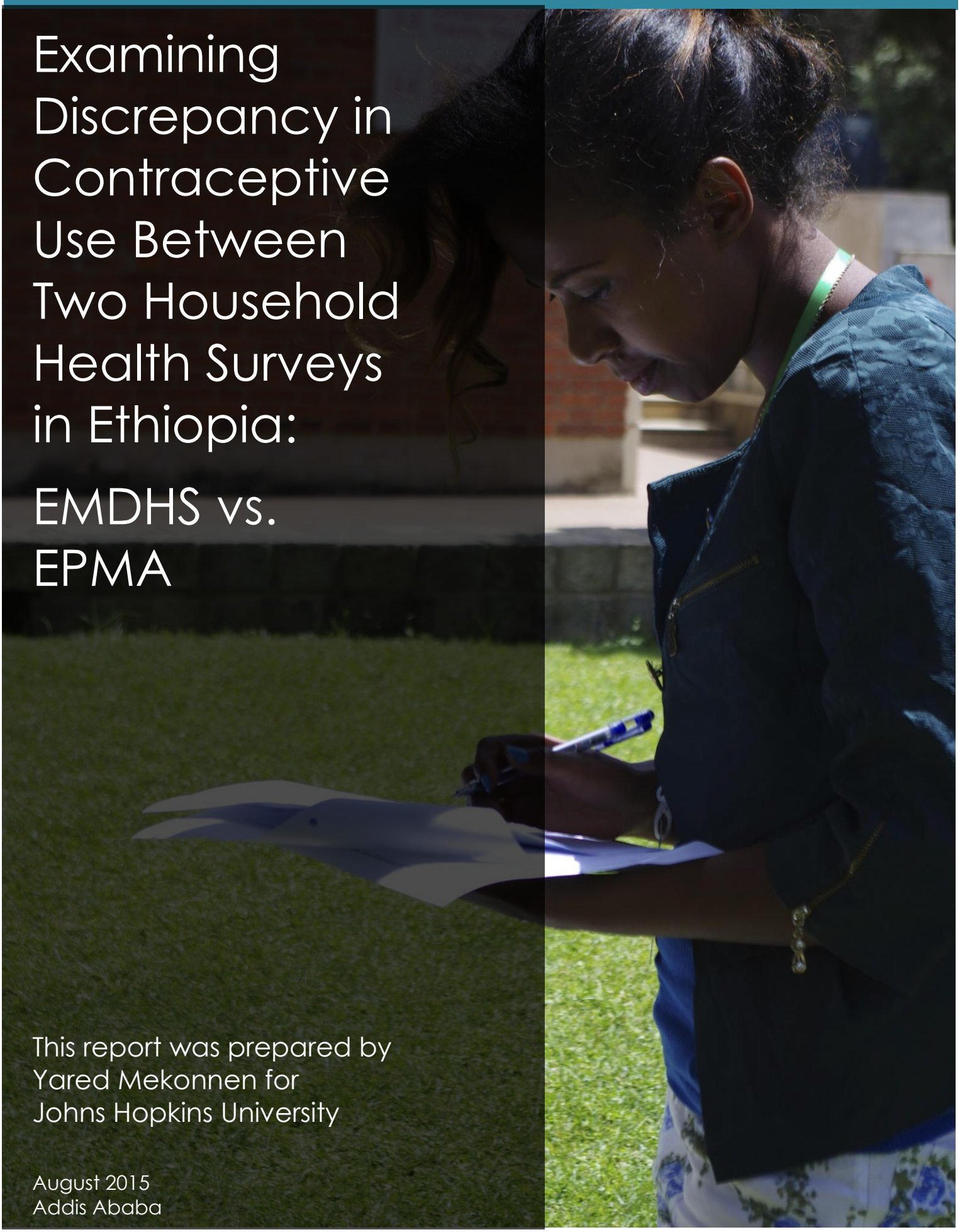
Examining Discrepancy in Contraceptive Use Between Two Household Health Surveys in Ethiopia:

EMDHS vs. EPMA



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ABSTRACT

Background and Method:

The Ethiopia Mini-DHS (EMDHS) and the Ethiopia Performance Monitoring and Accountability 2020 (EPMA) surveys collected data that allow the estimation of modern contraceptive prevalence rate (mCPR), method mix, fertility rate, among other indicators at the national, urban/rural and regional levels. Both surveys employed a multi-stage cluster sampling design. In addition, the surveys were fielded around the same time period: January-April 2014. However, the surveys differed in their use of technology for data collection. The EPMA employed a Smartphone-based technology for data collection while the EMDHS was based on the usual pen and paper-based approach.

This analysis was setout to compare the mCPR, contraceptive method mix, source of current method and fertility rates between the EMDHS and EPMA surveys, and also to examine the sources of discrepancies. It also envisages to provide useful recommendation for future improvement of the EPMA survey.

The tables and figures presented in this report are based on reanalysis of the EMDHS and EPMA surveys data. Ethiopia DHS 2000-2011 were also used for trend analysis and comparison, as deemed necessary.

Results of analysis:

Comparison of key indicators between the tow surveys:

- Higher mCPR in EMDHS than EPMA at the national level; but the EPMA estimate appears more consistent with past trend.

- The two surveys found comparable mCPR in Tigray, Amhara and SNNP regions. Whilst large discrepancies in mCPR estimates between the two surveys were documented for Oromia and Addis Ababa regions.

- The discrepant mCPR in Oromia was the major source of variation between the two surveys at the national level because Oromia has the largest population of all regional states in the country. Of note, both surveys estimates for the Oromia region were inconsistent with past trends.

- The mCPR in Addis Ababa varied hugely between the two surveys. Nevertheless, the EMDHS estimate appears consistent with past trend.

- Contraceptive method mix and the distribution of the sources of current method compared well between the two surveys at the national level and across most regions. The few exception to this pattern are Tigray and Addis

Ababa where the surveys provided somehow differing results on method mix and source of current method in these regions.

- The Total Fertility Rate (TFR) and age-specific fertility rates (ASFR) compared well between the two surveys although regional TFR estimates suffer from small sample problem.

- Being one of the PMA2020 indicators, the fertility rate of young women age 15-19 was compared between the two surveys and results were similar.

Potential sources of discrepancies in mCPR between the two surveys:

- Within-stratum variability of mCPR appeared notably high for rural Oromia and SNNP regions of both surveys but more so in the EPMA

- High coefficient of variation (CV) associated with mCPR estimates of Oromia and SNNP in both surveys. This was exceedingly high in the EPMA data for these regions.

- Lower precision of regional mCPR estimates in both surveys compared to the same in the DHS 2011, which is a reflection of smaller sample size in both surveys compared to the DHS 2011.

- The two surveys differed notably by their sample allocation approaches across the strata.

- Respondent composition varied between the EMDHS and EPMA only in Addis Ababa but not in other regions. Part of the variation in mCPR between the two surveys in Addis Ababa is attributable to differences in sample composition of respondents.

- Women questionnaires varied between the two surveys in their format and contents. On the whole, EPMA collected a much more elaborated information on family planning (33 questions) than the EMDHS (8 questions). In fact, the EMDHS missed a number of important indicators of family planning unlike the previous DHS surveys that collected vast information on family planning and related issues. In contrast, the EPMA collected a wide range of information from women and service delivery points that are appealing to programmers, researchers and the academia. There are also differences between the two questionnaires in their use of question filters and skip rules that could affect data comparability.

- As one source of non-sampling error, age heaping around the eligible age boundaries appeared to be common in both surveys but more so in the EPMA

Conclusion:

Potential sources of discrepancies in mCPR between the two surveys at national as well as regional levels were identified and discussed in this report although they were by no means comprehensive. Non-sampling errors, as potential sources of discrepant findings, were not sufficiently evaluated in this analysis due to paucity of information. This analysis also presupposes no part of the difference in mCPR between the two surveys was attributable to differences in the data collection approaches implemented by the surveys - paper-based vs. Smartphone-based.

With the caveat of these limitations, it can be concluded that the mCPR estimates derived from the two surveys varied significantly at national level as well as in the Oromia and Addis Ababa regions. Differences in sample allocation across strata, variability in the socio-demographic compositions of respondents (in Addis Ababa), variability in questionnaires format, and age distortion around the eligible age boundaries emerged as potential sources of the discrepant findings. It should also be emphasized that most regional mCPR estimates of both surveys suffered from lower precision as compared to the DHS 2011 mainly due to smaller sample size.

The conduct of a household survey is often a complex and lengthy process that involves critical technical inputs, mobilizing huge resources, and decision makings at various stages. Gauging the accuracy and reliability of either of the surveys simply because they produced discrepant results is not warranted. Rather, each survey should be evaluated in accordance with its goal, methodological scope and resource environment.

I. INTRODUCTION

This section presents brief summaries of each survey, the goal of the discrepancy analysis, the data and methods as well as the limitations of this analysis. Table 1 and 2 briefly compare the overall organizations and sample designs of the two surveys.

1.1. The EPMA survey[1]

The goal of the Ethiopia Performance Monitoring and Accountability 2020 (EPMA) is to support the monitoring efforts of a number of countries by conducting rapid, Smartphone-based national surveys. Demographic and Health Survey (DHS) data are reported in five-year intervals—a lengthy gap that restricts the ability of stakeholders to make timely adjustments to policies and programs based on these data. EPMA data are intended to fill gaps in the availability of current and reliable information on population dynamics; family planning; reproductive health service delivery; and water, sanitation and hygiene (WASH). This nationally representative survey provides updates on key FP2020 indicators of contraceptive need, use, quality, choice and access as well as a small battery of questions on WASH in households and health facilities. The survey aimed for an overall sample size of 7,000 households, 7,000 women and 300 SDPs. The survey was conducted in the 11 regions of Ethiopia: Amhara, Oromiya, SNNPR, Tigray, Addis Ababa city, Afar, Gambella, Benishangul-Gumuz, Somali, Harari and Dire Dawa. Due to resource constraints, estimates are generated for only the first five regions, with the other six regions combined into one grouping. Data collection was conducted between January and March 2014. In the first two years of the EPMA project, data collection is conducted twice a year and then annually for each additional year.

The EPMA project in Ethiopia is implemented in a nationally representative sample of 200 enumeration areas throughout Ethiopia. The project is led by the School of Public

[1] Performance Monitoring and Accountability 2020 (EPMA) Project, School of Public Health – Addis Ababa University. 2014. Detailed Indicator Report: Ethiopia 2014 Baltimore, MD: EPMA.

Health at Addis Ababa University (AAU) in collaboration with the Federal Ministry of Health and the Central Statistical Agency (CSA).

1.2. The Ethiopia Mini-DHS (EMDHS)[2]

The 2014 Mini Ethiopia Demographic and Health Survey (EMDHS) was conducted by the Central Statistical Agency (CSA) under the aegis of the Ministry of Health. The main objective of the survey was to collect population-based data on key demographic indicators that support the monitoring and evaluation needs for Phase IV of the Ethiopia Health Sector Development Program. It is envisaged that the survey would provide a basis for measuring the progress of the health sector goals set under the Growth and Transformation Plan (GTP) and that is also closely aligned to the Millennium Development Goals (MDG). Specifically, the 2014 EMDHS was conducted to obtain current information on: contraceptive prevalence, maternity care indicators, including at least one antenatal visit, and skilled birth attendance at delivery; and, data to measure specific MDG indicators.

The EMDHS interviewed 8,070 women age 15-49 from a nationally representative sample of 8,475 households. Data collection took place over a four-month period from 10 January 2014 to the end of April 2014. The EMDHS was undertaken on a representative sample of women in the reproductive ages of 15-49.

1.3. The goal of the discrepancy analysis

The EPMA and EMDHS surveys collected data that allow the estimation of contraceptive prevalence rate, fertility rate, among other indicators at the national, urban/rural and regional levels. Both surveys employed a multi-stage cluster sampling design and with sufficiently large sample size to provide indicator estimates at national level. National survey standard was maintained, as the Ethiopia Central Statistical Agency (CSA) was

[2] Central Statistical Agency [Ethiopia]. 2014. Ethiopia Mini Demographic and Health Survey 2014. Addis Ababa, Ethiopia.

involved in selecting the clusters and providing the EA/cluster maps for both surveys. In addition, the surveys were fielded around the same time period.

Published reports showed discrepant contraceptive prevalence rates between the two surveys at the national level as well as in some regions. Certainly, this will affect the acceptability and utility of both surveys. This discrepancy analysis was thus set out to investigate in greater detail the major discrepant findings with regards to contraceptive prevalence rate, contraceptive method mix, source of current method and fertility rates. The analysis also examined major sources of discrepant findings. Some useful recommendations are also put forward to help improve future surveys.

Table 1. General summary of the EMDHS and EPMA surveys

Attributes	EMDHS	EPMA
Survey Goal	The objectives of the EMDHS were to collect data which allow for estimation of some of the MDG indicators including the 3 disbursement linked indicators1 agreed for the Ethiopia MDG Support Program for Results operation.	EPMA data are intended to fill gaps in the availability of current and reliable information on population dynamics; family planning; reproductive health service delivery; and water, sanitation and hygiene (WASH).
Main indicators	(1) the contraceptive prevalence rate; (2) maternity care indicators including antenatal visits and assistance at delivery; and, (3) some other MDG indicators.	(1) Family planning; (2) fertility, and (3) water and sanitation
Implementing organization	Central Statistical Agency (CSA) and Ministry of Health	School of Public Health, AAU in collaboration with the Federal Ministry of Health and the Central Statistical Agency (CSA) and the Bill & Melinda Gates Institute for Population and Reproductive Health
Survey field work period	January - April 2014	January-March 2014
Data collection approach	Paper-based	Smartphone-based
Target population	All women 15-49 who are usual residents of a selected household or who slept in a selected household the night before the survey are eligible for the survey.	All women 15-49 who are usual residents of a selected household or who slept in a selected household the night before the survey are eligible for the survey.

1.4. Data and Method

The author of this report acquired the raw data for the EMDHS and EPMA from the concerned agencies and performed primary reanalysis of the data. The two data sources were appended in STATA 11 for comparative analysis. The DHS 2000, 2005 and2011 raw data were also used for trend and comparative analysis, as deemed necessary. The tables and figures presented in this report are based on a primary reanalysis of the two data sources.

1.5. Limitations of the discrepancy analysis

Several factors can affect comparability of two surveys and the factors can be broadly categorized as sampling and non-sampling errors. For the obvious reason this analysis is heavily tilted towards the examination of sampling errors while it has limited contribution to the investigation of non-sampling errors. Indeed, post-survey examination of non-sampling errors is challenging due to lack of information on the various aspects of the survey implementation processes.

This analysis presumes no part of the difference in mCPR between the two surveys was attributable to differences in the data collection approaches - i.e. paper-based vs. Smartphone-based. This assumption is however difficult to validate but the few literature available suggest that the two approaches can yield comparable results [3,4]. Prerequisites to the successful application of the Smartphone data collection approach are availability of network services and electricity (for battery charging) and proper training to interviewers and other survey staff.

[3] Svab I. Smartphone Versus Pen and Paper Data Collection of Infant Feeding Practices in Rural China. J Med Internet Res. 2012 SepOct; 14(5): e119.
[4]Njuguna et al.. A comparison of smartphones to paper-based questionnaires for routine influenza sentinel surveillance, Kenya, 2011–2012. BMC Medical Informatics and Decision Making (2014) 14:107

Table 2. Summary of sample design and sampling attributes, EMDHS and EPMA.

Attributes	EMDHS	EPMA
Sampling design	Multistage cluster sampling	Multistage cluster sampling
Anticipated sample size - Households	9135 households	7000 households
Report Domains	National & 11 regions	National & 5 regions
Primary sampling unit (PSU)	Enumeration Area	Enumeration Area
Sampling frame	First stage frame: -Census enumeration areas (EAs) Second stage frame: -Fresh household listing at the cluster level	First stage frame: -Census enumeration areas (EAs) Second stage frame: -Fresh household listing at the cluster level
Sample allocation by strata	Power allocation (with a minimum sample size threshold of 500 households per domain)	Sample allocation in each strata was based on mCPR and DEFT
Selection of PSU	CSA selected the EAs using Probability proportion to size (PPS)	CSA selected the EAs using PPS
Number of sampled clusters (EAs)	305 clusters	200 clusters
Cluster size	30 households per cluster	35 households per cluster
Stratification	21 Strata	11 strata
Sample weights	Post stratification Sample weights adjusted for non response	Sample weights adjusted for household and individual non responses

II. RESULTS OF THE DISCREPANCY ANALYSIS

2.1. Modern contraceptive prevalence rate (mCPR)

The use of modern contraceptive methods among married women age 15-49 years was compared between the EMDHS and EPMA. As shown in Table 3, significantly higher rate of modern contraceptive use was found in the EMDHS than in the EPMA at 40.2% and 33.4%, respectively (p=0.04). Similarly, significant variation in mCPR was also noted in Oromia and Addis Ababa regions while rates compared well between the two surveys across the other regions; namely, Tigray, Amhara, and SNNP. In Oromia the EMDHS found that 39.4% of the married women reported using modern contraceptive method while the corresponding figure in the EPMA was only 23.9%. The difference was statistically significant at p=0.011. Akin to Oromia, the two surveys also reported discrepant mCPR for Addis Ababa - 56.9% in the EMDHS vs. 41.1% in the EPMA (p<0.000). The observed gaps in mCPR between the two surveys in Oromia and Addis Ababa were substantially large at over 15 percentage points.

Using multivariate binary logistic regression analysis we examined the differences in mCPR between the two surveys at the national and regional levels by controlling for a number of socio-economic and demographic factors including residence (urban/rural), age, number of children ever born, education, wealth and women's headship status (Table 5). The main interest of this analysis is to examine whether the noted differences in mCPR between the two surveys are influenced at least by the selected demographic and socio-economic factors. A variable "survey" was included in the multivariate models to indicate the source of data - EMDHS or EPMA. A positive and significant logistic regression coefficient associated with the variable "survey" indicates that the mCPR is significantly higher in EMDHS than in EPMA irrespective of the women's place of residence (urban/rural), age, parity, wealth, educational status and headship status. For the national, Oromia and Addis Ababa regions the analyses revealed that the univariate difference in mCPR between the two surveys persisted even after adjusting for the aforementioned factors. There was no significant net difference in mCPR between the

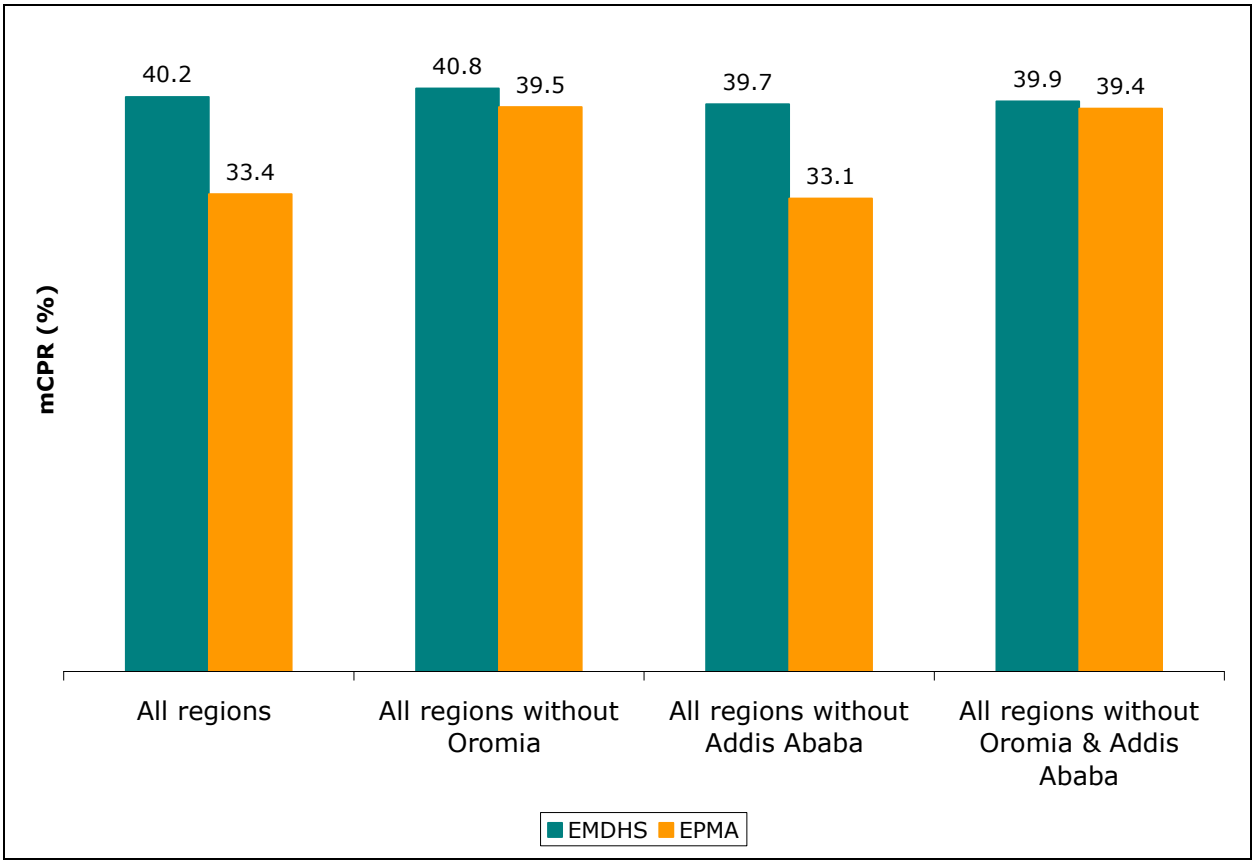
two surveys for the other regions after adjusting for the aforementioned socio-economic and demographic factors.

Excluding the Oromia data from the analysis resulted in comparable mCPRs between the two surveys at 40.8% and 39.5%, respectively, for the EMDHS and EPMA (Figure 1). Despite a large discrepancy of the Addis Ababa rate between the two surveys, removing it from the analysis had little and insignificant influence on the national estimate - 39.7% vs. 33.1% for the EMDHS and EPMA, respectively. Because Oromia has the largest population of all the regional states in the country (over one-third), any difference in mCPR between the two surveys in Oromia clearly influences the national estimate. When both Addis Ababa and Oromia are excluded from the analysis, the mCPR estimates became even more close at 39.9% and 39.4%, respectively, for the EMDHS and EPMA. Thus, the significant disparity in mCPR between the two surveys in Oromia is the major source of variation at the national level.

Table 3. Modern contraceptive prevalence (mCPR) & 95% CI, and absolute difference between the two surveys, married women age 15-49, EMDHS and EPMA

	EMDHS 2014 N (Unweighted), 4797			EPMA-2014 N (Unweighted), 3576			P-value (mCPR -EMDHS Vs. EPMA)	Absolute difference in mCPR
	mCPR (weighted)	95% CI Lower	95% CI Upper	mCPR (weighted)	95% CI Lower	95% CI Upper		
Total	40.2	36.2	44.4	33.4	28.9	37.8	0.040	6.8
Tigray	28.8	23.2	34.4	28.8	23.6	34.1	0.990	0.0
Amhara	47.7	40.3	55.0	48.2	40.5	55.8	0.928	-0.5
Oromia	39.4	31.3	47.5	23.9	16.2	31.7	0.011	15.5
SNNP	38.8	31.1	46.5	37.0	24.8	49.2	0.806	1.8
Addis Ababa	56.9	51.5	62.4	41.1	36.4	46.7	0.000	15.8

Figure 1. Modern contraceptive prevalence rate among married women for all regions combined, all regions without Oromia, without Addis Ababa, and without Oromia & Addis Ababa (both excluded) by data source, EMDHS & EPMA.



2.2. Trends in contraceptive use

Modern CPR trend:

In general, there has been a steady increase in contraceptive use in Ethiopia over the last one and half decade. During the period 2000-2011 the use of modern CPR increased from 6.3% in 2000 to 27.3% in 2011, an average of over 2 percentage points increase per annum. The rate of increase was even much faster between 2005 and 2011 (Figure 2 & 3).

Both the EMDHS and EPMA results showed a notable increase in modern CPR compared to the rate documented in 2011. But the rate of change was much faster in EMDHS than in the EPMA. According to the EMDHS modern CPR reached at 40.3% in 2014, representing an increase of nearly 4.3 percentage points per annum since 2011.On the other hand, with the EPMA's rate of 33.4% in 2014, the average increase since 2011 was estimated at 2 percentage points per annum. In the absence of true values, it is unknown which survey represents the real change in CPR in the country. However, if the trend in modern CPR that was documented between 2005 and 2011 persists in the recent years it is likely that the EMDHS overstates the current mCPPR at the national level while the EPMA's rate appeared more consistent with past trend . This assumption is difficult to validate and that recent trends may not necessarily follow past trends.

Temporal trend in mCPR are in particular dissimilar between the two surveys in Oromia and Addis Ababa. According to the EMDHS mCPR increased at a much faster rate in Oromia from 24.9% in 2011 to 39.4% in 2014. This represents an average annual increase of 4.8 percentage points. In contrast, trend was nearly stable since 2011 in Oromia when the EPMA rate is compared with the DHS 2011 (23.9% vs. 24.9%).

Trend of mCPR remained nearly unchanged in Addis Ababa when the 2011 DHS is compared with the EMDHS 2011 at 56.3% and 56.9%, respectively. On the other hand, the EPMA recorded a significant reversal trend in mCPR since 2011 - from 56.3% to 41.1%. Accordingly, the mCPR in Addis Ababa declined by 5 percentage points per annum during the period 2011-2014. In the absence of methodological biases, it is highly unlikely to expect a reversal trend in mCPR in Addis Ababa in the past three years unless the demographic compositions of the population changes due to migration. A severe shortage of family planning commodities could also affect current use. There is however no evidence suggesting the presence of these conditions in the city in recent years.

Figure 2. Trends in mCPR at the national level and by region, 2000-2014, DHS, EMDHS and EPMA

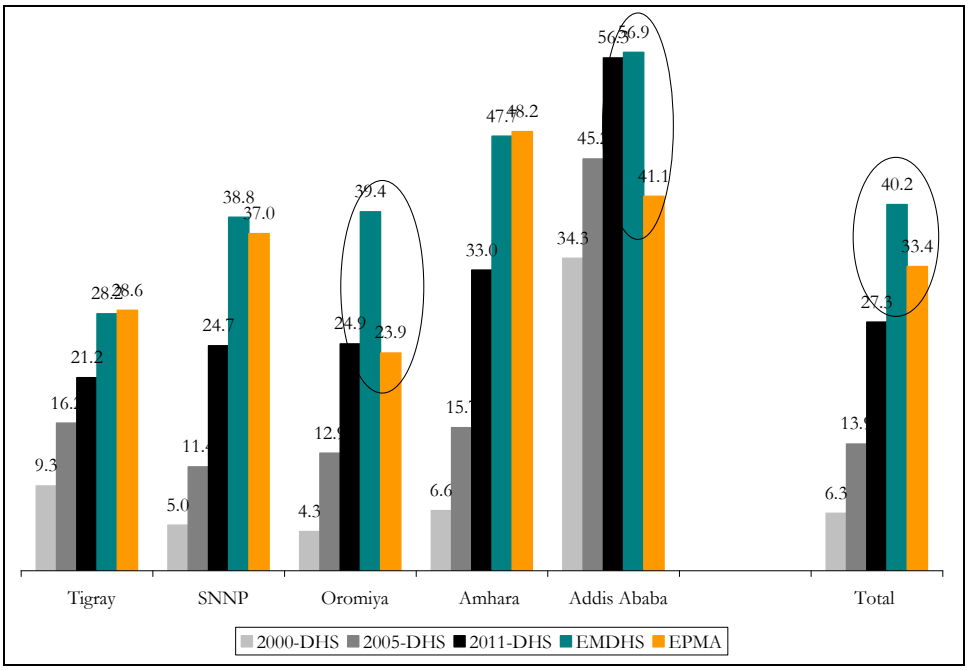
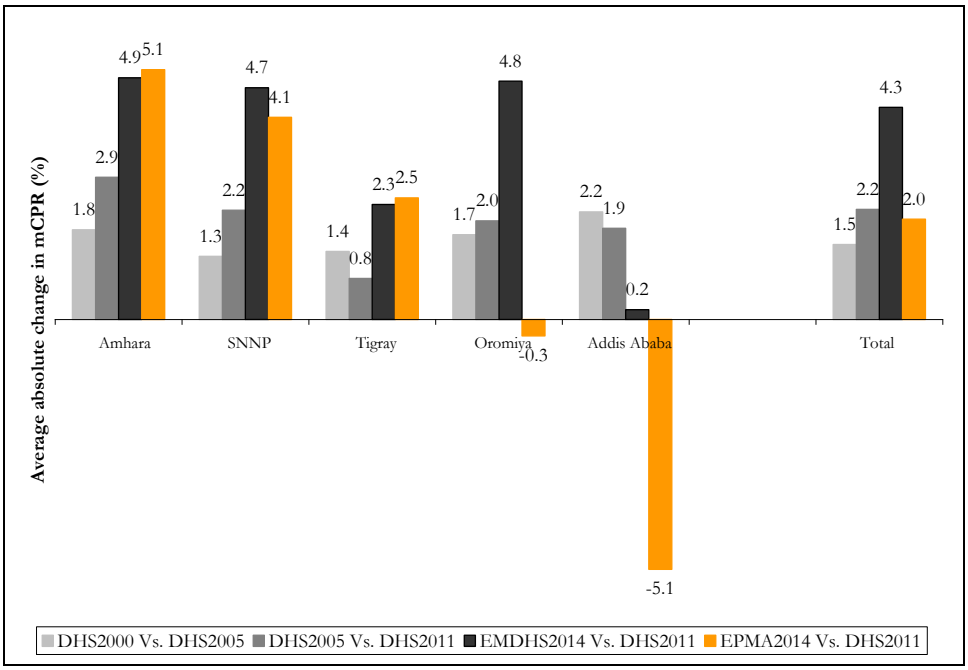


Figure 3. Average annual rate of change (absolute average in percentage points) in mCPR during 2000-2014, DHS 2000-2011, EMDHS & EPMA

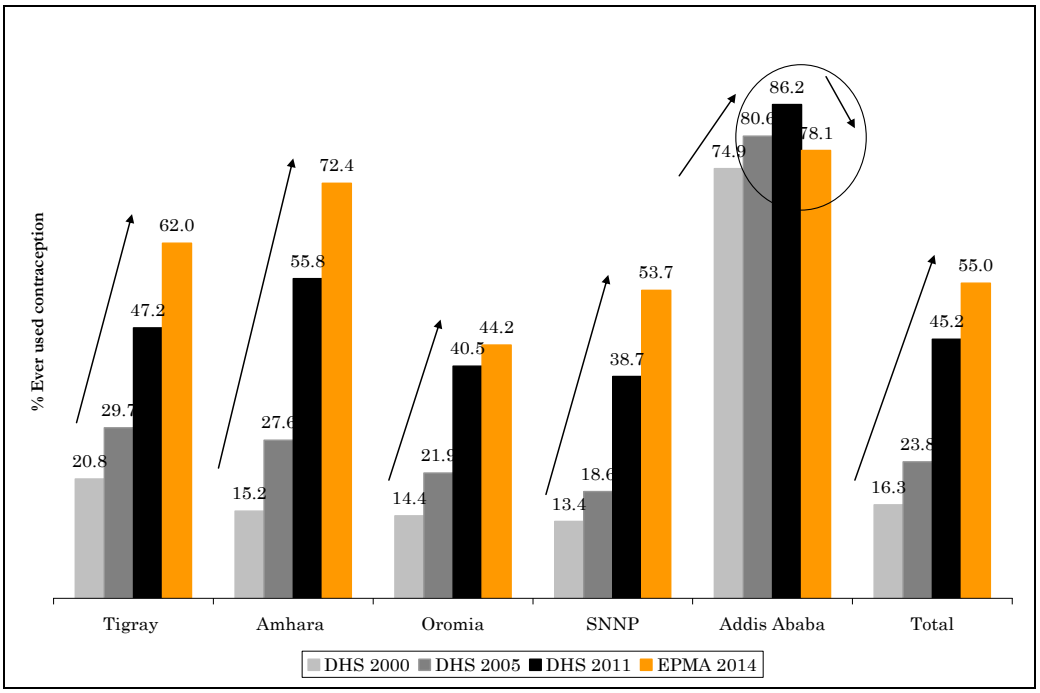


Ever use of contraception:

Another indicator of contraceptive use behavior in a population is the ever use of contraception that combines past and current use. The EPMA like the previous DHS surveys collected information on ever use of contraception. Unfortunately, this important indicator was not collected in the EMDHS.

On the whole, data show that ever use of contraception increased significantly since 2000 in Ethiopia - from 16.3% in 2000 to 45.2% in 2011. Consistent with previous trends the EPMA also recorded an increase in the proportion who ever used contraception at 55% compared to 45.2% in 2011 (Figure 4). With the exception of Addis Ababa, the EPMA also found positive increasing trend in the ever use since 2011 across all the regions. A reversal trend in the ever use of family planning methods in Addis Ababa - from 86.2% (95% CI: 83.3-89.5) in 2011 to 78.1% (95% CI: 73.7-82.5) in 2014 - is inexplicable. Ever use of family planning either increases or remain stable over time in a population unless there is a change in the socio-demographic composition of a population due to considerable in or out migration.

Figure 4. The proportion of married women who ever used family planning, 2000-2011 DHS, MDHS & EPMA



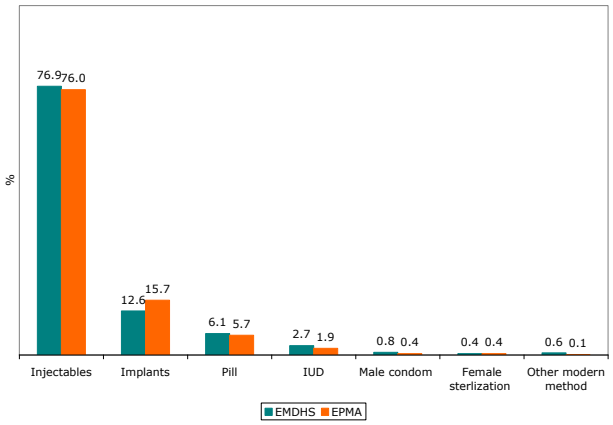
2.3. Contraceptive method mix

At national level contraceptive method mix compares well between the two surveys as shown in Figure 5A. In both the EMDHS and EPMA surveys over three-quarter of the current users reported using Injectables. This was followed by Implants at 12.6% in EMDHS and 15.7% in EPMA. While the other methods combined constituted less than 10% of the current method. Region specific comparison of method mix between the two surveys suggests comparable distribution in Amhara, SNNPR and Addis Ababa regions. Whilst variation in method mix can be apparent between the two surveys in Tigray and Oromia. A significantly higher reporting of Injectables among contraceptive users in the EMDHS (80.9%) than in the EPMA (62.2%) was documented in Tigray, as shown in Figure 5B. Most notably the share of Implants of all current methods in Tigray region was much higher in the EPMA at 31.4% compared to only about 10% in the EMDHS. The contribution of Implants to the overall current method also varies notably between the two surveys in Oromia - 20% in the EPMA and 12.2% in EMDHS - though not

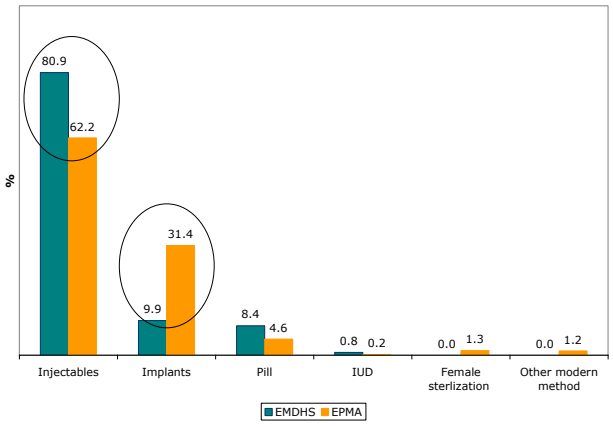
significantly. The noted very large variation in contraceptive method mix distribution between the two survey in Tigray region did not influence the national estimate because only about 7% of the women was sampled from Tigray.

Figure 5. Contraceptive method mix for the total and by region, EMDHS & EPMA

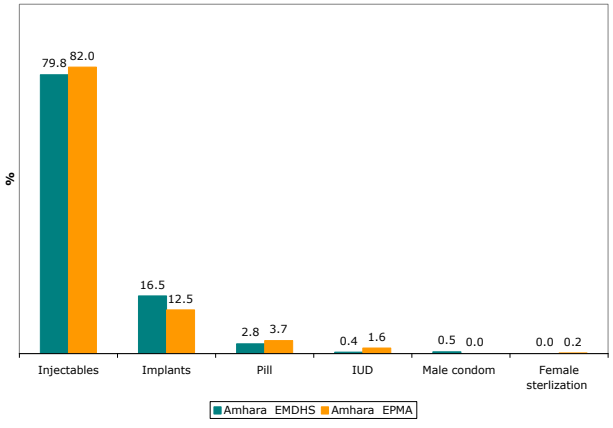
A. Total



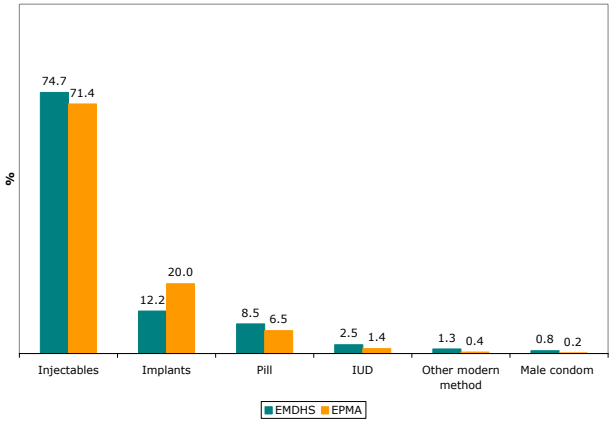
B. Tigray



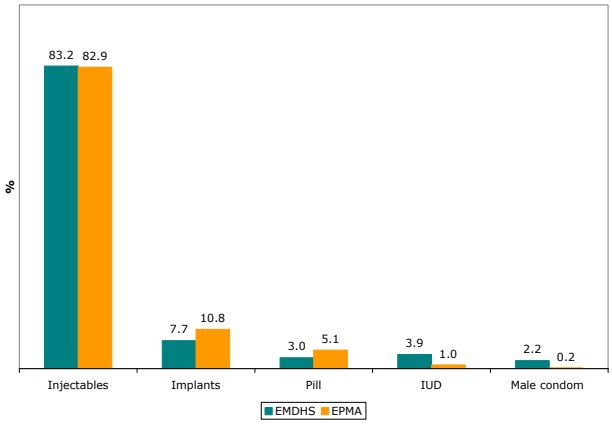
C Amhara



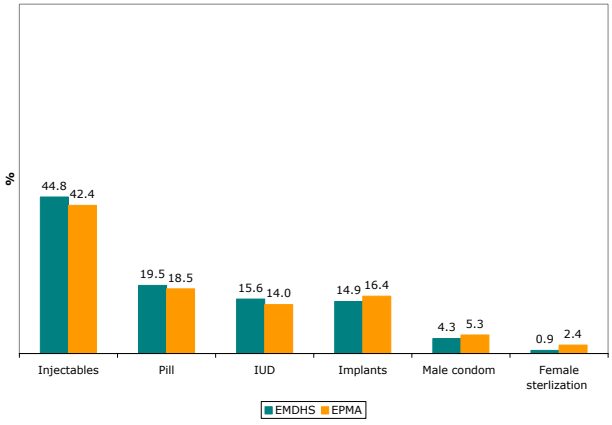
D: Oromia



E. SNNP



F. Addis Ababa



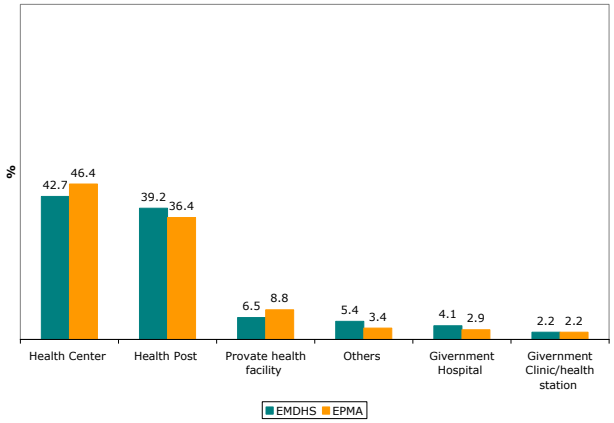
2.4. Source of current method

The reported sources of current contraceptive methods between the two surveys were compared at the national level and across regions. The two surveys asked slightly different questions on sources of current methods, which could partly influence comparison of the two data sources. In the EPMA women were asked to respond to the question *"Where did you obtain your (MOST RECENT / CURRENT METHOD) when you started using it?"*. Clearly this question refers to the first source where the women obtained the current method from. While the EMDHS asked the women "*Where did you obtain the method the last time?"*, which refers to the most recent source of the current method.

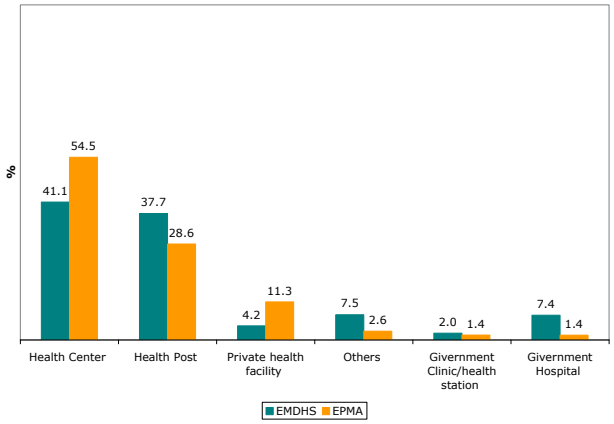
With the caveat of the small difference in the questions asked by the two surveys, the surveys in general arrived at comparable pattern of the sources of current methods at the national level (Figure 6A). The slight differences in the reporting of health center between the two surveys at the national level was not statistically significant. As in the previous surveys in the country both the EMDHS and EPMA surveys indicated that health centers were the predominant sources of current methods. Of all current users, 42.7% of the EMDHS and 46.4% of the EPMA respondents, reported obtaining their current method from health centers. This was followed by health post at 39.2% in the EMDHS and 36.4% in the EPMA. The reporting of other sources such as private health facilities, other government facilities also compared well between the two surveys. Most of the variations in the sources of current methods between the two surveys across the regions were not statistically significant. The only significant variation in the reporting of Pharmacy, as a source of current method between the two surveys was noted in Addis Ababa at 13.4% in the EPMA and 1.9% in the EMDHS (P=0.001) (Figure 6F). Of all the sources, Pharmacy/drug vendors were predominantly reported as sources for the Pills and male condoms by the EPMA respondents of Addis Ababa. In the EMDHS women in Addis Ababa reported to obtain pills and male condoms from different sources including pharmacy, health centers and other sources.

Figure 6. Source of current contraceptive method for the total and by region, EMDHS & EPMA

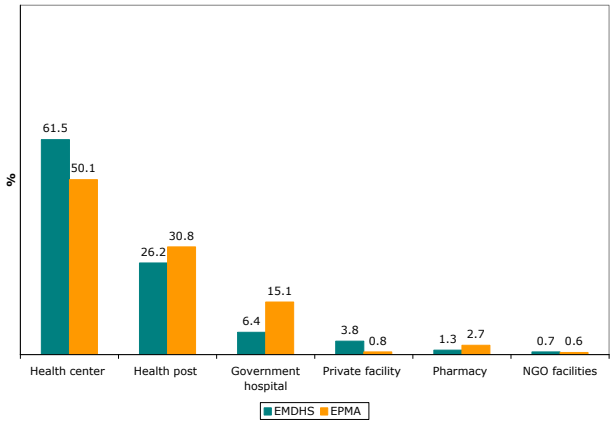
A. Total



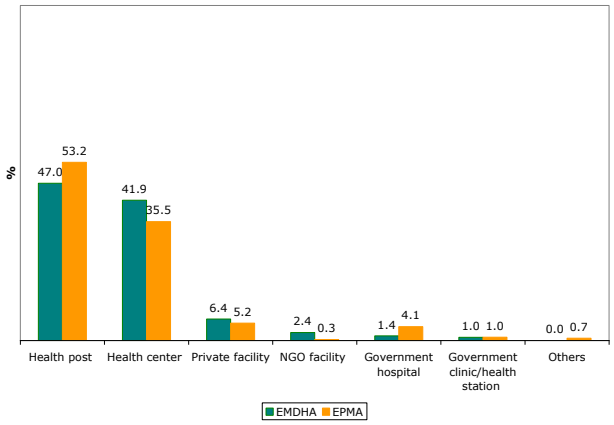
D: Oromia



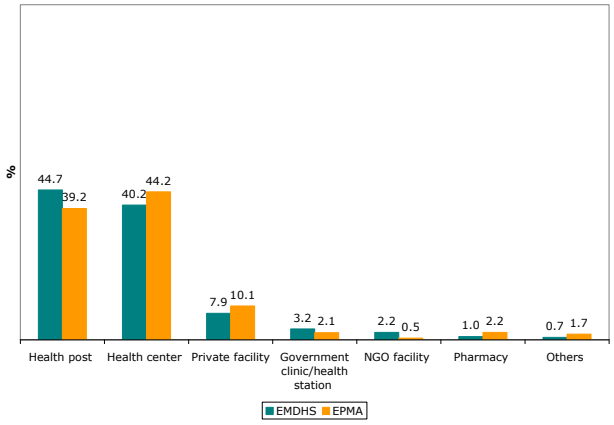
B. Tigray



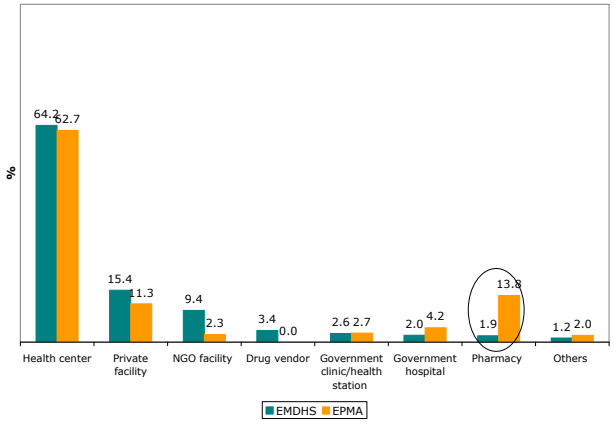
E. SNNP



C Amhara



F. Addis Ababa



2.5. Fertility

Both surveys collected birth history data that allow the estimation of the age-specific fertility rate (ASFR) and the total fertility rate (TFR). There was a slight difference in the reference period of the birth-history information in the tow surveys - 3-year in the EMDHS vs. 2-year in the EPMA. Of note, the EMDHS gathered a relatively more detailed information on birth history than that did the EPMA. The structure and format of the birth history questions in the two surveys also have slight variations. The EMDHS employed similar format as in the previous Ethiopia DHS's.

The birth history data from the two surveys were reorganized so as to make them suitable for the analysis and estimation of the ASFR and TFR for the national, urban and rural areas as well as for the five focus regions. For the purpose of comparison, a 2-year reference period was used for both surveys. The fertility rates were computed based on the STATA module ***tfr2***[5] that allows the inclusion of survey weights in the calculation. As shown in Table 4, with a 2-year reference period, the two surveys yielded comparable TFR at an average of 4 children per woman. The confidence intervals around these estimates also overlap. Besides, the age-specific fertility schedules of the two surveys compared well as can be seen in Figure 7. Notably, both data suggest a peaking of the ASFR in the age group 25-29 years and a mean age of childbearing at 30 years; these pattern of ASFR is consistent with the findings from the 2000, 2005 and 2011 DHS's. Akin to the national estimates, the two surveys provided comparable TFRs and ASFRs in the urban as well as in the rural areas. As expected, the rural TFR was much higher than that of the urban in both surveys (4.4 vs. 2.3); an increase by nearly three-quarter. Previous DHS's also documented similar urban-rural pattern of TFR estimates.

Fertility rate among young women (15-19 years):

The fertility experience of young women is of interest to this analysis because PMA2020 identified the ASFR of young women age 15-19 years amongst its core indicators. The surveys found comparable ASFR among this group at 59 per 1000 and 55 per 1000, respectively, in the EMDHS and EPMA.

[5] Schoumaker Bruno (2012), "A Stata module for computing fertility rates and TFRs from birth histories: tfr2", Demographic Research, vol. 28.

Region-specific fertility evaluation is subject to small sample size and low precision. Of note regional TFR estimates were provided and published in the Mini-DHS but not in the EMPA report. The author of this report calculated regional TFR estimates for the EPMA for the sake of comparison between the two survey. Despite the limitation due to small sample size, the two surveys in general provided comparable estimates across regions. Tigray appeared an exception to this as the two surveys resulted in TFR estimates that were departing from one another. The EMDHS's rate of 4.6 per woman (95% CI=2.8-4.6) in Tigray appeared higher than the EPMA's rate of 3.8 per woman (95% CI=3.1-4.6) but the difference between these two rates was not statistically significant. Similarly, the observed difference in TFR between the two surveys in Addis Ababa was not statistically significant.

Table 4. ASFR, TFR and mean age of child bearing estimated for a 2-year reference period, EMDHS & EPMA

Women's age	EMDHS			EPMA		
	ASFR (weighted)	Lower 95% CI	Upper 95% CI	ASFR (weighted)	Lower 95% CI	Upper 95% CI
15-19	0.059	0.043	0.075	0.055	0.040	0.070
20-24	0.156	0.132	0.181	0.193	0.167	0.220
25-29	0.191	0.168	0.215	0.197	0.170	0.223
30-34	0.164	0.140	0.188	0.149	0.119	0.179
35-39	0.128	0.106	0.150	0.113	0.087	0.138
40-44	0.078	0.051	0.105	0.055	0.030	0.080
45-49	0.014	0.000	0.029	0.028	0.004	0.053
TFR	4.0	3.5	4.4	4.0	3.5	4.4
MAC	30.3	29.7	30.9	29.7	28.9	30.5

MAC=Mean age of childbearing

Figure 7. ASFR in the EMDHS & EPMA

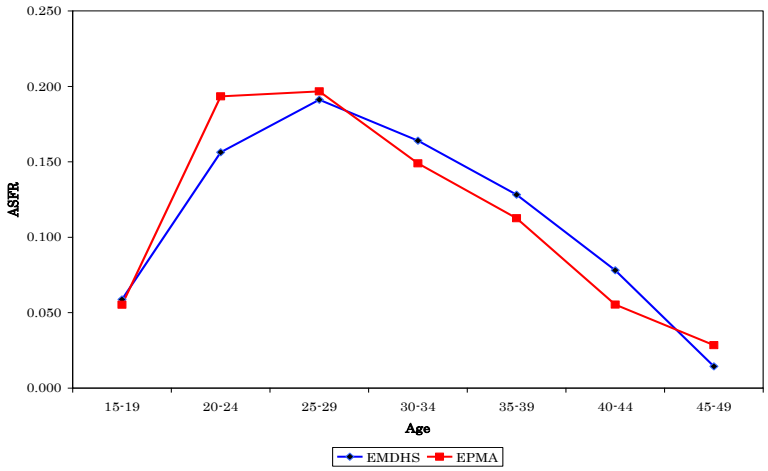
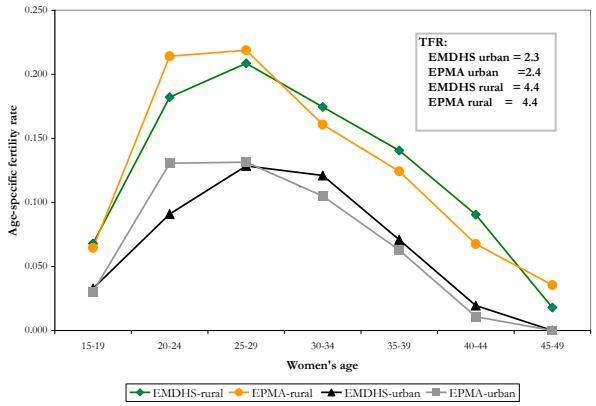
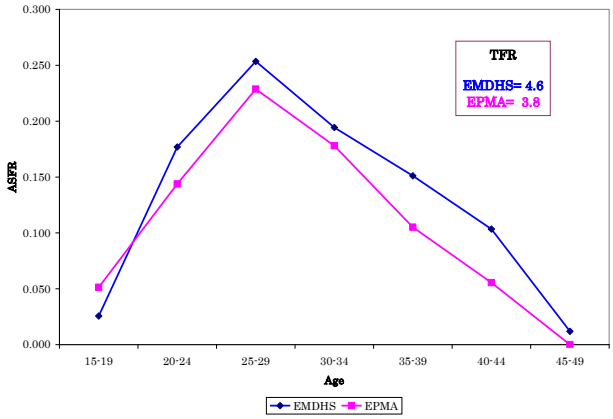


Figure 8. ASFR by urban/rural and region, EMDHS & EPMA

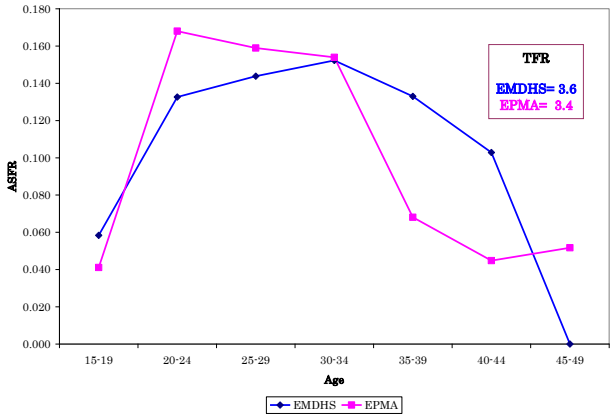
A. Urban/Rural



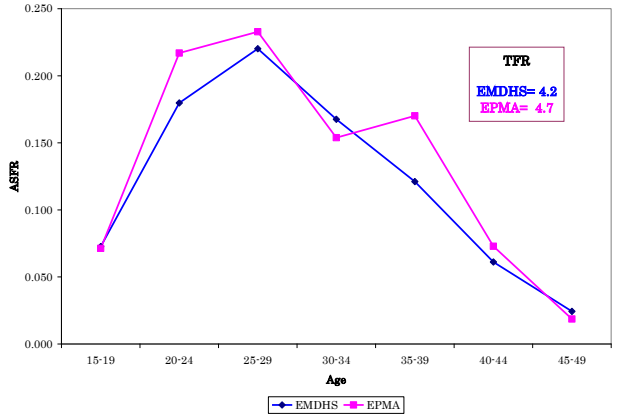
B. Tigray



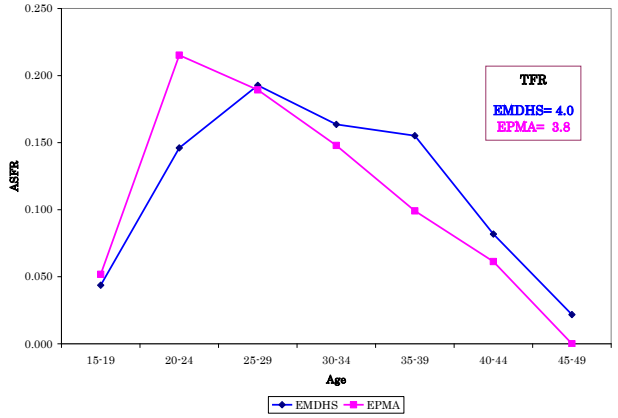
C Amhara



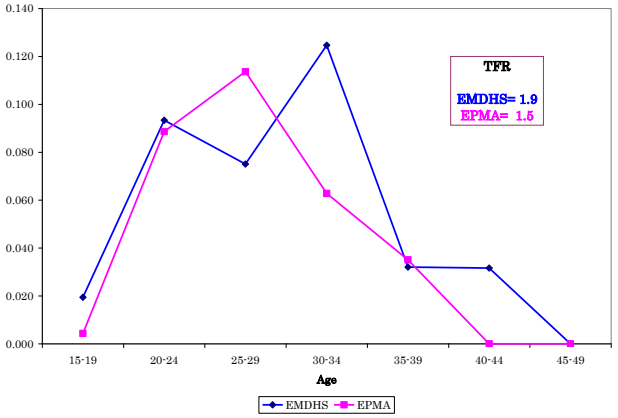
D: Oromia



E. SNNP



F. Addis Ababa



2.6. Consistency between mCPR and TFR

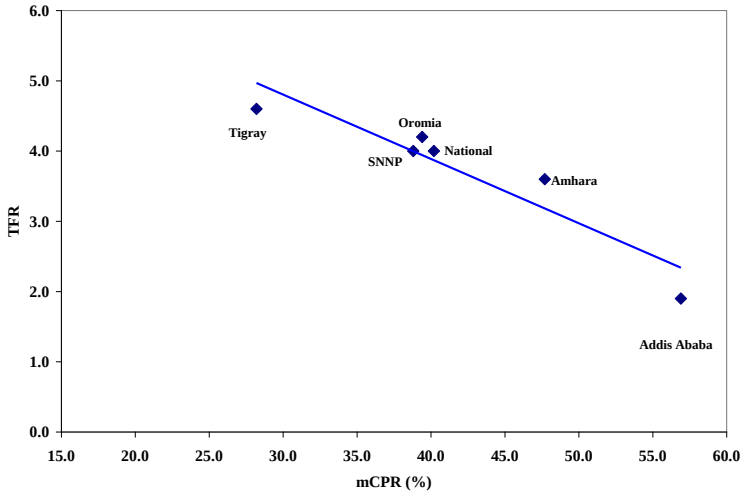
Bongaarts' proximate determinants framework identified contraception among the major proximate determinants of fertility in a population[6]. Keeping the other proximate factors constant, an increase in contraceptive use in a population results in a decline in fertility. The contribution of contraception to the recent decline in fertility in Ethiopia has also been documented[7].

Scatter plots that depict the relationship between mCPR and TFR for the EMDHS, EPMA and DHS 2011 are shown in Figures 9A-C. The data points that are shown in the scatter plots represent regional TFR and CPR estimates. In general, both the EMDHS and DHS 2011 surveys consistently show lower TFR in regions with higher CPR and vise versa. In the EPMA, however, due to the mismatch between CPR and TFR in Addis Ababa the expected inverse relationship between CPR and TFR did not hold. With an EPMA-based mCPR of 41.1% it is highly unlikely to record a TFR of 1.5 per woman in Addis Ababa. For instance, the EPMA reported a much higher TFR value of 3.4 children per woman for an mCPR estimate of 48% for Amhara. In short, this mismatch between the TFR and mCPR further corroborated the previous observation, suggesting that the EPMA-based mCPR of Addis Ababa is highly dubious.

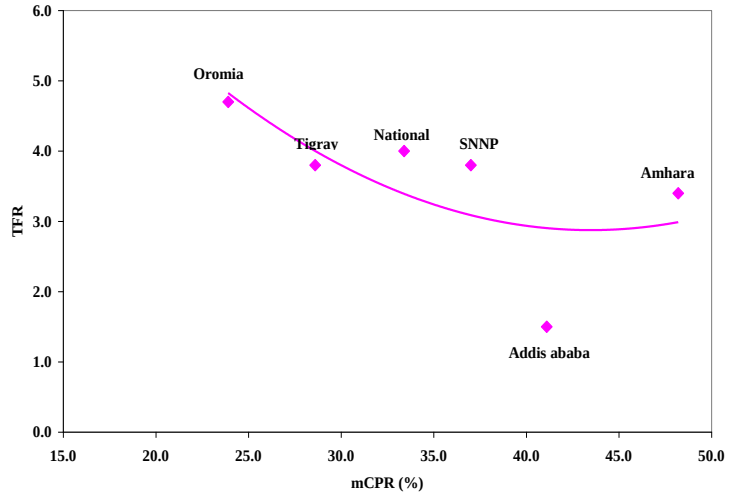
[6] Bongaarts. J and G.R. Potter, Fertility, Biology and Behavior: An Analysis of the Proximate determinants, Academic press, New York. 1983.
[7] UNFPA. A decade of change in contraceptive use in Ethiopia. Addis Ababa. 2012.

Figure 9. Scatter plots showing TFR vs. mCPR, EMDHS, EPMA & DHS2011

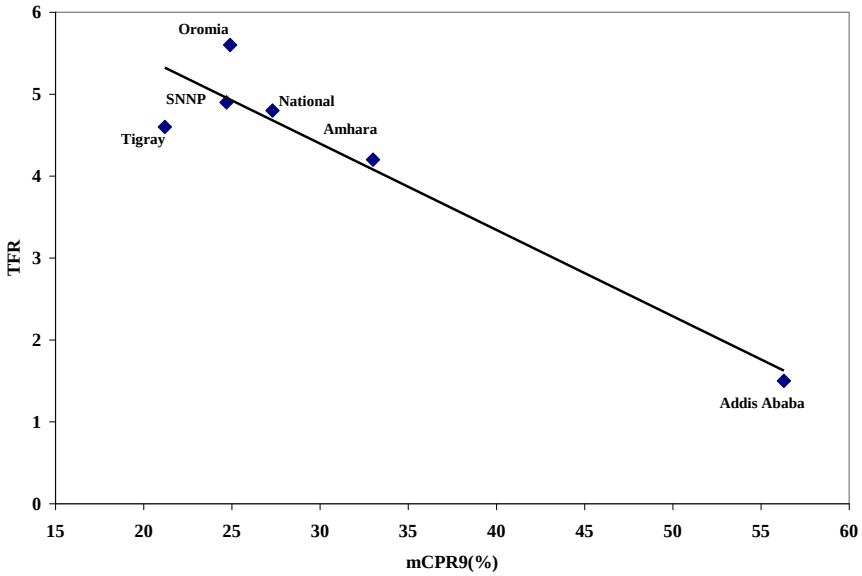
A. EMDHS - mCPR vs. TFR



B. EPMA- mCPR vs. TFR



C. DHS 2011 - mCPR vs. TFR



III. EXAMINING THE CAUSES OF DISCREPANCIES

The discrepancy analysis presented in Section II of this report concluded that the mCPR estimates derived from the two surveys differed significantly at national level as well as in Oromia and Addis Ababa regions. This section examines the potential sources of discrepancies, encompassing the sample compositions of respondents, the survey design, sampling error, coverage of eligible respondents, response rates, and measurement variability. Not all sources of non-sampling errors are evaluated due to paucity of information.

3.1. Sample composition

Two surveys with similar methodology can yield different results due to many reasons, and one concerns differences in the composition of the respondents sampled by the surveys. Most importantly, if the sample compositions of two surveys differ on key respondents' characteristics that are known to influence the outcome of interest this will lead to discrepant results.

Although the EMDHS and EPMA employed similar survey design and targeted similar population of women, one cannot rule out possible variations in the composition of the sampled population due to different reasons. The compositions of the respondents in the two surveys were examined to understand whether or not the surveys sampled and interviewed respondents of comparable socio-economic, demographic and other key characteristics. Here two steps were followed. First, using Multivariate binary logistic regression analysis, the socio-economic and demographic determinants of current use of contraception were identified. Second, the respondents of the two surveys were compared in regards to the different characteristics/factors that are identified via the multivariate analysis.

Factors influencing contraceptive use among married women:

The two surveys collected few but important variables that could influence contraceptive use in a population. The multivariate analysis revealed that, among the variables included in the model, the use of modern contraceptive among married women in the country is significantly shaped by the number of children ever born, their household wealth, women's education, and the headship

status of the women. High parity women were found more likely than those with low parity to adopt contraceptive use. Women from the poorest households were found to have the lowest uptake of contraceptive compared to any other wealth category. Education carries a significantly higher likelihood of contraceptive use. Compared to women with no education, women who had at least elementary schooling were found to have significantly higher uptake of modern contraceptive methods. Married women were categorized into four groups based on their relationship to the head of the household - female head, wife, daughter and other. The multivariate model revealed that those married women who reported to be the head of the family were significantly less likely than those from a male-headed household to use contraception. In most Ethiopian communities it is uncommon if not nonexistent to have a female head in a household where the husband and wife live together. It may well be that most of the married female heads reported by the present surveys represent those households where the husbands are away from home for long. Naturally, such women are less sexually active than married women who live with their husbands. The lower contraceptive use in these group of women may be due to the less sexual activity in these women due to absence of husbands. Of note, the huge urban-rural divide in contraceptive use in the country disappeared in the multivariate analysis that controlled for the aforementioned factors.

Region-specific multivariate analysis suggests that the number of children ever born and wealth remained to be significant associated with contraceptive use across most regions. Whilst the role of education, age, residence and women's headship status exhibited varying relationships with contraceptive use across the regions. For instance, women's place of residence was found to be significantly associated with contraceptive use only in Tigray. Significant inverse relationship between age and contraceptive use was also found in Addis Ababa unlike in the other regions. The relationship between education and contraceptive use is not uniform across the regions. In Addis Ababa, for instance, having tertiary or higher education was significantly and independently associated with low contraceptive use. While in Amhara, a positive dose-response relationship can be noted between education and contraceptive use. There is no significant disparity in contraceptive use by education in the other regions. Compared to women in male-headed households, women in female households were significantly less likely to uptake

contraception in Oromia, SNNP and Adds Ababa. Previous studies in Ethiopia and elsewhere reported most of these factors as important determinants of contraceptive use.

Table 5. Multivariate logistic regression **β** Coefficient and p-value in the estimation of the likelihood of using modern contraception among married women, EMDHS and EPMA

Selected characteristics	**Total**	**Region**				
		Tigray	**Amhara**	**Oromia**	**SNNP**	**Addis Ababa**
	β coeff.	**β coeff.**	**β coeff.**	**β coeff.**	**β coeff.**	**β coeff.**
Survey						
EPMA (ref)	0.00	0.00	0.00	0.00	0.00	0.00
EMDHS	0.34*	0.17	0.01	0.73*	0.16	0.54***
Residence						N/A
Rural (ref)	0.00	0.00	0.00	0.00	0.00	
Urban	0.27	0.86*	0.47	0.27	0.63	
Age						
15-19 (ref)	0.00	0.00	0.00	0.00	0.00	0.00
20-24	0.15	0.27	0.18	0.07	0.52	-1.31
25-34	0.12	0.11	0.18	0.08	0.67*	-1.46*
35-49	-0.11	-0.32	-0.25	0.09	0.39	-2.17***
Children ever born						
0 (ref)	0.00	0.00	0.00	0.00	0.00	0.00
1	0.25*	-0.18	0.19	0.18	0.62***	0.54*
2	0.26*	0.43	0.02	0.48*	0.12	0.59*
3	0.29*	0.53*	0.37*	0.04	0.57*	0.49
4 +	0.76***	1.76**	0.07	1.36**	1.53***	2.17***
Wealth						
1st quintiles (ref)	0.00	0.00	0.00	0.00	0.00	N/A
2nd quintiles	0.44***	0.79*	0.25	0.64*	0.45	
3d quintiles	0.55***	0.52	0.27	0.81*	0.23	
4th quintiles	0.86***	1.33***	0.65*	1.08***	0.45	
5th quintiles	0.91***	0.98	0.13	1.38***	0.82*	
Education						
No education (ref)	0.00	0.00	0.00	0.00	0.00	0.00
Elementary	0.23*	0.17	0.25	0.28	0.25	-0.02
Secondary	0.48***	0.51	0.61	0.67	0.26	-0.38
Tertiary or higher	0.31*	-0.38	1.03*	0.41	-0.17	-0.59*
Relationship to the head						
Female head (ref)	0.00	0.00	0.00	0.00	0.00	0.00
Wife	0.69***	0.53	0.06	0.90*	0.90*	0.75*
Daughter	0.09	0.72	-0.29	0.10	-0.18	-1.34*
Others	0.21	0.24	0.03	0.88	-1.89	-0.35

**p<0.05; **p<0.001; ***p<0.0001; N/A=Not Applicable ; ref=reference category*

Comparing respondents composition between the two surveys:

We compare the residence, age, parity, wealth, education and headship status of married women between the two surveys (Table 6). Most of these characteristics of the women emerged as significant predictors of contraceptive use in the aforementioned analysis. As shown in Table 5, at the national level as well as in most regions, the respondents that were sampled in the two surveys did not vary significantly by these characteristics. Exception to this is Addis Ababa where the composition of the sampled respondents vary notably and significantly between the two surveys in terms of their parity, educational status and headship status. The proportion of women respondents in Addis Ababa that reported four or more children was 20.5% in the EPMA compared to 12% in the EMDHS and this difference was statically significant ($p<0.05$). A significantly higher ($P<0.05$) proportion of women in the EMDHS (32.1%) reported having had two children compared to 21.8% for the same in the EPMA. Married women in Addis Ababa that were sampled in the two surveys also varied significantly by their educational status. In particular, the proportion that reported to have had higher level of education was significantly higher ($p<0.05$) in the EMPA than in the EMDHS (27.6% vs. 15%). More married women who were the heads of their households (female-headed) were sampled in the EPMA than in the EMDHS at 16.5% and 9.7%, respectively ($p=0.09$). Further, we compared these characteristics of the women respondents of Addis Ababa from the two surveys against the DHS 2011, as shown in Figure 10. On the whole, the EMDHS and DHS 2011 compared well in terms of the distribution of married women in Addis Ababa according to the number of children ever born. The EPMA provided a somewhat different distribution of the number of children ever born as compared to the EMDHS and the DHS 2011. In particular, high parity women who are shown to have higher contraceptive uptake were underrepresented in the Addis Ababa sample of the EPMA survey. Likewise, the distribution of Addis Ababa women by their educational status compared well between the EMDHS and DHS 2011. On the other hand, respondents to the EMPA have their education profile significantly deviated from the pattern seen in the EMDHS and DHS 2011. The EMPA survey sampled significantly higher proportion of women who had higher education (tertiary level) compared to the DHS 2011 and EMDHS. Notably, the aforementioned multivariate analysis revealed that women with tertiary level education in Addis Ababa in particular exhibited a significantly lower uptake of contraception. Though not

significantly, the proportion of married women that were female headed was higher in the EPMA than in DHS 2011. While the lowest proportion of such women was recorded in the EMDHS.

Taken together, the variability in the sample composition of women respondents between the EPMA and EMDHS may well explain part of the differences in mCPR between the two surveys in Addis Ababa. The lower contraceptive prevalence rate of married women in Addis Ababa in the EPMA vis-à-vis in the EMDHS can be partly due the relatively higher concentration of low parity women, those women with tertiary level of education and female heads in the EPMA sample. These are particular group of women with relatively lower contraceptive uptake, as revealed by the multivariate analysis.

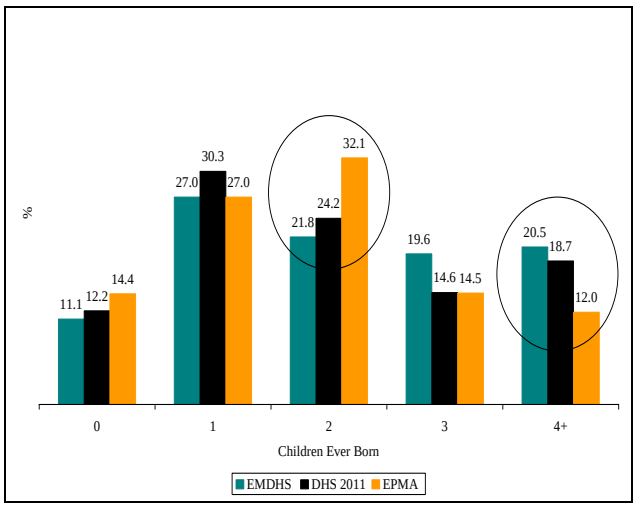
Table 6. Selected socio-economic and demographic composition of the women interviewed (married women) in the two surveys, EMDHS & EPMA

	Tigray		Amhara		Oromia		SNNP		Addis Ababa		Total	
	EMDHS	EPMA	EMDHS	EPMA	EMDHS	EPMA	EMDHS	EPMA	EMDHS	EPMA	EMDHS	EPMA
	N=395	N=535	N=560	N=689	N=624	N=627	N=609	N=814	N=255	N=353	N=4797	N=3576
% Rural	78.3	77.9	87.4	85.7	88.7	87.3	88.8	86.3	N/A	N/A	84.0	82.0
Age												
15-19	5.6	7.6	8.7	5.3	8.7	5.2	5.7	3.9	2.6	0.6	6.3	5.4
20-24	16.5	17.5	17.8	17.5	17.8	16.2	12.7	16.7	13.4	10.7	16.0	15.8
25-34	37.9	35.6	42.1	40.8	42.1	43.9	47.7	45.4	50.4	50.1	44.2	43.1
35-49	40.0	39.3	31.5	36.4	31.5	34.7	33.9	34.0	33.6	38.6	33.6	35.7
Children ever born												
0	8.9	11.3	12.0	9.1	6.9	8.8	6.3	5.5	11.1	14.5	8.5	8.7
1	11.6	14.6	12.7	13.1	13.0	12.7	11.5	14.4	27.0	27.0	13.0	14.0
2	12.8	16.0	14.9	14.7	13.9	13.2	14.4	15.6	21.8	**32.1***	14.5	15.0
3	9.7	11.2	12.3	14.7	13.1	13.7	12.1	12.8	19.6	14.5	12.6	13.7
4+	57.0	46.9	48.0	48.4	53.2	51.6	55.8	51.7	**20.5***	12.0	51.5	48.5
Wealth												
1s quintile	19.7	11.6	19.7	16.3	16.1	20.0	25.5	25.2	0.0	0.0	19.9	18.4
2nd quintile	21.4	21.1	25.1	21.5	19.6	19.9	20.2	18.5	0.5	0.0	20.4	20.7
3rd quintile	21.0	18.3	25.9	26.9	17.7	21.1	21.0	15.5	2.2	0.2	19.7	20.1
4th quintile	12.1	24.2	15.4	22.7	25.3	24.1	16.9	19.1	4.5	1.3	19.0	21.0
5th quintile	25.8	24.9	13.9	12.6	21.3	15.0	16.5	21.7	92.8	98.6	21.0	19.8
Education												
No education	62.6	52.8	70.4	73.4	61.2	61.8	55.8	51.3	19.5	10.6	61.7	61.0
Elementary	27.1	34.8	22.3	20.4	31.4	31.7	39.2	37.7	36.6	33.2	30.1	29.5
Secondary	6.8	7.6	4.4	4.0	5.1	4.9	3.4	5.7	28.9	28.6	5.5	5.8
Higher	3.5	4.8	2.9	2.2	2.3	1.7	1.6	5.3	15.0	**27.6***	2.7	3.7
Relationship to the head												
Female head	4.0	3.2	4.9	3.1	4.8	4.3	5.8	8.5	9.7	**16.5+**	5.6	6.1
Wife	88.0	85.4	87.8	91.2	88.9	91.7	87.6	86.0	81.4	75.6	87.5	88.6
Daughter	3.0	6.1	2.5	3.0	2.5	1.8	1.4	1.0	3.2	2.3	2.5	2.2
Other	4.9	5.2	4.8	2.8	3.7	2.2	5.2	4.4	5.6	5.7	4.4	3.1

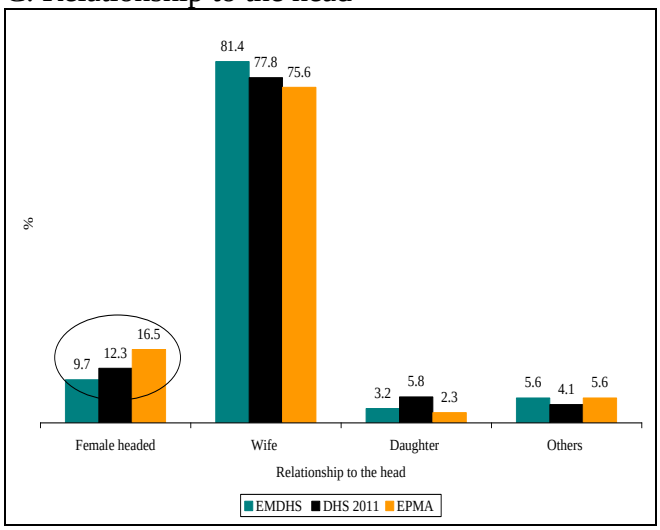
**p<0.05; +p=0.09 ; all percentages are weighted percentages ; N=Unweighted*

Fig 10. Distribution of married women interviewed in Addis Ababa in accordance with the number of children ever born, educational status and headship status, EMDHS, EPMA and DHS 2011

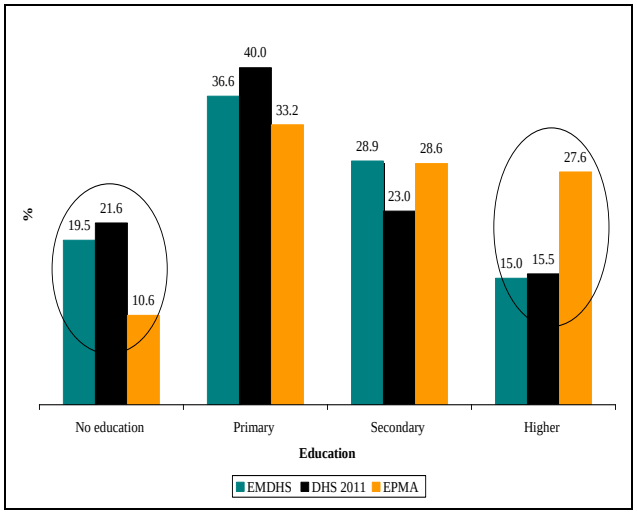
A. Children Ever Born



C. Relationship to the head



B. Education



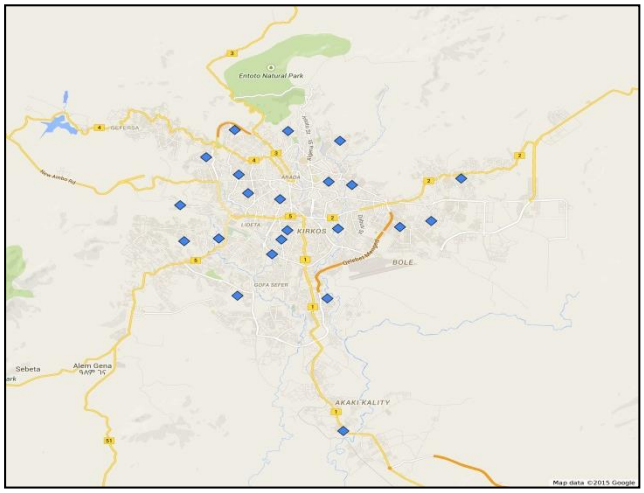


Figure 11A . EPMA(blue spots) AA clusters

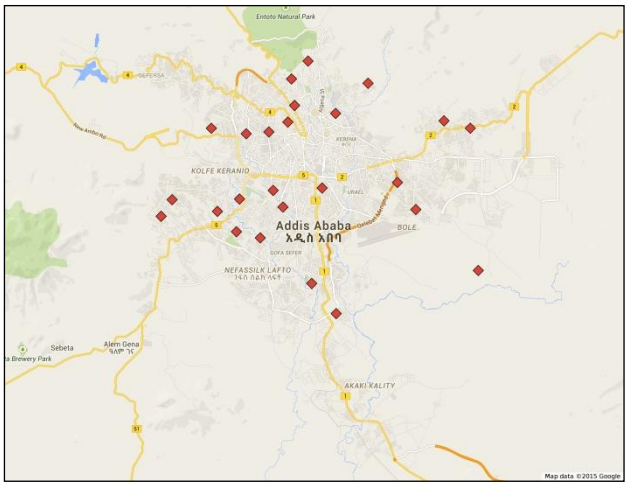


Figure 11B. EMDHS (red spots) AA clusters

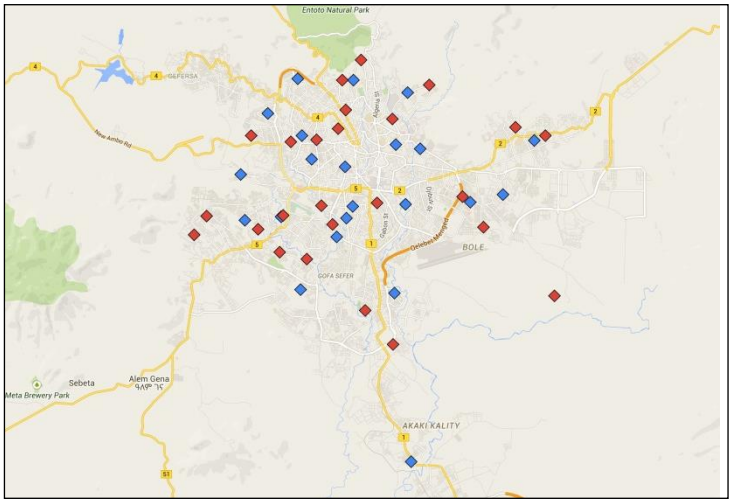


Figure 11C . EMDHS (red) & EPMA (blue) AA clusters

3.2. Survey design and sampling error

3.2.1. Stratification and sample allocation

The principal objective of stratification is to reduce sampling errors and increase survey efficiency. In a stratified sample, the sampling errors depend on the population variance existing within the strata but not between the strata. For this reason, it pays to create strata with low internal variability (or high homogeneity)[8].

Both the EMDHS and EPMA surveys by design employed a multi-stage stratified cluster sampling. The EMDHS created 21 strata where the clusters were drawn independently from each stratum. In the EPMA there were 11 strata with similar sampling strategy. For the purpose of comparison of the two surveys we collapsed several small regions strata of the EMDHS to form a stratum "other regions"[9] . As can be seen in Table 7, the EMDHS was based on a total of 305 clusters that were allocated over the 21 strata. Nearly half of the EMDHS clusters (n=150) were allocated to the other regions. Next to the other regions, more clusters were allocated to rural SNNPR (10.5%), rural Amhara (9.8%) and rural Oromia (9.5%) and Addis Ababa (8.2%). The EPMA survey appears to follow a different sample allocation strategy with the largest number of clusters (n=28; 9.2%) went into urban SNNP, followed by rural Amhara (n=26; 8.5%), Other regions, Addis Ababa, urban Tigray, among others. Large-sized strata such as rural Oromia (n=19) and rural SNNP (n=19) received relatively smaller number of clusters in the EPMA.

The EMDHS employed a power allocation of samples across the strata[10] , as implemented in the previous Ethiopia DHS. The power allocation is in particular recommended for multi-indicator surveys such as in the DHS. This strategy requires fixing the minimum sample size per strata or domain. Accordingly, the EMDHS estimated the minimum sample size per domain (region) at 500 women in the age 15-49 years. In the EPMA the sample allocation across strata takes account

[8] ICF International. 2012. Demographic and Health Survey Sampling and Household Listing Manual. MEASURE DHS, Calverton, Maryland, U.S.A.: ICF International

[9] Other region strata: (1) Dire Dawa ruban, (2) Dire Dawa rural,, (3) Harari urban, (4) Harari rural, (5) Gambella urban, (6) Gambella rural, (7) Benishangul Gumuz urban, (8) Benishangul Gumuz rural.

[10] Central Statistical Agency [Ethiopia]. 2014. Ethiopia Mini Demographic and Health Survey 2014. Addis Ababa, Ethiopia.

of the mCPR and DEFT. It should be stressed, however, that both surveys lacked details about how the samples were allocated.

Table 7. Sample allocation across strata, EMDHS & EPMA.

Strata	EMDHS		EPMA	
	# of Clusters	% allocation	# of clusters	% allocation
Tigray urban	5	1.6	21	6.9
Tigray rural	20	6.6	13	4.3
Amhara urban	5	1.6	14	4.6
Amhara rural	30	9.8	26	8.5
Oromia urban	6	2.0	12	3.9
Oromia rural	29	9.5	19	6.2
SNNP urban	3	1.0	28	9.2
SNNP rural	32	10.5	19	6.2
Addis Ababa	25	8.2	22	7.2
Other regions	150	49.2	26	8.5
Total	305		200	

Recalculating sample allocation of the EPMA:

Recalculating the sample allocation of the EPMA using common approaches is of paramount importance for the following: First, the sample allocation of the EPMA deviated from the most commonly used approaches; Second, large-sized strata such as rural Oromia and rural SNNP were given smaller number of clusters while small areas such as urban SNNP and urban Tigray received larger number of clusters; and the reason for this pattern of allocation is unclear.

There are different approaches to sample allocation across strata, the major ones being equal sample allocation, proportional allocation, optimum allocation and power allocation[11]. In this section the three approaches - optimum, proportional, and power allocation - are presented to evaluate the plausibility of the EPMA sample allocation across strata. In this evaluation the overall sample size of the EPMA (N=7000 households), the total number of clusters (N=200) and the cluster size (35 households per clusters) will remain unchanged. Of note, independent

[11]ICF International. 2012. Demographic and Health Survey Sampling and Household Listing Manual. MEASURE DHS, Calverton, Maryland, U.S.A.: ICF International

computation of the overall sample size requirements for the EPMA survey arrived at similar sample size estimate. So this section focuses primarily on evaluation of the allocation of the total sample across the strata.

Proportional allocation:

The proportional allocation of clusters into the strata is based on the population size of each stratum. With this approach larger number of clusters will be assigned to strata with larger population size. As shown in Table 7, the largest number of clusters will go to three strata; namely, rural Oromia (n=62), rural Amhara (n=44) and rural SNNP (n=36). Although this is an ideal sample allocation, it doesn't give sufficient number of clusters to small regions to allow estimation region-based mCPR estimates. As a result, the proportional allocation cannot be a viable option for the EPMA unless the survey employs a much larger sample size.

Table 8. Proportional allocation of clusters across strata, EPMA

Strata h	N=7000 households; Cluster size=35 households $n_h = n * [N_h / \sum N_h]$		
	N_h	n_h	# of Clusters
Tigray urban	242223	112	3
Tigray rural	749827	348	10
Amhara urban	627630	291	8
Amhara rural	3348912	1555	44
Oromia urban	885615	411	12
Oromia rural	4697753	2181	62
SNNP urban	367168	170	5
SNNP rural	2729936	1267	36
Addis Ababa	662020	307	9
Other regions	768600	357	10
$\sum N_h$	15079684	7000	200

Optimum allocation:

The optimum allocation that is shown in Table 9 is a viable option for surveys that primarily target one or very few key indicators. Contraceptive prevalence rate, being the primary indicator of interest of the EPMA, the optimum sample allocation that is based on mCPR could be a viable option. The method is based on weighting the population proportion of each stratum by the corresponding mCPR value. The mCPR value for each stratum was obtained from the DHS 2011 with an anticipation of a conservative 5% absolute increase in mCPR by 2014. According to this

sample allocation, the largest number of clusters (n=49) would go to rural Oromia, followed by rural Amhara and rural SNNP. This is an improvement to the proportional allocation in terms of assigning a relatively higher number of clusters to strata with small population. Nevertheless, with the optimum allocation regions such as Tigray and the other regions still suffer from small clusters that may well affect estimation of mCPR at these domains with the required level of precision.

Table 9. Optimum allocation of clusters across strata, EPMA

Strata h	n=7000 households ; Cluster size=35 households $n_h = n * [N_h X mCPR_h / \sum N_h X mCPR_h]$				
	Population size N_h	Anticipated mCPR 5% increase from DHS 2011 $mCPR_h$	N_h*$mCPR_h$	n_h	# of Clusters
Tigray urban	242223	0.4934	119513	164	5
Tigray rural	749827	0.2151	161288	222	6
Amhara urban	627630	0.6043	379277	522	15
Amhara rural	3348912	0.3438	1151356	1584	45
Oromia urban	885615	0.6073	537834	740	21
Oromia rural	4697753	0.266	1249602	1719	49
SNNP urban	367168	0.5416	198858	274	8
SNNP rural	2729936	0.253	690674	950	27
Addis Ababa	662020	0.6807	450637	620	18
Other regions	768600	0.1946	149570	206	6
$\sum N_h$	15079684			7000	200

Power allocation:

The power allocation is a widely used sample allocation strategy in the DHS. A power allocation is an allocation proportional to the power of a size measure *M (see formula in Table 10).* A power value of 1 gives proportional allocation; a power value of 0 gives equal size allocation; a power value between 0 and 1 gives an allocation between proportional allocation and equal size allocation. A power allocation with power values between 0 and 1 is a tradeoff between the national level precision and the domain level precision[12]. This sample allocation requires fixing the minimum sample size per domain (region) and it is estimated that a minimum sample size of 600 is required to have reliable estimate for mCPR. Under this assumption and with a power value of 0.25, the power allocation provides the most plausible allocation of samples across the strata.

[12] ICF International. 2012. Demographic and Health Survey Sampling and Household Listing Manual. MEASURE DHS, Calverton, Maryland, U.S.A.: ICF International

With this allocation strategy, the largest number of clusters will be allocated to rural Oromia (n=29), rural Amhara (n=26) and rural SNNPR (n=25). Other regions such as Tigray and Addis Ababa also received sufficient number of clusters that allow estimation of the mCPR and other indicators with the required precision.

Table 10. Power allocation of clusters across strata, EPMA

Strata H	M	Nn=7000 households ; Cluster size=35 households Minimum sample size per region=600 $n_h = n\frac{M_h^{\alpha}}{\sum_{h=1}^{H} M_h^{\alpha}}$								
		Power (α) =0.25			Power (α) =0.5			Power (α) =0.75		
		M^{α}_h	n_h	# of clusters	M^{α}_h	n_h	# clusters	M^{α}_h	n_h	# clusters
Tigray urban	242223	22	481	14	492	312	9	10918	192	5
Tigray rural	749827	29	638	18	866	549	16	25481	448	13
Amhara urban	627630	28	610	17	792	502	14	22299	392	11
Amhara rural	3348912	43	927	26	1830	1161	33	78285	1377	39
Oromia urban	885615	31	665	19	941	597	17	28869	508	15
Oromia rural	4697753	47	1009	29	2167	1375	39	100906	1775	51
SNNP urban	367168	25	533	15	606	384	11	14916	262	7
SNNP rural	2729936	41	881	25	1652	1048	30	67161	1181	34
Addis Ababa	662020	29	618	18	814	516	15	23209	408	12
Other regions	768600	30	642	18	877	556	16	25958	457	13
$\sum M^{\alpha}_h$	15079684	323	7004	200	11037	7000	200	398002	7000	200

Evaluating the EPMA sample allocation:

In the whole, the EPMA implemented sample allocation differs notably from both the optimum and power allocation that are presented above. Huge variation in sample allocation can be apparent between EPMA and the power allocation for urban SNNP, rural Oromia, other regions, urban Tigray and rural SNNP (Table 11). In almost every stratum there are differences in the number of clusters allocated/implemented by the EPMA vis-à-vis the power allocation. In particular, it is not clear why the EPMA allocated huge number of clusters to urban SNNP (n=28) and urban Tigray (n=21). Whilst a relatively smaller number of clusters (n=19) in rural Oromia and rural SNNP.

As discussed above, the rationale behind stratification is to reduce sampling errors by creating strata with low internal variability (or high homogeneity). The next section will examine the degree of internal variability of each stratum (i.e. between-cluster variability within a stratum) , and thereby discusses the likely effect of the sample allocation on the stability of the mCPR in the different strata.

Table 11. Evaluating the EPMA cluster allocation against two scenarios

Strata	# of Clusters			EPMA allocation vs. Optimal allocation	EPMA allocation vs. Power allocation
	EPMA allocation	Optimum allocation	Power allocation (value=0.25)		
Tigray urban	21	5	14	PMA over-sample	PMA over-sample
Tigray rural	13	6	18	PMA over-sample	PMA under-sample
Amhara urban	14	15	17	Comparable	PMA under-sample
Amhara rural	26	45	26	PMA under-sample	Comparable
Oromia urban	12	21	19	PMA under-sample	PMA under-sample
Oromia rural	19	49	29	PMA under-sample	PMA under-sample
SNNP urban	28	8	15	PMA over-sample	PMA over-sample
SNNP rural	19	27	25	PMA under-sample	PMA under-sample
Addis Ababa	22	18	18	PMA over-sample	PMA over-sample
Other regions	26	6	18	PMA over-sample	PMA over-sample
Total	200	200	200		

3.2.2. Within stratum variability

In multistage stratified cluster sampling the amount of gain in precision is determined by the extent the within stratum variability (measured by the between-cluster variances within a stratum) of the study variables are reduced while the within cluster variances of the study variables are increased. Thus, homogeneity of the clusters in terms of the study variables of interest within a stratum is key to achieving good precision. On the other hand, maximizing the within cluster heterogeneity is an important feature of such designs.

Table 12 presents, for each stratum, the number of clusters, the average number of married women interviewed per cluster, the modern contraceptive prevalence rate and the between cluster variance and the variance-to-mean ratio (VMR) for each stratum, separately for the EMDHS and EPMA. Two statistical parameters are of interest here: (1) the between-cluster variance and (2) the VMR. In particular, high variance-to-mean ratio (VMR) that exceeds 1 suggest high variability or over dispersions of mCPR across clusters within a given stratum. In other words this means the within stratum variability is high, which is indicative of heterogeneity of the clusters within a stratum in terms of the mCPR as well as the inadequacy of the number of clusters sampled in a given stratum.

As shown in Table 12, the between-cluster variance of mCPR varies greatly across strata in both surveys but this is more so in the EPMA. In particular, the EPMA's strata of rural SNNP and rural Oromia exhibited exceedingly high between-cluster variance compared to the other strata. While in the EMDHS notably high between-cluster variance was estimated for urban SNNPR. As a measure of despersion, the VMR ranges from a low of 0.2 to 7.4 across the EPMA strata while from 0 to 4.3 across the EMDHS strata. The highest VMR was recorded in the EMPA survey for rural Oromia at a value of 7.4. In contrast, the corresponding VMR value for rural Oromia in the EMDHS was much lower at a value of 1.03. This suggests that clusters means of mCPR in the rural Oromia stratum were more dispersed in the EPMA than in the EMDHS. Similarly, the high VMR value of 5.2 for rural SNNPR in the EPMA is indicative of high dispersion of clusters means within the rural SNNPR. Of note, the corresponding VMR value of rural SNNP in the EMDHS was also high at 2.4 although this was lower than that of the EPMA

for the same. Indeed, the high between-cluster variance and high VMR values in rural Oromia and SNNP may well suggest that the EPMA stratification was less efficient in reducing sampling error in these strata. Both the optimum and power allocation of clusters across strata that are presented in this report indicated that the EPMA survey allocated relatively fewer number of clusters in rural Oromia and rural SNNPR. With the power allocation the number of rural clusters in rural Oromia should have been increased by 10 (n=29). Coincidentally, the EMDHS implemented 29 clusters in rural Oromia. Figures 12A-C show the distribution of the clusters.

It can be posited that the huge variation in mCPR between EPMA and EMDHS in Oromia could partly be explained by the differences in sample allocation between the two surveys and the number of clusters allocated to this particular stratum. It should be noted that this analysis does not suggest the EPMA sample size for rural Oromia is inadequate rather it is simply implying that the clusters are fewer and suffer from high variability. In other words this means the EPMA based mCPR estimate for rural Oromia and SNNP may not be replicable if the survey are repeated in other randomly selected clusters (keeping the number of cluster same). Naturally high variability across rural Oromia clusters is not unexpected because the area is vast in size and also contains the largest sampling frame in the country with a total of 25,264 EAs (39% of the total) - Table 13. The recorded comparable mCPR estimates between the two surveys in SNNPR is arguable and, in fact, most likely due to chance and do not necessarily be reproducible in future surveys with same sample allocation approach. It should be emphasized that getting comparable mCPR results in different survey rounds that gathered data from same clusters does not necessarily indicate validity; it only suggests reliability of estimates within the selected clusters.

There are two possible solutions to dealing with the high between-cluster variability in some of the strata. One is to consider a better stratification of the Oromia region that takes account of homogeneity of the EAs/clusters with regards to mCPR because creating a single stratum under rural Oromia may result in violation of the assumption of within stratum homogeneity. This suggestion holds for both surveys. But this is challenging mainly because there is a dearth of information on contraceptive behavior of the population at lower level; such as zone or Woreda. Perhaps a better and more feasible solution is to increase the number of clusters to be sampled in

rural Oromia as suggested in the Power allocation without affecting the total sample size. The power allocation rearranges the number of clusters across the strata because some strata such as urban SNNP and urban Tigray have received larger number of clusters than required while others including rural Oromia received much lower than the required.

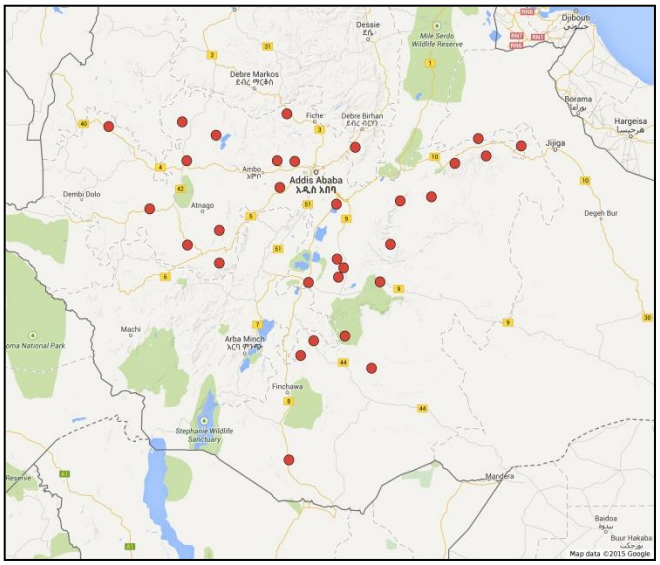


Figure 12A . EMDHS (red) Oromia clusters

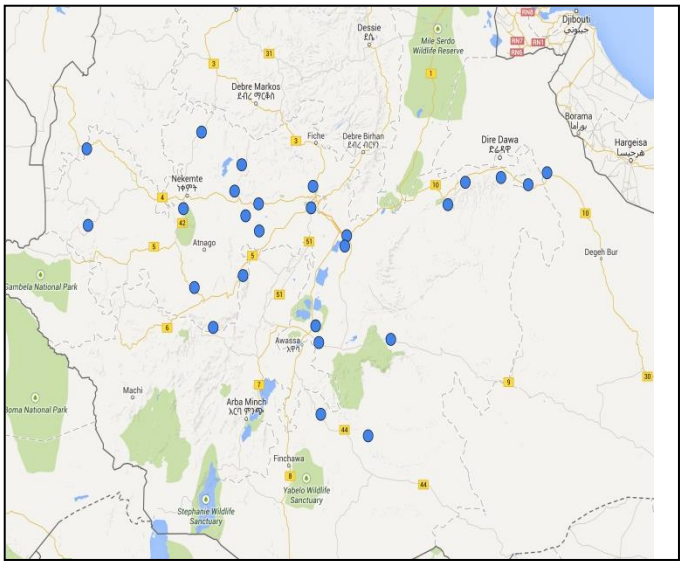


Figure 12B. EPMA (blue) Oromia Clusters

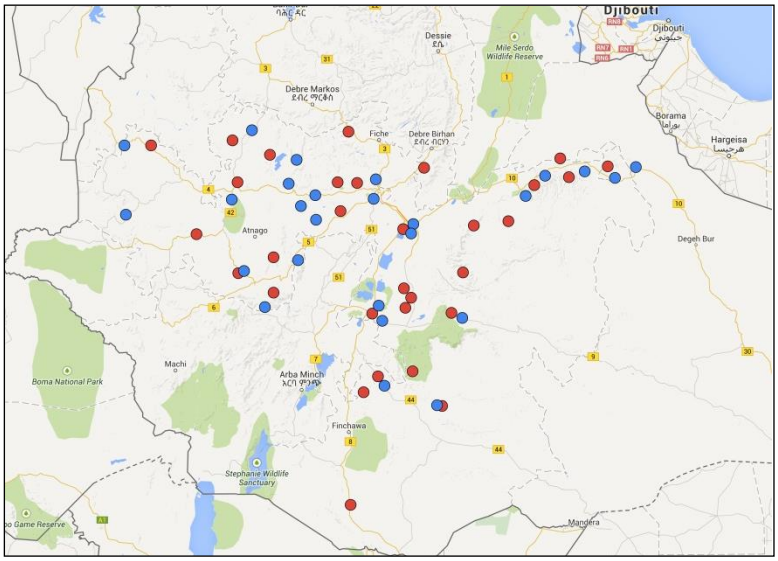


Figure 12C . EMDHS (red) & EPMA (blue) Oromia clusters

Table 12. Between cluster variance and variance-to-mean ratio (VMR) associated with mCPR by strata, EMDHA & EPMA

Strata	EMDHS					EPMA				
	No. of clusters	Average number of married women interviewed per cluster@	mCPR	Between cluster variance	VMR	No. of clusters	Average number of married women interviewed per cluster@	mCPR	Between cluster variance	VMR
Tigray Urban	5	13	50.6	0.000	0.0	21	14	44.1	0.094	0.2
Tigray Rural	20	17	22.8	0.253	1.1	13	19	24.5	0.116	0.5
Amhara Urban	5	9	65.3	0.219	0.3	14	13	61.2	0.117	0.2
Amhara Rural	30	17	45.1	0.721	1.6	26	20	46.0	0.786	1.7
Oromia Urban	6	12	56.1	0.209	0.4	12	17	48.4	0.147	0.3
Oromia Rural	29	19	37.3	1.033	**2.8**	19	23	20.4	1.499	**7.4**
SNNP Urban .	3	14	66.6	2.870	**4.3**	28	16	57.0	0.998	1.8
SNNP Rural	32	18	35.3	0.838	**2.4**	19	19	33.8	1.757	**5.2**
Addis Ababa	25	10	56.9	0.000	0.0	22	16	41.6	0.092	0.2

VMR=Variance-to-Mean Ratio

@ The average number of married women per clusters is higher in the EPMA because EPMA samples more households per clusters than that of the EMDHS (35 VS. 30 households).

Table 13. Distribution of census enumeration areas (EAs)/Clusters across regions: (Source: CSA, Ethiopia)

Region	Total	Urban	Rural
Tigray	5582	1484	4098
Afar	1019	245	774
Amhara	21127	3300	17827
Oromia	30173	4909	25264
Somali	1977	214	1763
Benshangul Gumuz	952	171	781
SNNP	16357	2058	14299
Gambela	400	127	273
Harari	262	167	95
Addis Ababa	3747	3747	Not applicable
Dire Dawa	441	313	128
All Regions	**82037**	**16735**	**65302**

3.2.3. Design Effect and Coefficient of variation

Post-estimation parameters including standard error (SE), design effect (DEFT) and coefficient of variation (CV) are presented by domain for EMDHS and EPMA in Table 14. The table also shows the DHS 2011 parameters for comparison. The design effect measures the impact of departing from simple random sampling on sample estimate precision and is the ratio of the estimated variance of a statistic derived from considering the sample design to that derived from the formula for simple random samples[13]. At the national level, the values of the design effect and coefficient of variation compare well between the two surveys as well as with the DHS 2011. The surveys found a design effect in the range of 2.6-2.9.

Here more emphasis is given to the coefficient of variation because it provides a good indication as to whether the mCPR estimates from the different surveys are reliable or not. The coefficient of variation (the ratio of the standard error to the mean) measures the degree of variability or stability of the mCPR estimates. The literature suggest that a coefficient of variation of less than

[13] Selfa, L. A., Suter, N., Myers, S., Koch, S., Johnson, R. A., Zahs, D. A., et al. (1997). 1993 National Study of Postsecondary Faculty (NSOPF:93) methodology report (NCES Publication No. 97-467). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

10% is generally considered an acceptable level of random variation for an estimate[14, 15]. While larger coefficient of variation makes it difficult to determine where the true value lies within a given confidence interval, which makes the estimate uncertain or instable. In other words, this concerns the repeatability of an estimate.

The CV values for mCPR at the national level for the EMDHS and EPMA fall within acceptable range at 5.2% and 6.7%, respectively. In both surveys, however, the associated CV values of mCPR in Oromia and SNNP regions appeared to be notably high and this is more so in the EPMA survey. In contrast, the DHS 2011 reported CV values lower than 10% for both regions. Both the Oromia and SNNP mCPR estimates of the EMPA suffered from exceptionally high CV values that are exceeding 16%, suggestive of instability of the mCPR estimates in these regions. The EMDHS also exhibited high CV values for these regions with estimates a little bit over the recommended cut-off value of 10% (10.4% for SNNP and 10.1% for Oromia). The noted high CV values for these regions should be a cause for concern. First, the mCPR values for these regions are highly likely to be less stable and thereby non-replicable. Second, with such large CV values associated with the mCPR estimates tracking any change in mCPR values from one period to the next will be uncertain.

Indeed, the high CV values associated with the mCPR estimates in the two regions is corroborated by the observed high between-cluster variations and high variance-to-mean ratio described elsewhere above in this report. This in turn crystallizes the suggestion of increasing the number of clusters (and the sample size) in these two regions as detailed by the optimum and power allocation of clusters across the strata.

[14] Hansen MH, Hurwitz WN, Madow WG (1953) Sample survey methods and theory. New York: Wiley.
[15] Pedersen J, Liu J (2012) Child mortality estimation: appropriate time periods for child mortality estimates from full birth histories. PLoS Med 9: e1001289

Table 14. Standard error (SE) , design effect (DEFT) and coefficient of variation (CV) by strata, EMDHS, EPMA & DHS 2011

	EMDHS 2014				EPMA-2014				DHS 2011			
	mCPR	SE	DEFT	CV (%)	mCPR	SE	DEFT	CV (%)	mCPR	SE	DEFT	CV (%)
Total	40.2	0.021	2.9	5.2	33.4	0.022	2.8	6.7	27.3	0.012	2.6	4.3
Tigray	28.8	0.029	1.3	9.9	28.8	0.026	1.4	9.3	21.2	0.190	1.4	8.2
Amhara	47.7	0.037	1.8	7.8	48.2	0.038	2.0	8.0	33.0	0.024	1.8	7.1
Oromia	39.4	0.041	2.1	**10.4**	23.9	0.039	2.3	**16.4**	24.9	0.021	1.8	8.6
SNNP	38.8	0.039	2.0	**10.1**	37.0	0.062	3.6	**16.7**	24.7	0.022	1.7	9.5
Addis Ababa	56.9	0.028	0.9	4.8	41.1	0.027	1.0	6.4	56.3	0.023	1.1	4.0

*SE: Standard Error (Linearized); DEFT: Design Effect ; CV=Coefficient of Variation (SE / mCPR)*100*

3.2.4. Sampling weights

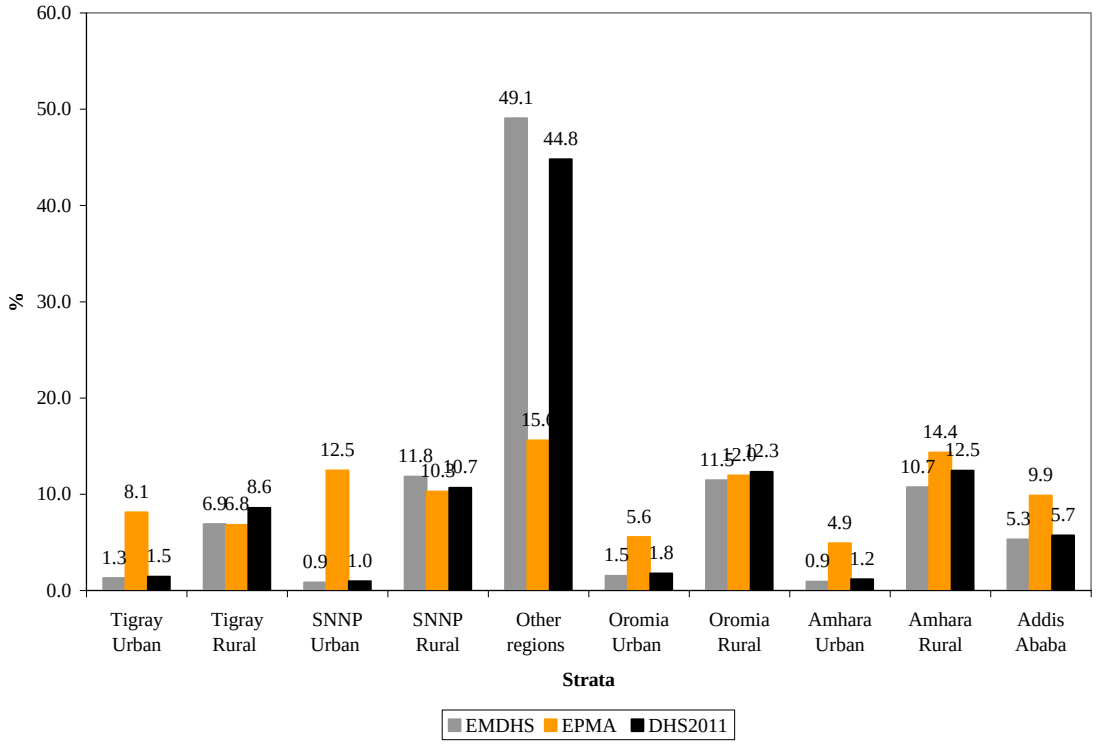
Sampling weights are an inflation factors which extrapolate the sample to the target population and are used to make the sample more like the target population[16]. The EMDHS and EPMA survey both employed a post-stratification weighting that adjusted for non-responses. The validity of the weighting procedures that were employed in the different surveys can be evaluated by simply comparing the weighted distribution of the population interviewed in the surveys against the census distribution.

Because married women are the primary target population for the estimation of the mCPR, the unweighted and weighted distribution of the married women sampled in the three surveys were compared against the census population distribution. As shown in Figure 13A and presented elsewhere above in this report, the EPMA's distribution of married women across the strata was different from that of the EMDHS as well as the DHS 2011. Of note, the EMDHS and DHS 2011 have implemented similar sample distribution across strata. However, after the sampling weights were applied to each of the surveys, the weighted distributions of married women across the strata became nearly similar between the two surveys and also reflected somehow the true population distribution as reported in the 2007 national census (Figure 13B). Thus, we can safely rule out any likely influences the sample weighting might have on the observed differences in mCPR between the two surveys.

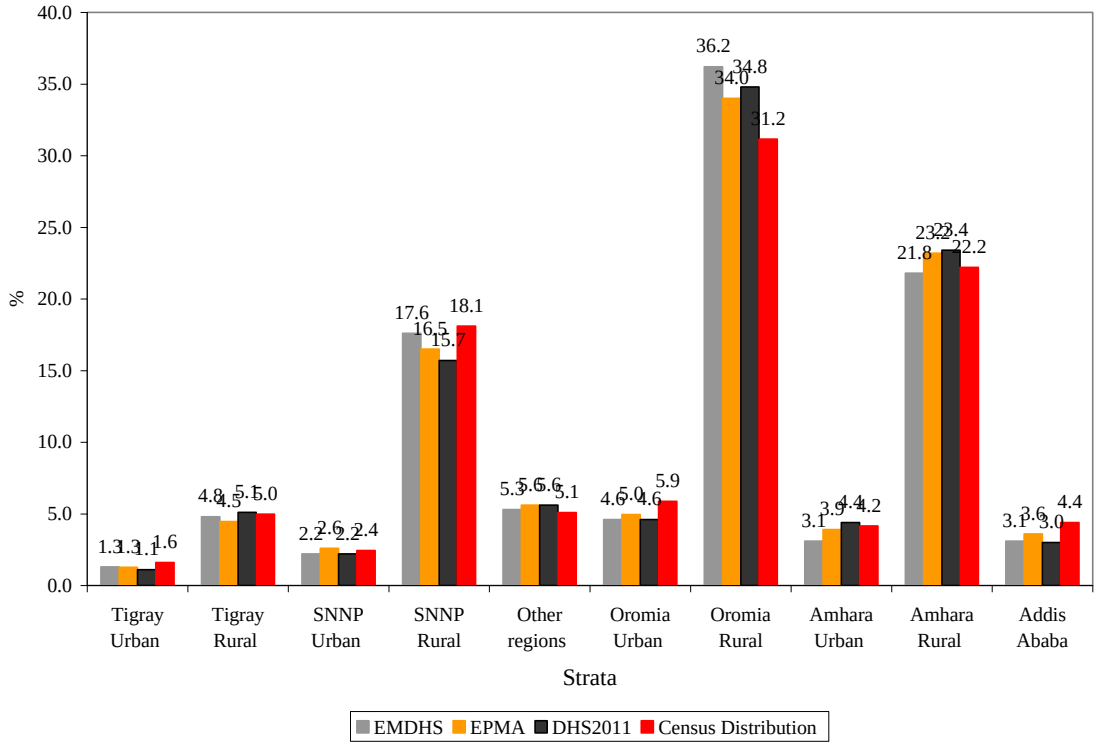
[16] ICF International. 2012. Demographic and Health Survey Sampling and Household Listing Manual. MEASURE DHS, Calverton, Maryland, U.S.A.: ICF International

Figure 13. Percent distribution of married women by strata A: unweighted B: weighted , PMA, EMDHS, DHS 2011

A. Unweighted



B. Weighted



3.3. Coverage and non-response

3.3.1. Coverage of eligible respondents

One source of non-sampling error in household surveys is under-coverage of eligible respondents due to different reasons. Omission of eligible respondents from the sampling frame and from the interview could lead to biased results. One way to evaluate whether or not there is coverage error in relation to eligible respondents is to compute the proportion of eligible respondents in the sampled households. The household questionnaires collected information on the age, sex and residence status of each household member along with few other variables. Eligible respondents included those women in the age bracket 15-49 years who are usual members of a household.

Comparison of the two surveys along with the DHS 2011 revealed that the surveys identified almost comparable proportions of eligible women in the sampled households, as shown in Table 15. Of all household members, the proportion of eligible respondents were 21.6%, 23.4% and 23.3%. respectively, in the EMDHS, EPMA and DHS 2011. Similarly, at the regional levels the proportion of eligible women identified by the three surveys also compared very well. Consequently, coverage error appeared less relevant for the observed differences in mCPR between the two surveys.

Table 15. Proportion of eligible women out of all household residents, EMDHS, EPMA and DHS 2011

	EMDHS N=40,931	EPMA N=28,538	DHS 2011 N=77,744
Total	21.6	23.4	23.3
Tigray	22.5	26.5	23.3
Amhara	21.8	21.9	23.6
Oromia	20.8	20.8	21.6
SNNP	20.0	22.6	21.1
Addis Ababa	32.3	32.0	33.4

3.3.2. Age distortion / age heaping

When surveys have eligibility criteria such as age limits, there is always the risk of omission of eligible respondents by survey interviewers due to different reasons. Intentional misreporting of the ages of women who are around the eligible age boundaries by moving the reported age out of the eligible boundaries remains among the many sources of non-sampling errors in household surveys that target women in the age group 15-49 years. Such distortions in the age distribution of women can be investigated by examining the discontinuity in trends across the eligibility boundaries. The ratio of women age 14 with those age 15, and those age 49 compared with those age 50[17] can provide a good insight into the presence of age distortion or heaping.

The ratio of the number of women at exact age 14 to those at exact age 15 revealed that both the EPMA and EMDHS surveys have reported notably higher number of women at the exact age 14 compared to those at the exact age 15. For instance, in the EPMA there were 491 women recorded in the household roster at exact age 14, which was much higher than the 292 women at the exact age 15. Likewise, the EMDHS recorded 549 vs. 351 women at the exact ages of 14 and 15, respectively. Unlike the two surveys, the DHS 2011 recorded more women at the age of 15 (n=985) than at the age of 14 years (n=739). Assuming equal proportion of women falling at the ages of 14 and 15 years in the general population, there appears a likely pushing out of substantial number women of age 15 years away from the eligibility both in the EPMA and EMDHS. Both surveys data suggest that the household questionnaire records 60-70% more women at the age of 14 years vis-à-vis those at the age of 15. This pattern of under-coverage of women at the age of 15 years also holds in the regions for both surveys but more so in the EPMA.

Age heaping appears more severe at the age of 50 years especially in the EPMA. Records of the family members in the sampled households indicated that the number of women at the age of 49 years were much lower than those at the age of 50 years (29 vs. 298). This pattern of age distortion may well reflect an intentional shift of a considerable number of women from age 49

[17] ICF International. 2012. Demographic and Health Survey Sampling and Household Listing Manual. MEASURE DHS, Calverton, Maryland, U.S.A.: ICF International

to age 50 years by the survey interviewers. Such shift appeared more severe in Oromia and SNNP of the EMPA survey. As shown in Table 16, the number of women at age 50 were 29.3 and 26.5 times higher compared to those at age 49 years, respectively, in SNNP and Oromia. Although age heaping at the age of 50 years is present in both the EMDHS and DHS 2011 it was much less severe than the EPMA.

In short, such age heaping/distortion at the eligible age boundaries, as an important form of non-sampling error, might have influenced comparability of mCPR results between the two surveys. It is however unknown how and to what extent such age heaping influenced the accuracy the mCPR estimates.

Table 16. Age heaping/distortion of women's age around the eligible age boundaries , EPMA, EMDHS & DHS 2011.

EPMA						
	Age 14 (N)	age 15 (N)	Ratio: age 14 (N)/age 15(N)	age 49 (N)	age 50 (N)	Ratio: age 49 (N)/age 50 (N)
Total	491	292	1.7	29	298	10.3
Tigray	73	57	1.3	6	36	6.0
Amhara	108	47	2.3	6	50	8.3
Oromia	93	45	2.1	2	53	26.5
SNNP	142	72	2.0	3	88	29.3
Addis Ababa	44	31	1.4	8	37	4.6
EMDHS						
	Age 14 (N)	age 15 (N)	Ratio: age 14 (N)/age 15(N)	age 49 (N)	age 50 (N)	Ratio: age 49 (N)/age 50 (N)
Total	549	351	1.6	53	174	3.3
Tigray	25	40	0.6	10	3	0.3
Amhara	74	41	1.8	6	6	1.0
Oromia	39	51	0.8	4	11	2.8
SNNP	65	40	1.6	11	17	1.5
Addis Ababa	36	47	0.8	4	16	4.0
DHS 2011						
	Age 14 (N)	age 15 (N)	Ratio: age 14 (N)/age 15(N)	age 49 (N)	age 50 (N)	Ratio: age 49 (N)/age 50 (N)
Total	739	985	0.8	99	282	2.8
Tigray	85	124	0.7	14	17	1.2
Amhara	93	165	0.6	28	26	0.9
Oromia	80	144	0.6	20	26	1.3
SNNP	91	105	0.9	6	20	3.3
Addis Ababa	83	66	1.3	11	42	3.8

3.3.3. Response rate

High response rates have been achieved in both the EMDHS and EPMA surveys at over 97% for the household interview and over 95% for eligible women. The overall eligible response rate is also high at 96.2% for the EPMA and 92.2% for the EMDHS (Table 17).

Table 17. Household and individual response rates, EMDHS & EPMA

	EMDHS	EPMA
Household interviews		
Household selected	9135	7000
Household occupied	8727	6919
Household interviewed	8475	6782
Household response rate@	97.1	98.0
Interview with women ages 15-49 years		
Number of eligible women	8492	6688
Number of eligible women interviewed	8070	6550
Eligible response rate #	95.0	98.2
Overall response rate (HH response rate X Eligible response rate)	92.2	96.2

@Household response rate=Household interviewed/ Household occupied
#Eligible response rate=eligible women interviewed/ Household occupied

3.4. Measurement variability - The questionnaires

Variability in the way key survey questions are constructed can be a source of non-sampling error and, thereby, affects comparability of indicators estimates between surveys. The contents and wording of questions, instructions, formats of responses categories, the use of different filter questions and skip rules are all important ingredients of a questionnaire. Against this backdrop, the two surveys were compared in terms of the contents, wording, filter questions, instructions and skip patterns of the family planning section of the questionnaires. The Ethiopia DHS 2011 questionnaire was also included for further comparison. Table 18 presents a summary of the key

questions, filters and skip patterns in relation to the family planning parts of the questionnaires implemented by the three surveys. The EPMA collected more information on family planning than the EMDHS. In total, there were 33 family planning related questions in the EPMA while the EDHS asked only eight questions related to family planning. The key question of interest is the question on "current use of family planning methods". This question was asked by all the three surveys with almost similar wording in English as well as in the Ethiopia local languages of Amharic, Oromiffa and Tigrigna[18]. Another important question that is related to family planning is the question on "ever use of family planning methods", which was asked in the EPMA and DHS 2011 but was not asked in the EMDHS.

Apart from the differences in the number of family planning related questions asked in the two surveys, perhaps the major difference between the two surveys lies in their use of filter questions/skip rules before asking the question on "current use". In the EMDHS "current use" was asked to all non-pregnant women irrespective of whether they have ever used family planning methods or not. In fact, EMDHS did not ask the "ever use" question. As a result of which, 91.4% (7374 women out of 8070) of the EMDHS eligible women (non-pregnant) were asked the "current use" question. In contrast, the EPMA asked the "ever use" question before asking the question on "current use" and only those women who responded "yes" to the question on "ever use" were asked the question on "current use". Consequently, only 52.3% (i.e. 3464 women out of 6627) of the eligible women (non-pregnant) were asked of the question on "current use" in the EPMA. About 23 questions would be skipped if a woman responded "no" to the question on "ever use" in the EPMA. It is indeed logical that the question on "ever use" preceded the question on "current use" and only those who ever used a method should be eligible to be asked for their current contraceptive behavior. Nevertheless, this type of ordering of the two questions and the use of a skip rule require proper care and close supervision during data collection. Because 23 questions are skipped if "no" to the question on "ever use" this can be tempting to some interviewers who are irresponsible and those who want to significantly cut their workload. This type of problem is not uncommon in household surveys especially when interviewers are instructed to complete a fixed minimum number of questionnaires per day. Only

[18] As part of this assessment the validity and consistency of translation of the questions was verified by language experts.

close monitoring of interviews such as spot checking, questionnaire review, re-interview and tallying of key indicators before leaving a cluster by survey supervisors can minimize such types of non-sampling errors.

Of note, the DHS 2011 asked the question on "current use" before asking the question on "ever use" and, apart from women's current pregnancy status, there was no other filter question prior to asking the question on "current use". Over 92% of the DHS 2011 eligible women were asked the question on "current use". Noteworthy, previous DHS surveys including the 2000 and 2005 Ethiopia DHS asked "ever use" prior to "current use" and only those who responded affirmatively to the question on "ever use" were asked "current use". This was almost the same format as implemented in the EPMA. However, this format has changed in the 2011 DHS with the "current use" questions preceding the "ever use". It is unknown why the DHS changed the format in the recent survey. There are also other variations between the two questionnaires including reference points of the question on "source of current methods", definitions of contraceptive methods in the interviewers manual, among others.

In short, the noted variations in the questions asked by the two surveys, especially the filter/skip rule associated with "ever use" question could be potential sources for the discrepant mCPR results between the two surveys.

Table 18. Summary comparison of the contents, wording and formats of the family planning sections of the questionnaires used in the three surveys; EPMA, EMDHS and DHS 2011.

Attributes	EPMA	EMDHS	DHS 2011
Family planning related questions	33 questions	8 questions	25 questions
"current contraceptive use" question Wording	Are you/your partner currently doing something or using any method to delay or avoid getting pregnant?	Are you currently doing something or using any method to delay or avoid getting pregnant?	Are you currently doing something or using any method to delay or avoid getting pregnant?
"ever use" question wording	Have you ever used anything or tried in any way to delay or avoid getting pregnant?	Not asked	Have you ever used anything or tried in any way to delay or avoid getting pregnant?
"current use" Vs. "ever use" questions order in the questionnaire	"Ever use" precedes "current use"	Not applicable	"Current use" precedes "ever use"
"curent use" filtre questions	Two filter questions: Ever use of family planning Plus Current pregnancy status [Never users plus pregnant women were not asked the question on "current use"]	One filter question Current pregnancy status only [Pregnant women were not asked the question on "current use"]	One filter question Current pregnancy status only [Pregnant women were not asked the question on "current use"]
No. of women interviewed	N=6627	N=8070	N=16515
No. of women who responded to the question on "ever use"	N=6627	Not applicable	N=16515
No. of pregnant women	N=359	N=696	N=1277
No. of women who ever used a family planning method	N=2804	Not applicable	N=5047
No. (%) of women who responded to the question on "current use"	N=3464 (52.3% of all women interviewed asked the "current use")	N=7374 (91.4% of all women interviewed asked the "current use")	N=15238 (92.3% of all women interviewed asked the "current use")

Table 18 (continued)

Attributes	EPMA	EMDHS	DHS 2011
Skip rules (# of question to skip if "never used a method")	Several questions (23 questions) including the question on "current use" were not asked if the women reported "never used a family planning method"	Not applicable	10 questions were not asked if the women reported "never used family planning" BUT the question on "current use" was asked irrespective of ever or never used a method.
"sources of current method" (slight difference between the two surveys)	"Where did you obtain your (CURRENT METHOD) when you started using it?".	"Where did you obtain the method the last time?"	"Where did you obtain the method the last time?",
Definition of contraceptive methods: Use of contraception for purposes other than birth control.	The EPMA interviewers manual mentions about use of family planning for purposes other than birth control. And those woman who reported using methods for purposes other than birth control are recorded as contraceptive users. In general, the use of contraception for other purposes is extremely rare in Ethiopia and the instruction may be irrelevant.	The EMDHS did not make any mention of use of contraception for other purposes	The DHS did not make any mention of use of contraception for other purposes

IV. SUMMARY OF KEY FINDINGS

The salient findings of this discrepancy analysis can be recapitulated as follows:

- ***Higher mCPR in EMDHS than EPMA at the national level; but the EPMA estimate appears more consistent with past trend***
    - National-level mCPR differed significantly between the EMDHS and EPMA surveys at 40.2% and 33.4%, respectively. However, both findings represented a significant increasing trend since the DHS 2011 rate of 27.3%. Compared to the 2011 rate, the recorded mCPR in the EMDHS suggests an average absolute increase of 4.3% per annum while this is 2% per annum in the EPMA. In terms of the rate of change in mCPR at the national level, the EPMA finding appears consistent with previous trends. The Ethiopia DHS found that between 2005 and 2011, the mCPR increased by an absolute average of 2.2 % per annum.

- ***The two surveys found comparable mCPR in Tigray, Amhara and SNNP regions.***

- ***Surveys women compared well in the reporting of method mix and source of current method except in some regions***
    - In the whole, the two surveys can be considered comparable in the reporting of contraceptive method mix. Exception to this was Tigray where the share of Implants (of all current methods) was much higher in the EPMA at 31.4% compared to only about 10% in the EDHS. At the national level and in most regions the reported sources of current methods did not vary significantly between the two surveys. But the two surveys did not agree in the reporting of Pharmacy, as a source of current method, in Addis Ababa (13.4% in the EPMA and 1.9% in the EMDHS).

- ***Fertility rates are comparable between the two surveys***
    - The TFR and ASFR compared well between the two surveys although—while not a provided measure by EPMA--regional TFR estimates suffer from small sample size.

- Being one of the PMA2020 indicator, the fertility rate of young women age 15-19 was compared between the two surveys. The surveys arrived at comparable fertility rate for young women at 59 per 1000 and 55 per 1000, respectively, in the EMDHS and EPMA.

- ***Huge discrepancy in mCPR estimates between the two surveys for Oromia; both estimates are inconsistent with past trends***
  - The mCPR reported by the EMDHS for Oromia was 15 percentage points higher than that by the EPMA. Trend analysis with previous DHS revealed that EMDHS estimate for Oromia exhibited by a fast trend with an absolute average increase of 4.8 % per annum. This rate of change is not consistent with the previous trend at around 2% per annum. On the other hand, the mCPR remained nearly unchanged since 2011 according to the EPMA estimate. Both estimates are inconsistent with past trends.

- ***Huge discrepancy in mCPR estimates between the two surveys for Addis Ababa; the EMDHS estimate is consistent with past trend***
  - Akin to Oromia, the two surveys found mCPR estimates that are furthest apart from each other for Addis Ababa - 56.9% in EMDHS and 41.1% in EPMA. There are sufficient reasons to believe the mCPR estimate by the EPMA represents an underestimate of the "true rate" for Addis Ababa. First, Addis Ababa already recorded a high mCPR at 56.3% in 2011. Second, the proportion who ever used a family planning method, which combines past and current use, showed a reversal trend according to the EPMA estimate - from 86.2% in 2011 to 78.1% in 2014 (EPMA). Reversal trend in the proportion who ever used a family planning method is highly unlikely unless there is a major change in the demographic and socio-economic compositions of the population due to migration. Third, the low TFR estimate of 1.9 children per woman in Addis Ababa does not correspond with the relatively low EPMA-based mCPR but could also reflect the relative importance of increased abortion practice in the city.

- ***The discrepant mCPR in Oromia was the major source of variation between the two surveys at the national level***
    - Excluding the Oromia data from both surveys resulted in similar mCPR estimates between the two surveys at the national level (40.8% in EMDHS vs. 39.5% in EPMA), pointing to the fact that Oromia is the major source of discrepancy in mCPR between the two survey at the national level. This is because Oromia is home for over 36% of the population in the country. Due to small population the discrepant mCPR in Addis Ababa has insignificant effect on the national estimates.

- ***High within-stratum variability of mCPR for rural Oromia and rural SNNP in both surveys but more so in the EPMA***
    - The variance-to-mean ratio (VMR) was computed by stratum in order to measure the level of dispersion of the mCPR estimates (i.e. homogeneity or heterogeneity) between clusters within a given stratum. It appears that the VMR values for rural Oromia and rural SNNP strata of the EMPA were exceedingly high and suggest highly dispersed cluster-level mCPR estimates in these strata. In other words, this means the mCPR estimates of rural Oromia and rural SNNP can be considered highly unstable and non-replicable. Though to a lesser extent these same strata including urban SNNP also exhibited high VMR values in the EMDHS. The high between-cluster variability of mCPR values may explain part of the huge disparity in mCPR estimates between the two surveys in Oromia. High between-cluster variability warrants a more efficient sample allocation of clusters across the strata.

- ***High coefficient of variation (CV) associated with mCPR estimates of Oromia and SNNP in both surveys but more so in the EPMA***
    - In both surveys the CV associated with the mCPR in Oromia and SNNP regions appeared to be notably high. In particular, the CV estimates for these two regions in the EPMA exceeded 16%. Similarly, the CV values for these regions in the EMDHS also high; a little bit over the recommended cut-off value of 10%. These findings are also corroborated by the aforementioned high between-cluster variability. Indeed, a high CV value makes it difficult to determine where the true mCPR value lies within

a given confidence interval, which in turns makes the estimate uncertain. Furthermore. with such large CV values tracking any change in mCPR from one period to the next is bound to high uncertainty.

- ***The two surveys differed in their sample allocation approaches across the strata***
    - Sample allocation across strata differed notably between the two surveys. The EMDHS employed the power allocation approach, as in the previous DHS including the 2011. While the EPMA used a different approach of allocation that relied upon domain-level mCPR estimates and DEFT. According to the EPMA allocation, big stratum such as rural Oromia and rural SNNP were given fewer number of clusters (19 each) while smaller strata such as urban SNNP (28 clusters), and urban Tigray (21 clusters) have received larger number of clusters. This does not correspond with the most commonly used sample allocation procedures such as the power or optimum allocations. It was neither a proportional nor an equal allocation approach. Indeed, the smaller number of clusters allocated to rural Oromia and rural SNNP by the EMPA contributed to the observed high between-cluster variance, high VMR and high CVs in these strata, and thereby for the discrepant findings between the two surveys. This necessitates a more efficient sample allocation strategy.

- ***Lower precision of regional mCPR estimates in both surveys compared to the DHS 2011***
    - On the whole, precisions of the mCPR estimates in both the EMDHS and EPMA were lower than in the DHS 2011. This is a reflection of the much larger sample size in the DHS 2011. Of note, the DHS 2011 surveyed over 16,000 households in 624 clusters.

- ***The two survey employed similar survey design, sampling approach and sampling frame (Census enumeration areas).***
    - Standard DHS survey design was implemented in both of the surveys; and the sampling was done by the CSA for both surveys. Coincidentally, the surveys were fielded around the same time period- January-April 2014 - that further enhances their

comparability. The slight difference in sample weighting procedures used in the surveys was less likely to account for the difference in mCPR.

- The surveys differed in their use of technology for data collection. The EMPA employed a Smartphone-based technology for data collection while the EMDHS was based on the usual pen and paper-based approach.

- ***Respondents composition compare well between the two surveys with the exception of Addis Ababa***
  - The compositions of married women that were interviewed in Addis Ababa varied notably between the two survey in accordance with their number of children ever born, educational status and headship status. Multivariate analysis revealed the importance of these characteristics in shaping women's contraceptive behaviors in both surveys. Part of the discrepant mCPR estimates between the two survey in Addis Ababa is thus explained by the noted variability in the composition of the married women in the surveys.

- ***Women's questionnaires vary between the two surveys in their contents and format***
  - The EPMA employed a much more elaborated questionnaire that allows the measurement of several aspects of family planning (33 questions). In contrast, the EMDHS not only asked few questions (8 questions) related to family planning but also missed several important questions including "ever use of a family planning method". The depth of family planning related information collected in the EPMA was designed to enable family planning programmers, academia and researchers to monitor progress annually.

  - Both surveys asked the question on "current use of family planning method" with similar wording and format. But the major difference between the two surveys lies in their use of filter questions/skip rules before asking the question on "current use". In the EPMA "ever use of family planning method" was used as a filter question for the "current use" and only those women who responded "yes" to the question on "ever

use" were asked the question on "current use". EMDHS did not ask the question on "ever use". The DHS 2011 also asked the question on "ever use" but it succeeded "current use" and was not used as a filter question. This difference in the use of filter questions and skip rules can affect comparability of the mCPR estimates between the two surveys.

- ***Age heaping around the eligible age boundaries were common in both surveys but more so in the EPMA***
    - Both data sources suffer from sever age heaping at the ages of 14 and 50 years. But the level of heaping appeared more severe in the EPMA. This pattern of age heaping may well reflect an intentional shift of a considerable number of women out of the eligible boundaries by survey interviewers. Such age shifting appeared more severe in Oromia and SNNP data of the EMPA survey. The effect of such age distortion on the comparability of the two surveys cannot be undermined.

V. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Major sources of discrepancies in mCPR between the two surveys at national as well as regional levels were identified although they were by no means comprehensive. Non-sampling errors, as potential sources of discrepant findings, were not sufficiently evaluated in this analysis due to paucity of information. This analysis also presupposes no part of the difference in mCPR between the two surveys is attributable to differences in the data collection approaches implemented by the surveys - paper-based vs. Smartphone-based.

With the caveat of these limitations, it can be concluded that the mCPR estimates derived from the two surveys varied significantly at national level as well as in the Oromia and Addis Ababa regions. Differences in sample allocation across strata, variability in the socio-demographic compositions of respondents (in Addis Ababa), variability in questionnaires format, and age distortion around the eligible age boundaries emerged as potential sources of the discrepant findings. It should also be emphasized that most regional mCPR estimates of both surveys suffered from lower precision as compared to the DHS 2011 mainly due to smaller sample size.

The conduct of a household survey is often a complex and lengthy process that involves critical technical inputs, mobilizing huge resources, and decision makings at various stages. Gauging the accuracy and reliability of either of the surveys simply because they produced discrepant results is not warranted. Rather, each survey should be evaluated in accordance with its goal, methodological scope and resource environment.

5.2. Selected Recommendations

The following recommendations are put forward in order to serve as inputs for the future rounds of EPMA surveys.

- Revise the sample allocation across strata without increasing the total sample size. The power allocation presented in this report can be a viable option and with this, the number of clusters that will be allocated to rural Oromia and SNNP will increase. Thereby improves the precision of mCPR estimates in these regions. This allocation also assures that each domain receives sufficiently large number of clusters with the required precision.

- The low mCPR in Addis Ababa by the EPMA is most likely influenced by non-sampling errors rather than sampling errors. Future surveys need to make sure that the household listings at cluster level are exhaustive, households are properly located, eligible respondents in the selected households are interviewed, refusals, if any, are recorded. At cluster level, hand-tally indicators can be introduced to monitor data quality. Survey supervisors need to be instructed to closely monitor the data collection through spot checking, re-interview, review of completed interviews, hand-tallying of key indicators, among others, before leaving a cluster.

- The acceptability and utility of the EPMA findings can be enhanced when it is consistent with the well-established Ethiopia Demographic and Health Surveys in terms of the contents and formats of its questionnaires. In this regard it is highly recommended, first, to avoid the skip rule associated with the "ever use" question. Second, the question on "current use" should precede "ever use". Third, the different instructions used in the interviewers manual should be consistent with that in the DHS, especially those related to the questions on "current use" , "ever use", method mix and source of current method. The format of the birth-history section of the EPMA questionnaire can benefit from being changed to allow for easy application of existing analysis routines for DHS data.

- The accuracy of women's age especially around the eligible age boundaries should be given proper scrutiny during data collection. Supervisors can check for age heaping at the ages of 14 and 50 years by hand-tallying the household age distribution in each cluster.

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