and interviewing mothers and /or by observation of vaccination card kept at home. The analysis of under immunization cluster was done by using the SatScan software employing the purely spatial Bernoulli‟s model.

Results and Discussion

This study identified one significant cluster of under immunization among children 12–23 months of age within the Butajira HDSS .The most statistically significant under immunization cluster covered an area East of the Town of Butajira, including parts of the Kebeles of Bati Lejano to the North and Mekakelegna Jare demeka to the South. Children in this cluster had 1.24 (P value=0.011) times the rate of under immunization compared with children outside of that cluster , the study also identified factors like having received TT vaccination by mother, and delivery of the last pregnancy at home or with a TBA as predictors of cases of under immunization to be within the under immunization clusters with an adjusted Odds ratio of [AOR **5.1 [2.56, 10.1] P=0.000**]** and [AOR **2.21 [1.06, 4.63] P=0.035*]** respectively.

Conclusion and Recommendations

Under immunization of 12-23 months old children and under immunization with specific vaccines such as Polio, BCG, DPT (1-3) and Measles clustered geographically in the Butajira HDSS. Spatial studies including the current study could be effective in pinpointing areas of under immunization clustering, which would be very useful to programme managers of public health institutions in Ethiopia and beyond.

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1. INTRODUCTION

1.1.Background Information

Vaccination is defined as the act of introducing a vaccine into the human body to produce immunity to a specific disease [1]. According to World Health Organization (WHO), Immunization helps to prevent between 2 and 3 million deaths globally each year and it is widely accepted that it is one of the most cost-effective health interventions. One of the exciting property of immunization is its relative ease to make it available to difficult to reach and vulnerable populations [2].

In May 2012, WHO set out a plan which aimed to achieve a world free from vaccine preventable diseases by the year 2020 by envisioning vaccination coverage of ≥90% nationally and ≥80% in every District. By the year 2014, about 86% (115 million) of infants worldwide received complete doses of Diphtheria- Pertussis- Tetanus (DPT_3) vaccine and 85% (115 million) of infants had received at least one dose of Measles vaccine by their first year. Regarding coverage 129 countries had reached at least 90% coverage of DPT_3 vaccine in 2014[2, 3].

World Health Organization states that children are considered Fully vaccinated when they have received a vaccination against tuberculosis (BCG), three doses each of the DPT and polio vaccines, and a Measles vaccination by the age of 12 months [2]. In Ethiopia the Pentavalent vaccine DPT-HepB-Hib, introduced in 2007, replaced the previous DPT vaccine, which protects against Diphtheria, Pertussis (whooping cough), Tetanus, Hepatitis B, and Haemophilus influenza Type B , which calls for BCG vaccine to be given at birth or at first clinical contact, three doses of DPT-HepB-Hib (Penta) vaccine given at approximately 4, 8, and 12 weeks of age, four doses of oral polio vaccine given approximately at 0-2, 4, 8, and 12 weeks of age, and Measles vaccine given at or soon after reaching 9 months of age [4]

The United Nations Millennium Development Goals (UN MDG) specifically MDG 4 put as an objective to ensure full immunization of children under one year of age at 90% nationally, with at least 80% coverage in every District or equivalent administrative unit by 2015 [5]. In Ethiopia, the Expanded Programme on Immunization (EPI) was started in 1980 and later in 1986 it was revised to include only infants under one year in line with the global target [4].

A plan was set for the year 1990 for EPI to achieve a 100% DPT_3 coverage by having an annual increment of 10%. Nevertheless this plan was not met despite of significant gains made. A significant progress was made in the years between 2003 and 2010, whereby DPT_3 coverage increased from 52% to 80% [4].

Currently the Ministry of Health (FMOH) has set ambitious targets to achieve above 95% coverage of Penta 3 and Measles vaccination and also it has set a goal of nationally eradicating polio and Measles by the year 2020 [4].

Recent figures for the national immunization level in 2013 and 2014 showed that immunization coverage rose to 87% and 83% coverage, respectively, for Penta 3 and Measles vaccination [4], but still the EDHS 2011 report showed that the overall country level full immunization is relatively low at 24% [6].

In addition different literatures report varied figures of Full Immunization coverage in Ethiopia which is sometimes as high as 76% and as low as 36% showing marked Regional and Sub-Regional variations [7-12].

Spatial epidemiology is an exciting and relatively young field of science with early signs made by the famous Epidemiologist John Snow in the mapping of the cholera outbreak in broad street, London in 1854 [13].

In spite of the above varied prevalence of under immunization there has been a lack of study showing the geographical distribution of clusters of under immunization and cluster specific determinants of under immunization in Ethiopia, so with this fact in mind this study was set out to study the spatial distribution of under immunization in Butajira HDSS of Southern Nations, Nationalities and Peoples Region (SNNPR), Federal Democratic Republic of Ethiopia (FDRE).

1.2.Statement of the problem

It is estimated that about three million children under five years of age die each year in the African continent. Ten African countries including Ethiopia, account for 70% of these Vaccine Preventable Diseases (VPD), a significant number of these deaths could be prevented by vaccines[3].

Ethiopia is also experiencing an ongoing Measles outbreak. According to WHO as of May 5, the number of confirmed Measles cases for the year 2015 so far reached 9,732. In the previous year of 2014 there were more than 14,000 confirmed Measles. Maternal and neonatal Tetanus , which once contracted kills newborn usually within seven days is responsible for about 110,000 deaths a year in the African Region[3].

According to the recent EDHS (2011) , only one in every four children aged 12-23 months (24 %) were fully vaccinated in Ethiopia [6].

Current literatures on immunization in Ethiopia concentrate mostly on magnitude and factors affecting immunization with the exception of EDHS, which tries to visualize the regional distribution of immunization, which again does not explore pure spatial analysis.

1.3. Research questions

1. Does under immunization occur randomly or does it geographically cluster in Butajira HDSS?
2. What are the determinants of geographic clustering of under immunization within the Butajira HDSS?

1.4. Rationale of the study

The results of the study will be very much helpful to local health managers and the Ministry of Health EPI Case Team in providing real time spatially related under immunization status in the Butajira HDSS, which could help in coordinating immunization improvement activities in the District.

This information can then be used to specifically mobilize resources to areas having clusters of under immunization and also to prepare intervention packages specifically designed for each area in the District.

2. LITERATURE REVIEW

2.1.Spatial analysis in Public Health

It is a long known principle of Epidemiology that disease occurrence is not a random phenomenon, but rather it is a result of specific set of interactions between the agent, host and environment [13]. Spatial analysis in Epidemiology roots its foundation in the basic principles of descriptive Epidemiology in that it tries to identify the geographical or place distribution of disease occurrence, and whether the disease distribution is place dependent or whether there is geographical dependence in disease occurrence between neighboring regions or any pair of regions. Since the time of John Snow, Epidemiologists have been interested to know whether disease occurrence is different in different locations, the base of any spatial studies is the Tobler‟s first law of geography by Waldo Tobler (1930), which states "*Everything is related to everything else, but near things are more related than distant things*." Spatial studies are nowadays becoming an area of interest because of an increased advent of free user friendly softwares like SatScan ,GeoDa and the R project .

Some studies were done to see the spatial distributions of communicable diseases like visceral leishmaniasis and dengue fever around specified localities in Brazil and India and also some literatures also report on the application of spatial epidemiology to see the distribution of vectors like sand fly [14-17].

Local studies are also available including one such spatial study conducted in 2009 in East Shoa, Central Ethiopia, which used both global and local tests of clustering in order to check whether there is any spatial clustering [18]. Another study on the spatial distribution of malaria in Adama Town used the Kulldorf‟s spatial scan statistics and determined one significant cluster of malaria cases [19]. Also there have been literatures showing the application of spatial techniques to visualize Bed Net coverages and also to show spatial pattern of diarrhea incidence among rotavirus vaccinated infants in a Brazilian slum dwelling [20, 21].

The application of spatial analysis to non communicable diseases has become a common practice nowadays with literatures from different European countries reporting the spatial picture of diseases like medicated Parkinson‟s disease and to explore the spatial association between factors like drinking water hardness and stroke with acute myocardial infarction [22-25].

2.1.1. Spatial studies on Immunization

One recent study done in Kaiser Permanente, Northern California, USA identified five statistically significant clusters of under immunization among children who turned 36 months old during 2010–2012 by using the Kulldorf‟s spatial scan statistic. The under immunization rate within the clusters ranged from 18% to 23%, while the rate outside them was 11%, when compared to children outside the clusters those within the cluster had 1.58 (P =0 .001) times higher rate of under immunization. Also under immunization with Measles, Mumps, Rubella (MMR) vaccine and Varicella vaccines tended to be clustered in similar geographic areas. Compared with non cluster areas (2.6%) those within the clusters had vaccine refusal rates ranging from 5.5% to13.5% [26].

2.2.Immunization status in Ethiopia

2.2.1. Magnitude of Under immunization

The magnitude of under immunization is highly varied among different regions and localities in Ethiopia as evidenced by different literatures over the past 10 years. During this time, relatively high levels of under immunization have been found in areas like Ambo Woreda , where in 2011 it had 64 % under immunization [9], a similar study in 2014 in Kombolcha Woreda showed a 67 % under immunization rate [10].

A medium level of under immunization was reported in Mecha Town (2013) and Wonago District, Southern Ethiopia (2008) as 51 % and 58 % respectively [7, 12].

Other literatures report on relatively mild under immunization , for instance 23 % in Sinana District, South East Ethiopia in 2015 and 24 % in Lay Armachiho District ,Northern Ethiopia in 2014 [8, 11].

Currently, the latest national survey in 2011 showed prevalence of under immunization to be 76% [6].

2.2.2. Factors affecting Immunization

Different literatures have reported on the possible Socio demographic and related factors that are associated with low immunization status, below is the discussion of some recent literatures on the area done in Ethiopia.

In a study done in Ambo in 2012, child delivery at health facilities, utilization of antenatal care (ANC) and follow up and lack of knowledge about vaccination and vaccine preventable disease were identified as major factors affecting immunization [9].

Mother characteristics like taking Tetanus Toxoid immunization , ability to identify the number of sessions needed for immunization and being able to know the age at which a child was fully immunized were significant factors associated with Full child immunization in a study done in Lay Armachiho Gondar in 2014[11].

Child characteristics like being Male was also found to be a contributor for Full child immunization in the Lay Armachiho study [11].

Completion of ANC visits and better maternal education were found to be strongly associated with receiving at least one vaccination and with Full child immunization respectively in a 2009 study done in a Rural part of Jimma Zone, South West, Ethiopia [27].

A case control study done in Wonago District, Southern Ethiopia revealed that having Knowledge by mothers about child immunization, higher monthly income of family, not postponing child immunization and perceived positive health institution support to be the best protective factors from defaulting from completion of child immunization [12].

In Mecha District, North West Ethiopia, a cross sectional study done in 2013 revealed factors significantly associated with full vaccination to be urban residence, mothers who have good knowledge on vaccination and experience of taking the child to health institution during illness in the first year of life [7].

A 2015 study in Sinana District, South East Ethiopia showed full immunization was associated with antenatal care follow up, being a farmer by occupation, being a father with at least a secondary educational level, having Household family income greater than 1000 Ethiopian Birr

(ETB) , walking time from home to health facilities being less than an hour and having discussed about immunization with Health Extension Workers and Having sufficient knowledge by mothers‟ about immunization [8].

Being unaware of immunization schedule and/or time of immunization and wrong perception about contraindication were significant factors affecting full immunization in a study done in 2010 in Kombolcha District, Oromia Regional State, Eastern Ethiopia [10].

3. OBJECTIVES

3.1.General objective

- To describe the spatial distribution of under immunization of 12 to 23 months old children and its relationship with predictors of under immunization in Butajira HDSS

3.2.Specific objectives

- To determine clusters of under-immunization of 12 to 23 months old children in Butajira HDSS.
- To evaluate the determinants of spatial clustering of under immunization of 12 to 23 months old children in Butajira HDSS.

4. METHODOLOGY

4.1.Study Area and period

4.1.1. Study area

The study area was Butajira HDSS, which houses the Health and Demographic Surveillance (HDSS) Site for the School of Public Health, Addis Ababa University.

The Butajira HDSS site includes 10 Kebeles which are located in two zones in the Southern Nations Nationalities and Peoples Region (SNNPR), Federal Democratic Republic of Ethiopia (FDRE). There are three Woredas including, Meskan Woreda and Mareko Woreda from Guraghe Zone and one Woreda from Silte zone and the Town of Butajira , which is the capital of Meskan Woreda. There are currently 14,000 Households in the Butajira HDSS.

Meskan Woreda includes six Kebeles namely Dirama, Shershera Bido, Bati Lejano, Dobena, Misrak Meskan and Wurib, whereas Mareko Woreda consists of Hope Jare Demeka and Mekakelegna Jare Demeka Kebeles. Dobena and Yeteker are the other two Kebeles from Silte Zone and the Tenth Kebele is Kebele 04 from Butajira Town.

The Butajira HDSS consisting of 10 villages was selected from the entire District using a probability proportional to size technique. The HDSS population is currently estimated at 76,350 (year 2015).Of the Ten sites nine of them are Rural and one is Urban located in Town of Butajira .Guraghe is the main ethnic group, which is further divided into minor ethnic groups or tribes like Meskan, Mareko, Sodo, Silte and Dobi. Islam is the main religion having two-thirds of the people following the religion, while Orthodox Christianity is the second dominant religion in the area. Guragigna is the major language. Amharic, the official language of FDRE, is also widely spoken in the area, and is an important written language [28].

4.1.2. Study Period

The study was conducted from Dec 01, 2015 to June, 2016, and the data collection was done for a week from March 25, 2016 to April 1, 2016.

4.2. Source Population

The source population for this study was all Children 12-23 months years old in Butajira HDSS.

4.3.Study Population

The study population was those children aged 12-23 months in Butajira HDSS which have been selected by simple random sampling from each Kebele using a sample frame of all children 12 to 23 months old during the data collection period, provided from the Butajira Rural Health Project coordinating office located in the School of Public Health, Addis Ababa University.

4.4.Study Design

A community based cross sectional study was employed to evaluate the spatial distribution of under immunization status of 12-23 months old children in Butajira HDSS.

4.5.Sample Size

The sample size for this study was determined using single proportion formula and the following assumptions .The prevalence of immunization was taken to be 24% for SNNPR from the recent national survey (EDHS) in 2011 [2].

By using Epi Info version 7, Sample size was calculated for population survey using

- Prevalence of Full immunization =24% ,
- Margin of error = 4% and
- Confidence interval =95 %

The sample size was determined to be 438 and after adjusting for 10 % non response rate, the final sample size was determined to be 482 Households.

4.6.Sampling Technique

After the total sample size of 482 was determined proportional to size samples were selected from the Ten Kebeles in the Butajira HDSS based on the number of Households per Kebele which have been pre selected according to the Household number using simple random sampling from the sampling frame provided by the Butajira Rural Health Project coordination office in the School of Public Health , Addis Ababa University .If the Household selected does not have 12 to 23 months old children the next nearby Household along the direction of Household numbering

was considered for the interview according to the WHO EPI cluster sampling technique [29].More than one case can be reported per Household. A Household in these areas is typically defined as a family unit with a single land owner.

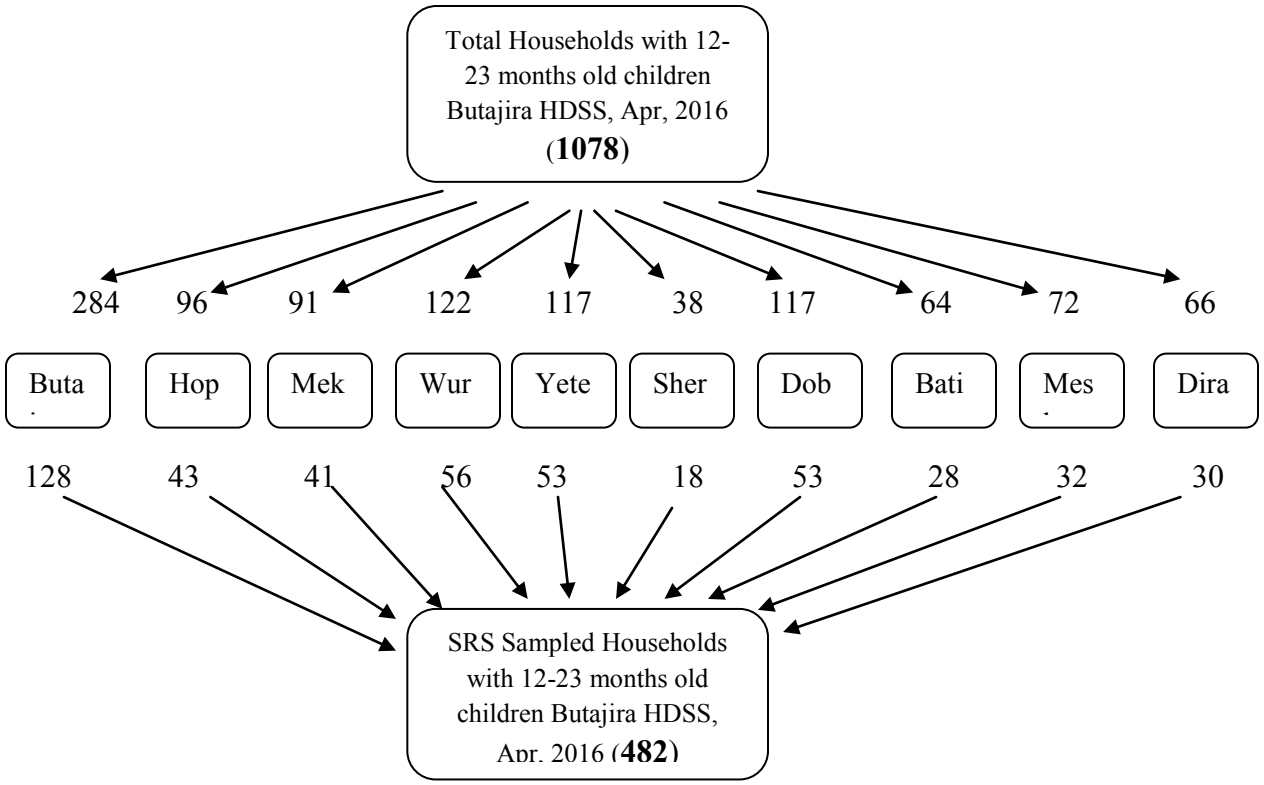

Figure 1. Schematic representation of sampling technique employed for the under immunization study in Butajira HDSS , Apr, 2016

4.7.Operational definitions

- **Under Immunization: A** child who has missed one or more of either BCG, OPV (0-3) ,Penta (1-3) or Measles Vaccines.
- **Fully Immunized child (FIC):**A child who has received doses of the "standard six" antigens: BCG, Diphtheria- Pertussis - Tetanus (DPT:three doses), Polio (three doses), and Measles vaccines (one dose) :
- **Vaccination by card:** The child‟s vaccination card was checked for the records and dates of vaccination for each vaccine.
- **Vaccination by history/Mothers recall:** The child‟s vaccination status was checked by asking the mothers if they remember the time and site of vaccination.
- **Cluster :** An unusually high number of under immunized children in a certain place.

4.8.Variables

4.8.1. Independent variables

- Characteristics of mother including, Education level, Wealth status, Marital status ,Religion, Age of mother, Residence, Occupation
- Health service utilization by the mother
- Mothers knowledge about VPD and child Immunization
- Geographical coordinates of the Household in Latitude and Longitude

4.8.2. Dependent variable

- Under Immunization clustering

4.9.Measurements

The geographic location of all villages / "Gotes" within the ten Kebeles was determined using a Handheld Global Positioning System (GPS) (Garmin GPSMAP®). For the Multivariate analysis of under immunization clustering the dependent variable was inclusion of the Households in the statistically significant cluster

The individual level exposure variables considered in this study were age of Mothers, Mother‟s occupation, religion, Marital status, Mothers education, wealth index, sources of information

about VPDs, Availability of vaccination card at home, receiving certificate of immunization completion, TT (Tetanus Toxoid) vaccination status of the mother, antenatal care (ANC), utilization and ANC visit frequency, place of delivery of last pregnancy and number of total births by the mother.

Whereas the community level exposure variables considered in this study were availability of health institution and its type.

4.10. Data collection and quality control

In order to have a quality data a pretest was done by the enumerators of the Butajira HDSS outside of the HDSS site in the Town of Butajira, before the actual data collection process commenced. Some minor changes in the remarks session was made after feedback obtained during the pre testing of the questionnaire by the data collectors.

Data was then collected by the data collectors who are permanent enumerators of the Butajira HDSS, who were trained two times, one before pre testing and another after pre testing. The training covered issues like confidentiality, ethical issues and also the proper way of completing the questionnaire. Then data collection technique used was interview of mothers by using the structured pre tested questionnaire to measure immunization status by combining methods like interviewing the mother, observation of the Households and checking or analysis of the vaccination card kept at home if it was available at the time of interview.

The data collection questionnaire used for this study was adopted from the 2011 EDHS and from other similar researches done previously on immunization status [6, 9].

Data quality was kept by daily checking completed questionnaires for completeness of data and by both the principal investigator and two experienced supervisors of the Butajira HDSS during the data collection period.

4.11. Data entry and analysis

4.11.1. Data entry

EpiData Version 3.1 was used for the data entry and Stata 13.0 (StataCorp, College Station, TX) for cleaning and analysis. Each record was given a unique id starting from 1 and running up to

482, and the same unique id was recorded in each questionnaire for the purpose of future reference during data cleaning.

4.11.2. Data analysis

SaTScan™ v9.4.2 software (http://www.satscan.org) was used to identify locations and estimate cluster sizes.

In this analysis, the dependent variable was under immunization clustering of the 12 to 23 months old children. According to the WHO guideline [27], "Complete or Full immunization" coverage is defined as a child who has received a BCG vaccination against tuberculosis; at least three doses of DPT vaccine to prevent Diphtheria, Pertusis, and Tetanus (DPT); at least three doses of polio vaccine; and one dose of Measles vaccine. We recoded each variable into 0 and 1. No responses were recoded as "0" and labeled "No". Households with no children between 12 to 23 months old were replaced with the nearby Household having a child with the defined age range.

Data about immunization was measured by information from the vaccination card if the mother presented the vaccination card at the time of questioning or by mothers recall if the mother didn‟t present the vaccination card. From the vaccination card, all the Yes - No scores were added for each vaccine and were set to give Immunization status of "yes" and coded as "1", if the score from the vaccination card for the vaccines BCG, polio(1-3),DPT (1-3) and Measles summed up to 8 or greater than 8,where as if the score from the vaccination card for the vaccines BCG, Polio (0-3),DPT (1-3) and Measles summed up to be 7 or less they were labeled as "No" and coded as "0" for the variable "Immunization status". The immunization status was recoded as "1" if the child had received all the doses of vaccinations and categorized as " Fully immunized" or "0" if the child had missed one or more doses of the vaccinations and categorized as "Under immunized". Regarding immunization status from mothers recall the reported frequency of child vaccination for the vaccines of BCG, Polio (1-3),DPT (1-3) and Measles were recorded and summed up and if the sum was determined to be 8 the child was given an immunization status of "Fully immunized" and coded as "1", on the other side if the sum was determined to be 7 or less the child was given an immunization status of "Under immunized" and coded as "0".

A principal component analysis was applied in order to construct a relative Household wealth index. The variables included in the principal component analysis model were ownership of land, type of house and construction materials used availability of fixed assets such as a radio, television, telephone, bed, chair and other Household items, possession of domestic animals, time it takes for fetching water for drinking and cooking, and availability and type of latrine. Then a relative socio-economic status was determined by dividing the resulting score into quintiles, with the top 20 % being "Richest" and the bottom 20% being "Poorest".

4.11.2.1. Analysis of spatial clustering

The SaTScan™ v9.4.2 software (http://www.satscan.org) was used to identify clusters of under immunization in Butajira HDSS. The spatial scan statistics, developed by Martin Kulldorf employs a circular scanning window; in this case the Bernoulli"s model was employed. These window were centered on the 32 geographical coordinates of the villages/ "Gotes" within the Ten Kebeles in the Butajira HDSS and the window size varied from 0 to 50% of the study population, which allowed for both small and large clusters to be detected.

4.11.2.2. Analysis of the determinants of clustering

Logistic regression was used to identify the determinants of under immunization clustering by comparing cases of under immunized children identified within the spatial cluster with those cases outside the cluster. This was done by taking the unique id of children determined to be within the under immunization cluster from the SaTScan™ v9.4.2 software output window and they were coded as "1" for the dependent variable of "under immunization cluster" and those unique id not included in the under immunization cluster were coded as "0" for the the variable "under immunization cluster". Bivariate logistic regression was then run and those predictor variables with a P value of less than 0.2 were considered for the multivariable analysis of determinants of under immunization clustering. Before running the Multiivariate regression a multi-collinearity test was done and the result showed no or little collinearity evidenced by variance inflation factors (VIF) and tolerance values of very close to 1(one). All the regression was done by using Stata 13.0 (StataCorp, College Station, TX) software.

4.12. Ethical considerations

Before conducting the study an ethical approval was obtained from the Institutional Review Board (IRB) of School of Public Health (SPH), Addis Ababa University (AAU).

A full and detailed explanation as to the benefits and risks of participating in the study was communicated to the study participants assuring their autonomy and the right to refuse to participate in the study. Any personal identifiers were not used during data collection as well as data analysis. A Verbal consent of study participants was obtained before continuing with the data collection.

5. RESULTS

A total of 482 mothers of children aged between 12–23 months old were interviewed, with a response rate of 100%.

Table 1. Socio–demographic characteristics of mothers in Butajira HDSS, Southern Ethiopia, April, 2016 (n=482)

Variable	Frequency	Percent (%)
Educational status		
Did not attend school	268	55.6
Attended School	214	44.4
Primary	136	63.5
Secondary	57	26.5
Certificate and Higher	21	9.8
Marital status		
Married	470	97.5
Divorced	3	0.62
Separated or Widowed	6	1.25
Single	3	0.62
Main Occupation		
House wife	273	77.3
Merchant	88	18.2
Other (Government employee, Farmer or Daily Laborer)	21	4.2
Religion		
Muslim	377	78.2
Orthodox Christian	59	12.2
Protestant	44	9.13
Other	2	0.14
Ethnic group		
Welene	8	1.6
Sodo	38	7.9
Dobi	13	2.7
Meskan	235	48.7
Mareko	53	11
Silte	96	19.9
Other	39	8.1
Mothers age in years		
15-24	82	17
25-34	314	65
35-49	86	18
Number of births		
1	89	18.5
2-5	282	58.5
>6	111	23

5.1.Characteristics of the respondents

The mean age of the mothers was 29.6 years with a standard deviation (SD) of 5.17 years, ranging from 17 to 43 years (Table 1).Only 136 (28.2%) and 78(16.2%) of the mothers attended primary education and secondary or higher level of education, respectively. The majority of mothers, 470 (97.5%) were married and 273 (77.3%) of the mothers were housewives in occupation.

Almost half (48.7%) of the study population belonged to Meskan ethnic group, while Silte (19.9%) and Sodo (7.9%) were the others.

Table 2. Immunization coverage by card or mothers‟ recall, Butajira HDSS, Southern Ethiopia, April, 2016 (n = 484)

	Fully immunized		**Under immunized**	
Kebele	**Frequency**	**Percent (%), 95% CI**	**Frequency**	**Percent (%), 95% CI**
ButajiraTown, (Kebele 04)	29	22	100	78
Hope Jare Demeka	3	7	40	93
Mekakelegna Jare Demeka	9	21	33	79
Wurib	16	29	40	71
Yeteker	18	34	35	66
Shershera Bido	3	17	15	83
Dobena	12	22	42	78
Bati Lejano	2	7	26	93
Misrak Meskan	10	32	21	68
Dirama	7	23	23	77
Total	109	22.4 (18.9, 26.4)	375	77.6 (73.6,81.1)

5.2.Immunization coverage

Out of the total surveyed children aged 12–23 months, vaccination card was only seen and confirmed for 111 (23%) children. From the total 484 children of 12-23 months old children included in the study only 22.4% were Fully immunized while the rest 77.6 % were under immunized (Table 2).

5.3.Specific vaccines Immunization coverage by card or mothers recall

From the four vaccines taken , BCG was the most frequently received vaccine (86.9%), followed by Measles (77.8 %), OPV(0-3) was taken by 279 (57.1 %) children and DPT(1-3) was received by 210 (43.6 %) of the children aged 12 to 23 months old (Table 3).

Table 3. Immunization coverage of specific vaccines by card or mothers‟ recall, Butajira HDSS, Southern Ethiopia, April, 2016 (n = 484)

Vaccine	Coverage by card or mothers' recall		
	Frequency	**Percent (%)**	**95 % CI**
BCG	419	86.9	(83.6, 89.7)
OPV(0-3)	279	57.1	(52.6, 61.4)
DPT(1-3)	210	43.6	(39.2, 48.1)
Measles	375	77.8	(73.9, 81.3)

5.4.Knowledge of mothers about vaccination

Of the total respondents, about 89% had heard about vaccination and vaccine preventable diseases. From those who heard about VPDs 313 (72.6%) reported hearing it from health professionals followed by Radio, Neighbors or friends and Television with proportions of 45(10.4%), 41(9.5%) and 22(5.1%) respectively. With regard to respondent‟s knowledge about the age at which the child begins and finishes immunization, 91(19%) of them knew the age at child immunization begins and 436 (90.5%) knew the age at which the child finishes immunization (Table 4).

In addition to these, 64 (13.3%) of the respondents knew the number of sessions needed to complete the child immunization.

Table 4. Mother‟s knowledge about vaccination in children, Butajira HDSS, Southern Ethiopia, April, 2016 (n = 482)

Mothers knowledge about vaccination in children	Frequency	Percent (%)
Heard about VPDs		
Yes	431	89
Source of Knowledge about VPDs		
Radio	45	10.4
TV	22	5.1
Health personnel	313	72.6
School	6	1.4
Friends/Neighbours	41	9.5
No	51	11
Knew time of vaccination starting age		
Yes	91	19
No	391	81
Knew time of vaccination completing age		
Yes	436	90.5
No	46	9.5
Knew the total number of sessions needed to complete vaccination		
Yes	64	13.3
No	418	86.7

5.5.Geographic Clusters of Under immunization

The spatial analysis for the period (March to April, 2016) identified one (1) statistically significant cluster of under immunized children of 12 to 23 months old in Butajira HDSS (Figure2).

Figure 2. Clusters of under immunization, Butajira HDSS, Southern Ethiopia, April, 2016 (n = 375), (Green circle is area of high rate of under immunization: Blue Circle is area of low rate of under immunization)

The most statistically significant cluster covered an area East of the Town of Butajira, and includes part of the Kebeles of Bati Lejano to the North and Mekakelegna Jare demeka to the South . Children in this cluster had 1.24 (P value=0.011) times the rate of under immunization compared with children outside of that cluster (Table 5).

Figure 3. Clusters of BCG under immunization, Butajira HDSS, Southern Ethiopia, April, 2016 (n=65)

Figure 4. Clusters of Polio under immunization, Butajira HDSS, Southern Ethiopia, April, 2016 (n=203)

Table 5. Spatial Cluster of children under immunization, Butajira HDSS, Southern Ethiopia, April, 2016 (n=484)

Cluster Number and General Description	Radius, km	Population in Cluster, n	Underimmunized Children in Cluster, %	Expected Underimmunized Cases, n	Actual Underimmunized Cases, n	RR	P Value
1: Enseno Town ,under immunization cluster	6.55 km	80	92.5	61.98	74	1.24	0.011
1.Polio cluster	<1km	24	70.8	3.14	17	7.05	0.00000000023
2.Polio cluster	0.34 km	35	37.1	4.57	13	3.32	0.0052
1.BCG cluster	<1km	24	70.8	3.14	17	7.05	0.00000000023
2. BCG cluster	0.34 km	35	37.1	4.57	13	3.32	0.0052
1. DPT Cluster	8.44 km	104	88.5	58.69	92	1.86	0.00000000000096
2. DPT Cluster	1.46 km	43	97.7	24.27	42	1.86	0.000000011
3. DPT Cluster	< 1km	24	91.7	13.54	22	1.68	0.010
4. DPT Cluster	0.93 km	42	81	23.7	34	1.5	0.027
5. DPT Cluster	2.96 km	28	85.7	15.8	24	1.57	0.029
1.Measles cluster,	<1km	24	75	5.33	18	3.86	0.00000034
2.Measles cluster, Enseno	2.96	28	64.3	6.22	18	3.28	0.000022

Of the 484 children in the study population evaluated from March to April, 2016, 80 (16.59%) were identified as being within the cluster of under immunization. The under immunization rate was 92.4% within the clusters, compared with 74.69% outside them (Table 5).

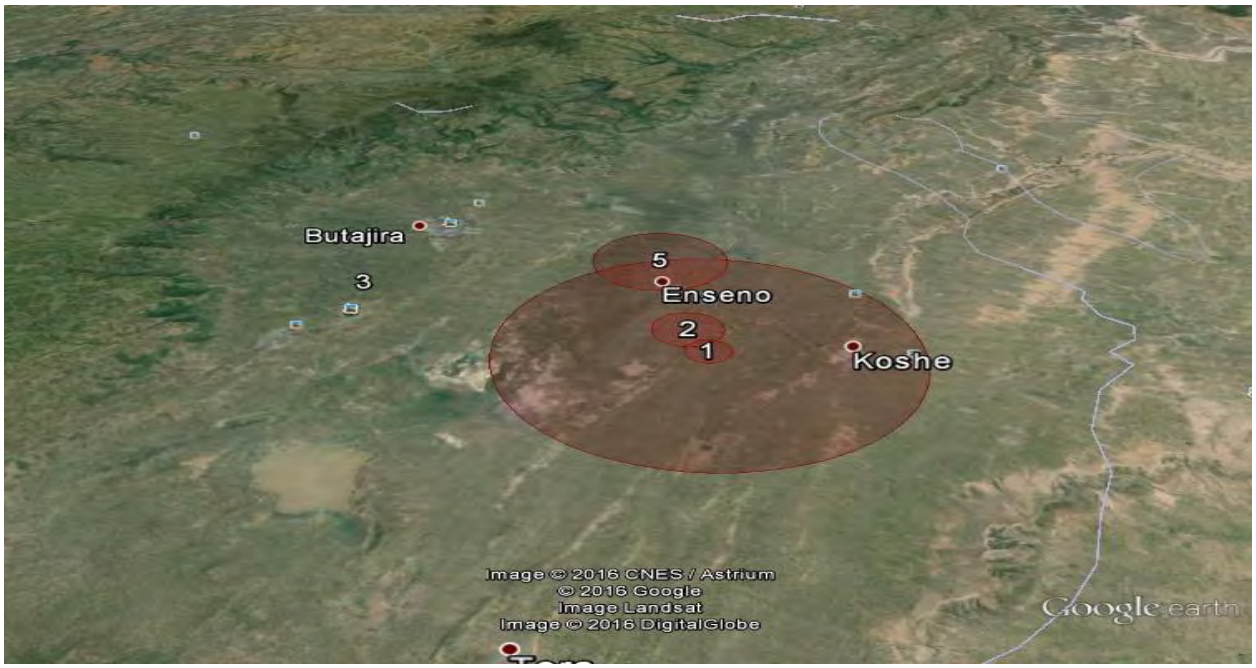

Figure 5. Clusters of DPT under immunization, Butajira HDSS, Southern Ethiopia, April, 2016 (n=272)

Figure 6. Clusters of Measles under immunization, Butajira HDSS, Southern Ethiopia, April, 2016 (n=107)

5.6.Multivariate analysis of under immunization clustering

Table 6. Multivariate analysis of Cluster of Under immunization of children 12 to 23 months old, Butajira HDSS, Southern Ethiopia, April, 2016 (n = 375)

Variables	COR with 95 % CI	AOR with 95 % CI , P Value
Wealth index	P value=0.0466	
Richest	1.00	
Poor	0.44 [0.22,0.87]	0.83[0.37,1.88] , P=0.661
Middle	0.66[0.3,1.46]	0.59[0.25,1.456], P=0.257
Rich	1.0[0.49, 2.06]	0.93 [0.41, 2.13], P=0.87
School attendance	P value=0.0032	
Yes	1.00	
No	2.24 [1.29, 3.9]	1.34 [0.69, 2.58], P=0.39
Mothers main occupation	P value=0.1891	
Merchant	1.00	
Housewife	2.06 [0.89,4.75]	1.87 [075, 4.69], P=0.181
Others(Gov.Emp, Farmer, Laborer)	2.06 [0.53,7.98]	1.97 [0.43, 9.08], P=0.387
Knowledge about VPD	P value=0.0725	
Yes	1.00	
No	0.41 [0.14, 1.2]	0.97 [0.26,3.56], P=0.963
Source of information about VPD	P value=0.0417	
Health professionals	1.00	
Radio/Television	0.42 [0.18,0.98]	0.62 [0.25,1.55], P=0.308
Neighbors or Friends/school	0.49 [0.2, 1.23]	0.77 [0.28,2.08], P=0.604
Mothers TT vaccination	P value=0.0084	
No	1.00	
Yes	2.2 [1.19, 4.06]	**2.21 [1.06,4.63], P=0.035***
Availability of child vaccination card at home	P value=0.0002	
Yes	1.00	
No	3.54 [1.69, 7.39]	2.15 [0.95, 4.88], P=0.066
Place of birth of last pregnancy	P value=0.0000	
Health care setup (Hospital ,Health center or Health post)	1.00	
Home or TBA	6.43 [3.48, 11.88]	**5.1 [2.56,10.1], P=0.000****

* P Value statistically significant below 0.05

** P Value statistically significant below 0.01

The Multivariate logistic regression model was checked for goodness of fit by using the Hosmer-Lemeshow test and it showed that the model was a good fit for the data with a P value of 0.0561 .The Multivariate analysis of the determinants of under immunization clustering in Butajira HDSS revealed that mothers who gave birth in their homes or with a TBA for the last pregnancy were [AOR **5.1 [2.56, 10.1] P=0.000**]** 5.1 times at greater odds of being within the cluster of under immunization than those mothers who gave birth in health care institutions like Hospital, Health center or Health post during their last pregnancy (Table 6).

Another significantly associated factor with under immunization clustering within the Butajira HDSS was having received TT vaccination by the mothers who were [AOR **2.21 [1.06, 4.63] P=0.035*]** 2.21 times at greater odds of being in the cluster than those mothers who didn‟t receive TT vaccination (Table 6).

6. DISCUSSION

This study was set out with the objective of determining under immunization clusters within the Butajira HDSS and to determine the predictors of the under immunization clustering of children 12 to 23 months old. The purely spatial Bernoulli‟s model was employed with a circular window to scan for spatial clusters of under immunization. The present study determined one significant under immunization cluster around Enseno Town spanning in the North to the Kebele of Bati Lejano and to the South to the Kebele of Mekakelegna Jare Demeka. Significant predictors of the under immunization were determined to be Mothers TT vaccination status and the place of birth of the mother during the last pregnancy.

6.1.Full immunization coverage of children 12to 23 months old

The percentage of children who were Fully immunized in this study was determined to be 22.4 %, 95% CI (18.9 %, 26.4 %) (Table 2) which is still very short of the goal of 96 %coverage [30] set for routine immunization in the country's health sector development plan (HSDP) IV by the FMOH in the year 2016, whereas the overall under immunization rate within the District was determined to be 77.6 % , 95% CI (73.6 %, 81.1 %) . The prevalence of Fully immunized children in this study was lower as compared to some Woreda level survey findings such as 36 % in West Shoa , Ambo Woreda [9], 42 % in Wonago District, Southern Ethiopia [12], and 76 % in Lay Armachiho District, Northern Ethiopia [11]. Nevertheless the findings of the current study was in agreement with a study [31] done in 2015, using the 2011 EDHS data with the prevalence of Fully immunized children determined to be 24.3 % and also with the full immunization coverage reported by the 2011 EDHS [6] study for SNNPR as 24 %. Compared to this studies finding of DPT(1-3) coverage of 43.6 %, OPV(0-3) of 57.1 % , Measles vaccination of 77.8% and BCG vaccination of 86.9% among 12-23 months old children ,a similar study done in Ethiopia [31] with the 2011 EDHS data revealed vaccination coverage of DPT(1 to 3), three doses of Polio, Measles and BCG as 36.5 %, 44.3 %, 55.7 % and 66.3 %, respectively , which were very low compared to the present study findings , this could be explained in part by the fact that the EDHS study consisted of varied populations throughout the country and also by the fact that the data was collected before 6 years in 2011 as compared to the current study.

Compared to an African full vaccination coverage study [32] done in 2014 using the DHS data of East African countries like Ethiopia, Burundi, Uganda ,Kenya ,Rwanda and Tanzania the full immunization coverage of 22.4 % determined with the current study was very low compared to figures of 80.6 % (Rwanda) , 76.6% (Burundi) ,52.7% (Kenya), 46.1% (Tanzania) and 37.7% for Uganda, But the DHS study for Ethiopia revealed a vaccination coverage of only 24.6% which was in agreement with the finding of the current study .This difference might be due to different socioeconomic status of the countries and also due to the fact that the DHS data is more diverse one including clusters from both rural and urban setting of the countries , another possible source of variation could be that the DHS study considered four doses of polio to be given to classify a child as fully immunized in contrast to this study which considered only 3 doses of polio as a sufficient criteria to consider a child as fully vaccinated.

6.2.Clusters of under immunization

The most statistically significant under immunization cluster which covered an area East of the Town of Butajira, includes parts of the Kebeles of Bati Lejano to the North and Mekakelegna Jare Demeka to the South. Children in this cluster had a higher rate of under immunization compared with children outside of that cluster, this finding is in agreement with a study in USA in 2015 which identified five significant cluster of under immunization with the SatScan software , also they identified that children within these five clusters of under immunization had a greater rate of under immunization compared with children outside of the five under immunization clusters. The USA study [26] also used the same probability model as the current study, the Bernoulli‟s Model, assuring that the SatScan software, especially the Bernoulli‟s model could be used to pinpoint areas of under immunization effectively. The SatScan spatial statistic has also been used effectively to pinpoint clusters of malnutrition like stunting and wasting [33] in the same study area, employing the Poisson model.

Regarding under immunization with specific vaccines the spatial clustering was determined for the vaccines BCG, Polio(1-3) ,DPT(1-3) and Measles (Figures 3-6) and it revealed that the determined under immunization clusters for the BCG and Polio(1-3) vaccines overlapped completely ,this phenomenon could be explained by the fact that both BCG and Polio are given right after birth and the respondents would have similar response since the schedule of

administration is similar for BCG and the first dose of Polio vaccine. Another research in USA in 2015 [26] have also shown that individual vaccines like MMR (Measles ,Mumps and Rubella) and Varicella vaccinations tend to cluster in such a way that is similar with the general under immunization cluster identified in the area.

6.3.Predictors of under immunization clustering

The current study identified factors like giving birth at home and receiving TT vaccination by mothers as a significant predictor of under immunization clustering within the Butajira HDSS (Table 6).Even though, there was no study done on determinants of under immunization clustering in Ethiopia to compare the current study findings , some literatures [9, 32] found that giving birth at home mothers were less likely to visit health institutions and so get their child vaccinated so that it is more likely that they will be in the under immunization cluster identified.

6.4. Limitations and strengths of the study

The limitations of the study include the fact that geographic location data were provided at the level of village /"Gote" rather than at the Household level which have resulted in a reduction in the number of geographical location units. Household GPS coordinates were not used due to shortage of GPS devices and resource which if collected would have increased the power of detecting under immunization clusters. Regarding the scanning window a circular scanning window was employed which could have missed the actual shape of the clusters that might have had an oval or irregular shape. Child characteristics like sex and birth order and also distance to heath facilities from clusters were not evaluated as predictors of under immunization clustering in this study.

On the other hand the fact that this study is probably the first one to describe the geographic clustering of under immunization in Ethiopia and the large enough sample size being used without the need to take a finite population correction to answer the research questions could be taken as possible strengths of the study.

6.5.Implications of the study findings

This study revealed significant areas of under immunization clustering and also areas of specific vaccine under immunization clustering , these areas tended to cluster in two major areas , the

first being around Enseno Town and the second one relatively of less size cluster (less than 1km radius) was consistently found South East of Butajira Town, clearly showing that efforts to improve EPI coverage by the respective "Woreda" Health Offices should be geared towards the Enseno Town area specifically to the Kebeles of Bati Lejano , Mekakelegna Jare Demeka and also to the Neighboring Kebele of Hope Jare Demeka. The SatScan spatial cluster detection techniques are nowadays becoming important in detection of outbreaks in hospitals, one such study [34] showed that the SatScan method detected all the outbreaks which were detected manually whereas excluding some which could have led to unnecessary resource mobilization to that area leading to wastage of resources. Other researchers in South Africa [35] showed that the SaTScan method employing the purely spatial Bernoulli‟s model can be used effectively to detect local malaria clusters for coordinating the malaria control programme in the area .

7. CONCLUSION AND RECOMMENDATIONS

7.1.Conclusion

Under immunization of 12-23 months old children and under immunization with specific vaccines such as Polio, BCG, DPT (1-3) and Measles clustered geographically in the Butajira HDSS.

Factors like having received TT vaccination by mother, and delivery of the last pregnancy at home or with a TBA were determined as predictors of cases of under immunization to be within the under immunization clusters .

7.2.Recommendations

Spatial studies including the current study have been shown to be effective in pinpointing areas of disease clustering, which could be very useful to programme managers of public health institutions in Ethiopia and beyond.

Similar studies in other study settings in Ethiopia involving heterogeneous populations are recommended to help validate and strengthen the current study findings. Also other studies aimed at analyzing other possible predictors of under immunization clustering like distance from health institutions should be considered by researchers in the future.

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ANNEX

ANNEX 1.Conceptual framework

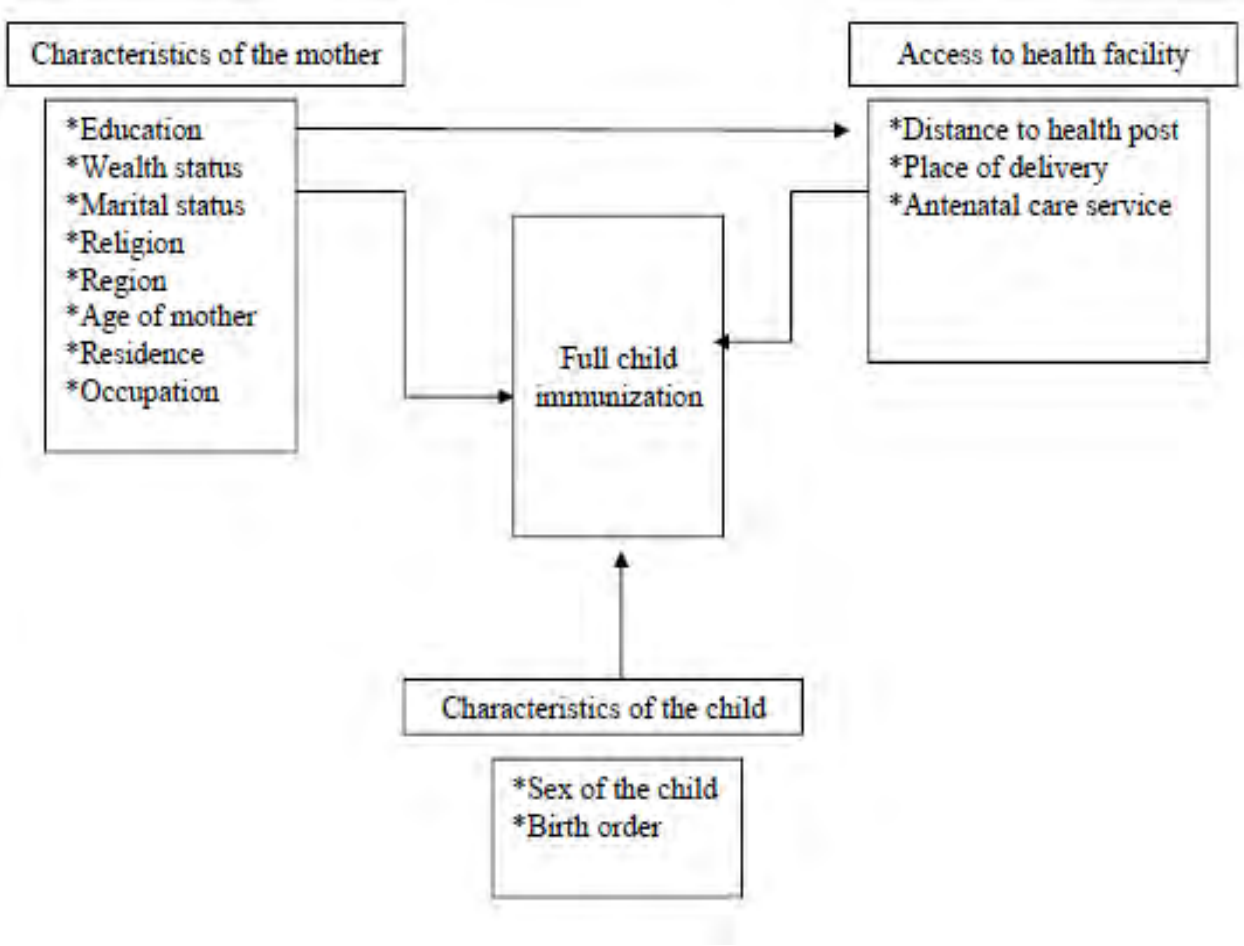

Figure 7 . Conceptual framework for determinants of full child immunization of children[36]. (Adopted from Adebiyi. F, 2013)

ANNEX 2. English Questionnaire

Research title : Spatial distribution of Under-Immunization in Butajira HDSS
This questionnaire form is to be used at Households to record information on the vaccinations for children aged 12 to 23 months.

IDENTIFICATION

1. Zone Name :_____	**2**. Kebele/Village Name:_____
3. Household number: _____	
4. Household GPS Coordinate	
N ☐☐ ☐☐☐☐	**E** ☐☐☐ ☐☐☐☐

SECTION I: Sociodemographic Characteristics

S.No	QUESTION	CODING	REMARK
101	What is your Marital status?	Married.....1 Divorced.....2 Separated.....3 Widowed.....4 Single.....5	
102	How old are you?	_____Years	
103	Have you ever attended school?	Yes……1 NO……..…2	If NO Go To Qn.105
104	What is the highest Education level you achieved?	Primary(1-6).....1 Secondary(7-10).....2 Certificate.....3	

		Degree and above 4	
105	What is your Main Occupation?	Housewife.....1 Government employee.....2 Merchant.....3 Farming /animal husbandry....4 Daily Labourer.....5 Others, Specify_____	
106	What is your Religion?	Muslim.....1 Orthodox.....2 Protestant.....3 Other, specify _____	
107	What is your Ethnicity?	Welene.....1 Sodo.....2 Dobi.....3 Meskan.....4 Mareko.....5 Silte .....6 Other (specify)_____	
108	WHICH OF THIS MATERIALS EXIST IN YOUR HOUSE		
	YES NO Has electricity ☐ ☐ Kerosene lamp ☐ ☐ Has radio ☐ ☐ Has television ☐ ☐ Has refrigerator ☐ ☐ Has bicycle ☐ ☐ Solar light ☐ ☐		YES NO Has motorcycle ☐ ☐ Has car ☐ ☐ Has mobile phone ☐ ☐ Has landline phone ☐ ☐ Chair ☐ ☐ Table ☐ ☐
109	MAIN MATERIAL OF THE FLOOR (Record observation)	Earth/sand .....1 Palm/bamboo.....2 Wood.....3 Cement 4	

		Ceramic tiles.....5 Carpet.....6 Other (specify.....	
110	MAIN MATERIAL OF THE ROOF(record your observation)	Has corrugate iron roofing .....1 Hatch/leaf/ mud.....2 Has roofing tiles.....3 Has other roofing 4	
111	MAIN MATERIAL OF THE WALLS (record observation.)	No walls .....1 Rudimentary walls.....2 Stone with mud .....3 Plywood.....4 Stone with lime/ cement.....5 Mud and wood.....6 Cement block.....7 Other (specify)----------	
112	How long does it take you to fetch water?	Minutes .....1 /-------/--------/ Don't Know.....2	
113	What is the toilet facility available?	Functional flush toilet.....1 Unfunctional flush toilet.....2 Functional pit latrine.....3 Unfunctional pit latrine.....4 Forest or open area.....5 Other(specify).....6	
114	Main fuel type used for cooking	Electric.....1 Solar power.....2 Kerosene.....3 Charcoal.....4 Wood.....5 Leaves.....6	

		Cow Dung.....7 Other(specify).....8	
115	Do you have agriculture land?	Yes……...…1 NO……..…2 →	If No Skip to Question 117
116	How many acres of agricultural land do you own?	Number .....Acres /-------/----	
117	Do you own any livestock?	Yes……...…1 NO……..…2 →	Skip to Section II
118	How many of the following do you own?	Cow/OX…….....1 /------/-----/ Horse/Donkey/Mule.....2 /------/-----/ Goat.....3 /------/-----/ Sheep.....4 /------/-----/ Hen.....5 /------/-----/ Bee Hive.....6 /------/-----/	

SECTION II: Health Service Utilization

S.No	QUESTION	CODING	REMARK
201	Is there any health facility rendering vaccination service near your home?	Yes.....1 No.....2 →	If NO go to Qn. 203
202	If Yes to the above question what type of health facility is it?	Hospital.....1 Health center.....2 Health post.....3 Private clinic.....4	
203	What was your Place of Delivery for the last pregnancy?	Home/TBA.....1 Health Facility.....2	
204	Have you attended ANC Service during your last pregnancy?	Yes.....1 No.....2	
205	Have you received TT vaccination during your last pregnancy?	Yes.....1 No.....2 →	If NO go to Qn. 207
206	If Yes to the above question. How many injections did you receive through your pregnancy?	_____	
207	How many children did you ever give birth to?	_____	

SECTION III: Knowledge And Attitude Towards Immunization

301	Have you heard about vaccination and vaccine preventable diseases?	Yes.....1 No.....2 →	If NO go to Qn.19
302	If yes to the above question from which source did you hear about it first?	Radio.....1 TV.....2 Friends/Neighbours.....3 School.....4 Health personnel.....5 Others, specify_____	
303	Can you tell me at what age should vaccination be started?	Right after birth.....1 One month after birth...2 Anytime after birth.....3 After one year.....4 I don‟t know.....5	
304	At what age the child should complete Immunization?	_____	
305	How many vaccination sessions are needed for a child to be fully protected?	One.....1 Three.....2 Five.....3 Repeated.....4 Don‟t know.....5	
306	Have you ever received a vaccination card for your child?	Yes.....1 No.....2 →	If NO skip to SECTION V QUESTION 50 3
307	Do you currently have a vaccination card for your child given from health facility?	Yes.....1 No.....2 →	If NO skip to SECTION V QUESTION 50 3

SECTION IV: Immunization Status from Vaccination Card

			Last Birth						Next to Last Birth						
Record day, month and year of birth as written on vaccination record			__ __ / __ __/ 200 ___						__ __ / __ __ / 200 __						REMARK
Copy dates for each vaccination from the card. Write „NO" in day column if card shows that vaccination was given but no date recorded.			Date of Immunization						Date of Immunization						
			Day		Month		Year		Day		Month		Year		
401	BCG	BCG													IF BCG TO Measles is all recorded skip to section V ,503H and finish
	OPV 0	POV0													
	OPV 1	OPV1													
	OPV 2	OPV2													
	OPV 3	OPV3													
	DPT-HepB Hib1	Penta 1													
	DPT-HepB Hib2	Penta 2,													
	DPT-HepB Hib3	Penta 3													
	PCV 1	PCV 1													
	PCV 2	PCV2													
	PCV 3	PCV3													
	Rota 1	Rota 1													
	Rota 2	Rota2													
	Measles	Measles													

SECTION V: Immunization Status from Mothers Recall

501		Has (NAME) received any vaccinations that are not recorded on this card, including vaccinations given in a national immunization day campaign? RECORD "YES" ONLY IF THE RESPONDENT MENTIONS AT LEAST ONE OF THE VACCINATIONS IN 1 THAT ARE NOT RECORDED AS HAVING BEEN GIVEN	YES----------1 (PROBE FOR VACCINATIONS SHOWN IN 2AND WRITE "66" IN THE CORRESPONDING DAY COLUMN IN 1) (SKIP TO 503) NO----------2 DON'T KNOW-------8	YES----------1 (PROBE FOR VACCINATIONS SHOWN IN 2AND WRITE "66" IN THE CORRESPONDING DAY COLUMN IN 1) (SKIP TO 503) NO----------2 DON'T KNOW-------8	" SKIP TO SECTION VI
502		Did (NAME) ever have any vaccinations to prevent him/her from getting diseases, including vaccinations received in a national immunization campaign?	YES----------1 NO----------2 DON'T KNOW------8 (SKIP TO 601)	YES----------1 NO----------2 DON'T KNOW------8 (SKIP TO 601)	
503		Please tell me if (NAME) had any of the following vaccinations:			
	503A	A BCG vaccination against tuberculosis that is an injection in the right arm or shoulders that usually causes a scar?	YES----------1 NO----------2 DON'T KNOW----------8	YES----------1 NO----------2 DON'T KNOW------8	
	503B	Polio vaccine, that is, drops in the mouth?	YES----------1 NO----------2 (SKIP TO 503D) DON'T KNOW----------8	YES----------1 NO----------2 DON'T KNOW------8	(SKIP TO 503D)
	503C	Was the first polio vaccine given	FIRST TWO WEEKS-------1	FIRST TWO WEEKS-------1	

		in the first two weeks after birth or later?	LATER----------2	LATER----------2	
	503D	How many times was the polio vaccine received?	NUMBER OF TIMES---- ☐	NUMBER OF TIMES--- ☐	
	503E	A DPT or DPT-HepB-Hib vaccination, that is, an injection given in the thigh or buttocks sometimes at the same time as polio drops?	YES----------1 NO----------2 (SKIP TO 503G) DON'T KNOW----------8	YES----------1 NO----------2 DON'T KNOW----8	(SKIP TO 503G)
	503F	How many times was a DPT or DPT-HepB-Hib vaccination given?	NUMBER OF TIMES---- ☐	NUMBER OF TIMES---- ☐	
	503G	A Measles injection or an MMR injection - that is, a shot in the arm at the age of 9 months or older to prevent him/her from getting Measles?	YES----------1 NO----------2 DON'T KNOW---------8	YES----------1 NO----------2 DON'T KNOW---------8	
	503H	Did (NAME) receive a vaccination certificate for completing the schedule for all vaccinations?	YES----------1 NO----------2 DON'T KNOW---------8	YES----------1 NO----------2 DON'T KNOW---------8	

SECTION VI: Reasons for under immunization

S.No	QUESTION	CODING	RE MARK
601	What are the reasons for the child not to receive full immunization?	Absence of health facility.....1 Distance of health facility being very far from home.....2 Vaccination has no use.....3 Vaccination harms the child.....4 Religious and cultural reasons.....5 Lack of awareness about vaccination.....6 Vaccination time not convenient.....7	

Field editor"s name and signature:	Main Supervisors name and signature:
Name_____	Name_____

ANNEX 3. Information Sheet and Consent Form

Information Sheet

Hello! My name is _____; we are currently working to determine the geographical distribution of under immunization in this Woreda. This study tries to identify the geographical distribution of under immunization of children 12 up to 23 months old in your Woreda and checks whether there is geographical clustering of under immunization and if so proposes area specific intervention methods to alleviate this problem of under immunization.

I am one of the data collectors and I was asking you some questions about your 12 up to 23 months old child and his/her immunization status .The interview will not take more than 25 minutes. Your contribution is of paramount importance to understand the problem of under immunization in your Woreda. The information you give was kept confidential by avoiding any personal identifiers like name and Household from any part of the study.

There is no obligation for you to participate in this study and you can decline even if after you start the study and there was no consequence as a result of refraining from the study.

So, would you be willing to participate in this study of geographical distribution of under immunization in your Woreda?

Yes _____, No _____

Thank You for your time!

ANNEX 4. Amharic Questionnaire

የጥናቱ ርእስ : የዝቅተኛ ክትባት አከባቢያዊ ስርጭት በቡታጅራ አካባቢ
ይህ መጠይቅ በቤት ለቤት ዳሰሳ ከ 12 እስከ 23 ወር እድሜ ያላቸው ህፃናት ላይ ስለ ክትባት ሁኔታ መረጃ ለመሰብሰብ የተዘጋጀ ነው ።

መለያ

1. የዞን ስም:_____	**2**. :የቀበሌ ስም:_____
3.የቤት ቁጥር: ☐☐☐☐☐☐☐☐	4.የጎጥ/ መንደር ስም:_____
4. የመኖሪያ ቤት ጂኦግራፊያዊ መረጃ	
ሰሜን ☐☐ ☐☐☐☐☐	**ምስራቅ** ☐☐☐ ☐☐☐☐☐

ክፍል አንድ: የሰነ ህዝብ መግለጫዎች

ቁጥር	ጥያቄ	መልስ	ምርመራ
101	የጋብቻ ሁኔታዎ ምንድን ነው ?	ያገቡ.....1 የፈቱ.....2 የተለያዩ.....3 በሞት የተለዩ.....4 ያላገባ.....5	
102	እድሜዎት ስንት ነው ?	_____አመት	
103	ዘመናዊ ትምህርት ተከታትለው ያውቃሉ ?	አዎ.....1 የለም .....2 →	መልሱ የለም ከሆነ ወደ ጥያቄ 105 ይለፉ
104	የደረሱበት ከፍተኛ የትምህርት ደረጃ ?	የመጀመሪያ ደረጃ(1-6).....1 ሁለተኛ ደረጃ(7-10).....2	

		ሠርተፍኬት(10+).....3 ከፍትኛ ደረጃ(ድግሪ እና ከዛ በላይ).....4	
105	ዋነኛ የስራዎ ሁኔታ ምንድን ነው ?	የቤት እመቤት.....1 የመንግስት ሰራተኛ.....2 ነጋዴ.....3 ገበሬ / እንስሳት ማርባት.....4 የጉልበት ሰራተኛ.....5. ሌላ ካለ ይግለፁ _____	
106	የምን ሃይማኖት ተካታይ ነዎት?	ሙስሊም.....1 ኦርቶዶክስ ክርስቲያን.....2 ፕሮቴስታንት.....3 ሌላ ካለ ይግለፁ _____	
107	ብሄርዎ ምንድን ነው?	ወለኔ.....1 ሶዶ.....2 ዶቢ.....3 መስቃን.....4 ማረቆ .....5 ስልጢ.....6 ሌላ ካለ ይግለፁ _____	
108	የትኞቹ እቃዎች በቤትሽ ውስጥ ይገኛሉ ? አዎአይአዎአይአዎአይ ኤሌክትሪክ ☐ ☐ ራዲዮ ☐ ☐ ፍሪጅ ☐ ☐ ሞተር ስይክል ☐ ☐ የሞባይል ስልክ ☐ ☐ ጠረጴዛ ☐ ☐ የኩራዝ መብራት ☐ ☐ ቴሌቪዝን ☐ ☐ ሳይክል ☐ ☐ መኪና ☐ ☐ የቤት ስልክ ☐ ☐ ወንበር ☐ ☐ ሶላር መብራት ☐ ☐		
109	የቤቱ ወለል የተሰራበት ቁስ (የተመለከቱትን ይመዝግቡ)	አሸዋ/ አፈር.....1 ቀርከሃ.....2 እንጨት.....3 ሲሚንቶ.....4 እምነበረድ.....5 ምንጣፍ.....6 ሌላ----------	

110	የቤቱ ጣሪያ የተሰራበት ቁስ (የተመለከቱትን ይመዝግቡ)	የቆርቆሮ ጣሪያ.....1 የሳር ጣሪያ/ጭቃ.....2 የሸክላ ማእዘን.....3 ሌላ----------	
111	የቤቱ ግድግዳ የተሰራበት ቁስ(የተመለከቱትን ይመዝግቡ)	ግድገዳ የሌለው.....1 የተጀመረ ግድግዳ.....2 ድንጋይና ጭቃ.....3 እረሱ የተጣበቀ ስስ እንጭት.....4 ዲንጋይ እና ሲሚንቶ.....5 ጭቃና እንጨት.....6 ሸክላ/ጡብ.....7 ሌላ----------	
112	ውሀውን ቀድቶ ለመመለስ ምን ያህል ደቂቃ ይፈጅቦታል?	ደቂቃ.....1 /-------/--------/ አላውቀውም.....2	
111	ቤቱ ምን አይነት መጸዳጃ ቤት አለው ?	የሚሰራ በውሀ የሚወርድ ሽንት ቤት.....1 የማይሰራ በውሃ የሚወርድ ሽንት በት.....2 የሚሰራ የጉድጓድ ሽንት ቤት.....3 የማይሰራ የጉድጓድ ሽንት ቤት.....4 ሜዳ ሊይ/ጫካ ውስጥ.....5 ሌላ (ይገለጽ).....6	
113	ቤተሰቡ በአብዛኛው ለማብሰያ የሚጠቀምበት የማገዶ አይነት ምንድን ነው ?	ኤላክትሪክ.....1 የሶላር ሀይል.....2 ነጭ ጋዝ.....3 ከሰል.....4 እንጨት.....5 ቅጠላ ቅጠል እና ጭራሮ.....6 ኩበት.....7 ሌላ(ይገለጽ).....8	
114	የእርሻ መሬት አለዎት ?	አዎ.....1 አይ.....2 →	አይ ከሆነ ወደ ጥያቄ 116 ይለፉ
115	ምን ያህል ሄክታር /ጥማድ/ መሬት ነው ያላችሁ	በቁጥር ----------ጥማድ----------ሄክታር	
116	በቤት ውስጥ ከብቶች፣ መንጋ፣ የእርሻ እንስሳ፣ ድሮዎች አለ	አዎ.....1 አይ.....2 →	አይ ከሆነ ወደ ከፍል 2ይለፉ
117	ከሚከተለት እንስሳቶች ውስጥ በቁጥር ምን ያህል በቤት ውስጥ አሉ ?	የወተት ላም/ በሬ.....1 /------/-----/ ፈረስ/አህያ/ በቅሎ.....2 /------/-----/ ፍየል.....3 /------/-----/ በግ.....4 /------/-----/ ዶሮ.....5 /------/-----/ የንብ ቀፎ.....6 /------/-----/	

ክፍል ሁለት: የጤና አገልግሎት አጠቃቀም

ቁጥር	ጥያቄ	መልስ	ምርመራ
201	በመኖሪያ አቅራቢያዎ የክትባት አገልግሎት የሚሰጥ የጤና ተቋም አለ ?	አዎ.....1 የለም.....2 →	ወደ 203 ይለፉ
202	ለጥያቄ 201 መልስዎ አዎን ከሆነ የጤና ተቋሙን አይነት ይግለፁ?	የግል ክሊኒክ.....1 ጤና ኬላ.....2 ጤናጣቢያ.....3 ሆስፒታል.....4	
203	በመጨረሻ እርግዝናዎ ወቅት የት ነው የወለዱት?	ቤት ውስጥ/ ልምድ አዋላጅ.....1 ጤና ኬላ.....2 ጤና ጣቢያ.....3 የግልክሊኒክ.....4 ሆስፒታል.....5	
204	በመጨረሻ እርግዝናዎ ወቅት የቅድመ ወሊድ ክትትል አድርገዋል?	አዎን.....1 አይ አላደረግኩም.....2 →	መልሱ አይ አላደረግኩም ከሆነ ወደ ጥያቄ 206 ይለፉ
205	ለምን ያህል ግዜ የቅድመ ወሊድ ክትትል አድርገዋል?	በቁጥር ----------	
206	በመጨረሻ እርግዝናዎ ወቅት በክንድ ላይ በመርፌ የሚሰጥ የቴታነስ ክትባት ተከትበዋል ??	አዎን.....1 አይአልተከተብኩም.....2 →	መልሱ አይ አልተከተብኩ ም ከሆነ ወደ ጥያቄ 208 ይለፉ
207	ለጥያቄ 206 መልስዎ አዎን ከሆነ በአጠቃላይ ስንት ግዜ ክትባቱን ደጋግመው ወስደዋል?	በቁጥር _____	
208	እስከዛሬ ድረስ ስንት ልጆች ወልደዋል?	በቁጥር _____	

ክፍል ሶስት: የእናትየው እውቀትና አመለካከትስለ ህፃን ክትባት

301	ስለ ክትባት እና በክትባት መከላከል ስለሚቻሉ በሽታዎች ሰምተዋል?	አዎ.....1 አልሰማሁም.....2 →	መልሱ አልሰማሁም ከሆነ ወደ ጥያቄ 303 ይለፉ
302	ለጥያቄ 301 መልስዎ አዎን ከሆነ ከየት ነው ስለክትባት መረጃ ያገኙት ?	ሬድዮ.....1 ቴሌቪዥን.....2 ጎረቤት/ጓደኛ.....3 ትምህርት ቤት.....4 ከጤና ባለሙያ.....5 ሌላ ካለ ይግለፁ _____	
303	ለህፃናት ክትባት መጀመር ያለበት በስንት እድሜያቸው ነው?	ወድያውኑ እንደተወለዱ.....1 ከተወለዱ ከአንድ ወር በኋላ.....2 ከወሊድ በኋላ በ ማንኛውም ግዜ.....3 ከአንድ አመት እድሜ በኋላ.....4 አላውቅም.....5	
304	ለህፃናት የክትባት ማጠናቀቂያ እድሜያቸው ስንት አመት(ወር) ነው??	_____	
305	የህፃናት ክትባት ሙሉ በሙሉ ለማጠናቀቅ ስንት የተለያዩ ግዜያት መከተብ አለባቸው ?	አንድ.....1 ሶስት.....2 አምስት.....3 በተደጋጋሚ.....4አላውቅም.....5	
306	ከጤና ተቋም የተሰጠዎት የህፃን ክትባት መግለጫ ካርድ እቤትዎ አለ?	አዎ.....1 የለም.....2	
307	ከጤና ተቋም የህፃን ክትባት መግለጫ ካርድ ተቀብለው ያውቃሉ ?	አዎ.....1 የለም.....2 →	መልሱ የለም ከሆነ ወደ ክፍል አምስት ጥያቄ 503 ይለፉ

ክፍል አራት: የህፃኑ የክትባት ሁኔታ ከክትባት ካርድ አንፃር

			የመጨረሻ ልጅ						ከመጨረሻ ቀጣይ ልጅ						
የህፃኑ የትውልድ ቀን/ ወር /አመተ ምህረት			___ ___ / ___ __ / 200 ___						___ __ /__ __ / 200 ___						
ከክትባት ካርድ ላይ ያለውን ቀን እዚህ ላይ ይመዝገብ. • **ክትባት ተሰጥቶ ነገር ግን ቀኑ ካልተፃፈ "አይ" ብለው የቀን መመዝገቢያው ላይ መዝገብ::**			ክትባቱ የተሰጠበት ቀን						ክትባቱ የተሰጠበት ቀን						ምርመራ
			ቀን	ወር	አመተ ምህረት				ቀን	ወር	አመተ ምህረት				
401	ቢሲጂ (BCG)	ቢሲጂ													**ከ** ቢሲጂ (BCG) ጀምሮ እስከ ኩፍኝ(Measles) ድረስ ሁሉም ክትባቶች ከተመዘገቡ /ከተሰጡ ወደ ክፍል አምስት ጥያቄ **503Hይሂዱ** እና መጠይቁን ይጨርሱ ::
	ፖሊዮ 0 (OPV 0)	ኦፒቪ 0													
	ፖሊዮ 1(OPV ነ)	ኦፒቪ 1													
	ፖሊዮ 2(OPV 2)	ኦፒቪ 2													
	ፖሊዮ 3(OPV 3)	ኦፒቪ 3													
	ዲፒቲ-ሄፕ-ሂብ 1(DPT-HepB Hibነ)	ፔንታ 1													
	ዲፒቲ-ሄፕ- ሂብ 2(DPT-HepB Hib2)	ፔንታ 2,													
	ዲፒቲ1-ሄፕ-ሂብ 3(DPT-HepB Hib3)	ፔንታ 3													
	ፒሲቪ ነ (PCV ነ)	ፒሲቪ ነ													
	ፒሲቪ 2(PCV 2)	ፒሲቪ 2													
	ፒሲቪ 3 (PCV 3)	ፒሲቪ 3													
	ሮታ ነ (Rota ነ)	ሮታ ነ													
	ሮታ 2 (Rota 2)	ሮታ ነ													
	ኩፍኝ(Measles)	ሚዝልስ													

ክፍል አምስት: የህፃኑ የክትባት ሁኔታ ከወላጅ እናት ቃለ መጠይቅ

501	ህፃን_____ከላይ ከተጠቀሱት ክትባቶች ውጭ የወሰዳቸው ክትባቶች ካሉ ይግለፁ ፡በሃገራዊ ዘመቻ የተሰጡ ክትባቶችም ካሉ ይጥቀሱ ? በ ''4ዐ'' ስር ከተጠቀሱት ቢያንስ አንዱን ክትባት ከጠቀሱ ‘‘አዎ ‘‘ የሚለው ላይ ምልክት ያድርጉ	አዎ----------1 (ከላይ በተራ ቁጥር ፣ ላይ ስለተገለፁት ክትባቶች ተጨማሪ ማብራሪያ እንድትሰጥ ተጨማሪ ጥያቄዎች እናቲቱን ይጠይቁ) የለም----------2 አላውቅም----------8	አዎ----------1 → (ከላይ በተራ ቁጥር ፣ ላይ ስለተገለፁት ክትባቶች ተጨማሪ ማብራሪያ እንድትሰጥ ተጨማሪ ጥያቄዎች እናቲቱን ይጠይቁ) የለም----------2 አላውቅም----------8 →	(ወደ ጥያቄ 503 ይሂዱ) ወደ ጥያቄ 502ይሂዱ)
502	ህፃን_____ ከበሽታ የሚከላከሉ ክትባቶች ወስዶ ያውቃል ? ፡በሃገራዊ ዘመቻ የተሰጡ ክትባቶችም ጨምሮ?	አዎ----------1 የለም----------2 አላውቅም--------- -8	አዎ----------1 የለም----------2 አላውቅም--------- -8 →	(ወደ ጥያቄ 601ይሂዱ)
503 503A	እባክዎን ህፃን_____ ከዚህ በታች የተዘረዘሩትን ክትባቶች ወስዶ ያውቃል ? ከሳንባ ነቀርሳ በሽታ ለመከላከል የሚያገለግል በቀኝ ክንድ ላይ በመርፌ የሚሰጥ እና ጠባሳ የሚተው ክትባት ወስዶ ያውቃል ?	አዎ----------1 የለም----------2 አላውቅም----------8	አዎ----------1 የለም----------2 አላውቅም----------8	ከጥያቄ 503A ፤503B ፤503E እና 503G ቢያንስ የአንዱ መልስ የለም ወይም አላውቅም ከሆነ ወደ ክፍል ስድስት ይሂዱ እና መጠይቁን ይጨርሱ፡፡
503B	በአፍ በጠብታ መልክ የሚሰጥ የፖሊዮ ክትባት ወስዷል /ወስዳለች ?	አዎ----------1 የለም----------2 አላውቅም----------8	አዎ----------1 የለም----------2 አላውቅም----------8 →	(ወደ ጥያቄ **503 D**ይሂዱ)
503C	የመጀመሪያው የፖሊዮ ክትባት የወሰደው በተወለደ በሁለት ሳምንት ውስጥ ነው ወይስ ከዚያ በኋላ ?	በሁለት ሳምንት ውስጥ ነው ---1 ከሁለት ሳምንት በኋላ--------2	በሁለት ሳምንት ውስጥ ነው --1 ከሁለት ሳምንት በኋላ-------2	
503D	ለምን ያህል ግዜ ፖሊዮ ክትባት ተከተበ/ች ?	የተሰጠበት ግዜ ብዛት ----☐	የተሰጠበት ግዜ ብዛት ---☐	

503E	የዲፕቲ ወይም የዲፕቲ-ሄፕ-ሂብ ክትባት በመርፌ በታፋ ወይንም በቂጥ ላይ በመውጋት የሚሰጥ ክትባት ወስዷል /ወስዳለች ? ብዙውን ጊዜ ከፖሊዮ ክትባት ጋር በተመሳሳይ ወቅት ሊሰጥ ይችላል	አዎ----------1 የለም----------2 አላውቅም----------8	አዎ----------1 የለም----------2 አላውቅም----------8	(ወደ ጥያቄ 503G ይሂዱ)
503F	ለምን ያህል ግዜ የዲፕቲ ወይም የዲፕቲ-ሄፕ-ሂብ ክትባት ተከተበ/ች ?	የተሰጠበት ግዜ ብዛት -----☐	የተሰጠበት ግዜ ብዛት ---☐	
503G	በዘጠኝ ወር እድሜ ወይንም ከዚያ በኋላ በቀኝ ክንድ ላይ በመርፌ የሚሰጥ የሚዝልስ ክትባት ተከትቧል/ባለች ?	አዎ----------1 የለም----------2 አላውቅም----------8	አዎ----------1 የለም----------2 አላውቅም----------8	
503H	ህፃን_____ ከበሽታ የሚከላከሉ ክትባቶችን በሙሉ ወስዶ ማጠናቀቁን የሚገልፅ የምስክር ወረቀት ወስዷል /ወስዳለች ?	አዎ----------1 የለም----------2 አላውቅም----------8	አዎ----------1 የለም----------2 አላውቅም----------8	

ክፍል ስድስት: ህፃኑ የተሟላ ክትባት ላለማግኘቱ ምክንያቶች

ቁጥር	ጥያቄ	መልስ	ምርመራ
601	ህፃኑ የተሟላ ክትባት ላለማግኘቱ ምክንያቶች ከዚህ በታች ካሉት አማራጮች ምንድን ናቸው ?	የጤና ተቋም በመኖሪያ አቅራቢያ አለመኖር.....ı ጤና ተቋም ከመኖሪያ ቤት በጣም ሩቅ መሆን.....2 ክትባተ ለህፃኑ ምንም ጥቅም ስለሌለው.....3 ክትባት ህፃኑን ስለሚጎዳው.....4 ከሃይማኖት ወይም ባህላችን ጋር በተገናኙ ምክንያቶች..5 ስለ ክትባት ያለው ግንዛቤ አናሳ በመሆኑ.....6 የክትባት መስጫ ግዜ አመቺ ባለመሆኑ.....7	

ANNEX 5 –Amharic Information sheet and Consent form

ስለ ጥናቱ መረጃ

እንዴት ነዎት

እኔ ስሜ_____ እባላለሁኝ ። በአሁኑ ግዜ ስለ የቡታጅራ አካባቢ የህፃናት ዝቅተኛ የክትባት አካባቢያዊ ስርጭትን በተመለከተ ጥናት እየሰራን ነው ። ይህ ጥናት ከ12 እስከ 23 ወራት እድሜ ስላላቸው ህፃናት ዝቅተኛ የክትባት አካባቢያዊ ስርጭትን በእርስዎ ወረዳ ውስጥ በአንድ የተወሰነ አካባቢ መከማቸቱን ለማወቅ ይጠቅማል ይህም ከታወቀ ችግሩን ለመፍታት ከወረዳው የጤና ፅ/ቤት ጋር በመሆን ችግሩን ለመፍታት ይውላል ።

እኔ የመረጃ ሰብሳቢ ባለሞያ ስሆን ስለህፃን ልጅዎት የክትባት ሁኔታ አንዳንድ ጥያቄዎችን እጠይቅዎታለሁ ። ቃለ መጠይቁ ቢበዛ 25 ደቂቃ ቢወስድ ነው ። የእረስዎ ተሳትፎ ለዚህ ጥናት ማለትም የህፃናት ክትባት ችግርን ለመፍታት በጣም አስፈላጊ ነው ። የሚሰጡት ማንኛውም መረጃ በሚስጥር እንደሚያዝ ለመግለፅ እወዳለሁ ።

በዚህ ጥናት ላይ እንዲሳተፉ ምንም አይነት ግዴታ የሌለቦት ሲሆን ጥናቱን ከጀመሩ በኋላም ቢሆን እንኳ ማቋረጥ ቢፈልጉ መብትዎ መሆኑን አሳወቆታለሁ።

ስለዚህ በዚህ የቡታጅራ አካባቢ የህፃናት ዝቅተኛ የክትባት አካባቢያዊ ስርጭትን በተመለከተ ለሚደረገው ጥናት ለመሳተፍ ፍቃደኛ ነዎት ?

አዎን_____ አይደለሁም_____

ስለትብብርዎና ስለጊዜዎት አመሰግናለሁ ።