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Multilevel analysis of Quality of antenatal care and associated factors among pregnant women in Ethiopia: A community based cross-sectional study

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Multilevel analysis of Quality of antenatal care and associated factors among pregnant women in Ethiopia: A community based cross-sectional study

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Abstract

Objective: To determine the magnitude of quality of antenatal care and associated factors among pregnant women in Ethiopia.

Design: A community based cross-sectional study

Setting: Ethiopia

Participants: A total of 4757 weighted sample of pregnant women from January 18 to June 27, 2016, were included for this analysis

Outcome: Quality of ANC.

Methods: Our analysis was based on secondary data using the most recent Ethiopian Demographic and Health Survey. A multi-level mixed-effect logistic regression analysis was fitted. Adjusted Odds Ratio with 95% confidence intervals was used to show the strength and direction of the association. Statistical significance was declared at a *P* value less than 0.05.

Results: The magnitude of quality of antenatal care in Ethiopia was 22.48% (95% CI: 21.31, 23.69). Educational status; primary (AOR=1.34; 95%CI: 1.06, 1.68) and secondary (AOR=2.46; 95%CI: 1.76, 3.45), middle (AOR=1.31; 95%CI: 1.01, 1.72) and rich (AOR=2.08; 95%CI: 1.59, 2.72) wealth status, being married (AOR=2.34; 95%CI: 1.08, 5.10), and four or more antenatal care (AOR=2.01; 95%CI: 1.67, 2.40) were statistically significant associated factors that affect the quality of ANC in Ethiopia.

Conclusions: This study found that nearly only one in five pregnant women received quality antenatal care during pregnancy. To improve the quality of ANC in Ethiopia, Ministry of Health and health facilities are needed to increase financial support strategies that enable pregnant women from poor households to use health services and enhance pregnant women's understanding of the significance of quality of antenatal care through health education.

58 Additionally, Community health workers should also be placed on supporting unmarried

59 pregnant women to have quality antenatal care.

60 **Keywords**: Quality, Antenatal care, factors, Ethiopia.

61 ## **Strengths and limitations of the study**

62 ➢ The study uses nationally representative data and large sample size

63 ➢ This study also used a multilevel-modeling technique to identify a more valid result

64 that considers the survey data's hierarchical nature.

65 ➢ The study has limitations due to the cross-sectional nature of the data, it does not show

66 a temporal relationship between independent variables and the outcome variable.

67 ➢ There could be recall bias, since we used the most recent live birth in the past five years

68 before the survey.

69 ➢ Due to the use of secondary data, we used only six essential components of ANC to

70 determine the magnitude of quality of ANC.

71

Introduction

Women and teens receive care from health professionals during pregnancy to ensure that both mothers and babies experience the most favorable outcomes. Aside from offering health education, screening, diagnosis, and disease prevention, antenatal care (ANC) can save lives. [1,2] Focused ANC primarily helps women to maintain normal pregnancies by detecting preexisting conditions, preventing complications that may arise during childbirth. [3] ANC is the main method for improving maternal health outcomes through early detection of pregnancy risks, and complications. Access to care also includes nutrition, vaccinations, medical tests, and therapies. [4] Moreover, women's access to comprehensive maternal health care, from conception to delivery and afterward, it is possible to minimize their risk of death. [1,5]

There was a 38% drop in maternal mortality worldwide between 2000 and 2017. [6] But according to the World Health Organization estimates, approximately 295,000 women died after pregnancy or childbirth since 2017, with 94% of these deaths occurring in low income and lower middle income countries. [6] The maternal mortality rate in Sub-Saharan Africa is also the highest in the world, with 546 maternal deaths per 100,000 live births. [1] In Ethiopia, approximately 14,000 maternal deaths occurred in 2017, resulting in an overall maternal mortality rate of 401 deaths per 100,000 live births. [6] In developing nations, the rate of maternal and neonatal death continues to rise despite improved access to ANC. This shows that even when coverage is high, negative health outcomes are still prevalent. [7]

Despite the good intervention to increase the coverage of ANC, coverage alone cannot be a guarantee to achieve the sustainable development goal. Quality of ANC service is an influencing factor for the health of the mother and the survival of newborn care. [8,9] In addition to this, quality of health care services for individuals and population increases the likelihood of desired health outcomes. [10]

96   The Ethiopian government had tried to improve the maternal health care services through

97   giving priority in its political agenda. [11] The government aimed to reduce the maternal mortality

98   below 267 deaths per 100,000 live births. To achieve this goal the country implemented

99   different interventions such as antenatal care, skilled birth services and postnatal care.

100   Additionally, expansion of health centers and hospitals with adequate medical equipment,

101   health extension programs, supporting facilities like private wing and non-governmental

102   organizations are still working to improve the maternal health. [11,12]

103   While Ethiopia has made the aforementioned interventions to reduce pregnancy-related

104   complications, maternal death rates due to these complications remained high. [13-15] Even

105   though multiple studies were conducted in Ethiopia, none of them were representative for the

106   country and are related with factors and coverage of ANC, [9,16-18] rather than quality of ANC.

107   Hence, it is essential to have a clear understanding of this issue in order to implement

108   interventions which would improve the quality of ANC. Therefore the aim of this study was to

109   determine the magnitude of quality of antenatal care and associated factors among pregnant

110   women in Ethiopia.

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Methods

Study Settings and Data Source

A cross-sectional study of Ethiopian Demographic and Health survey (EDHS) data was used for this study. The survey was conducted by the Central Statistical Agency (CSA) in collaboration with the Federal Ministry of Health (FMoH) and the Ethiopian Public Health Institute (EPHI). EDHS was a national representative sample conducted from January 18 to June 27, 2016. There are nine regional states in Ethiopia (Tigray, Afar, Amhara, Oromia, Benishangul, Gambela, South Nation Nationalities and People Region (SNNPR), Harari, and Somali), and two administrative cities (Addis Ababa and Dire-Dawa), 611 Districts, and 15,000 Kebeles.

We used the women's recode (IR file) data set and extracted the dependent and independent variables. The data set is freely available and possible to download from the link: https://dhsprogram.com/data/available-datasets.cfm. The DHS employs a two-stage stratified sampling technique. Which makes the data nationally representative. [19] A total weighted sample of 4757 pregnant women aged 15-49 years were included in the study. Pregnant women who had not received ANC visits during their recent pregnancy and who did have not all the six components of ANC services were excluded in this study.

The health care system in Ethiopia is structured in a three-tier system: primary, secondary, and tertiary levels of care. The primary level of care including primary hospitals, health centers, and health posts), the secondary level of care is delivered by general hospitals and the tertiary level of health care is given by specialized hospitals. [20]

Variables of the study

Dependent variable: The outcome variable was quality of ANC. The outcome variable is binary, and it is coded as 1 if they had received all the six essential ANC components and 0

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136 otherwise. These components were measurement of blood pressure, blood test, urine test,

137 informed on possible complication, counselling on nutrition, and advice on birth preparedness

138 plan during pregnancy. [21] Each component has a binary response (1=yes and 0 = no). The

139 construction of the outcome variable was guided by the WHO ANC guidelines. [22]

140 **Independent variables**

141 Different independent variables were considered in this study to determine factors associated

142 with quality of ANC (Table 1).

143 Table 1. List of variables for the assessment of quality of ANC among pregnant women in

144 Ethiopia.

Variables	Description
Age of the women's	15-24, 25-34, and 35+
Resident	Rural, Urban
Women education	No formal education, Primary education, and Secondary
Level	higher and higher education
Women occupation	Not employed, employed
Partner education level	No formal education, Primary education, and Secondary
	education and higher
Wealth index	It was categorized as Poor, Middle and Rich
Number of ANC visits	<4, ≥4
Birth order	1, 1-4, and ≥5
Marital status	Married, unmarried
Region	**Small peripheral** (Somali, Afar, Gambela, Benshangul
	Gumuz)

6 | P a g e

	Large central (Tigray, Amhara, Oromia, South Nation Nationalities)
	Metropolitan (Addis Ababa, Dire Dawa, Harar)
Community level education	High, Low
Community level poverty	High, Low

145

Data processing and analysis

147 Stata version 14 statistical software was used for data analysis. All frequency distributions were

148 weighted (v005/1000000) throughout the analysis to ensure that the DHS sample was a

149 representative sample and to obtain reliable estimates and standard errors before data analysis.

150 The first step was a graphical representation of the quality of ANC among pregnant women.

151 The second step was a bivariate analysis that calculated the proportion of quality of ANC across

152 the independent variables with their *p*-values. All the variables that showed statistically

153 significant in the bivariable analysis and used for multi-level analysis. In the final step of the

154 analysis, a multilevel logistic regression analysis comprising fixed effects and random effects

155 was done.

156 The results of the fixed effects of the model were presented as adjusted odds ratio (AOR) while

157 the random effects were assessed with intra-class correlation coefficient (ICC). Four models

158 were fitted; null model (model 0) which shows the variations in the quality of ANC in the

159 absence of any independent variables. Model I an adjusted for the individual-level variables,

160 Model II adjusted for the community level variables, and model III adjusted for both individual

161 and community level variables. Simultaneously, model fitness was done using the deviance (-

162 2 log likelihood).

Ethical approval

164 Not applicable/No human participants included. Consent to participants is not applicable since

165 the data is secondary and is available in the public domain. All the methods were conducted

166 according to the Helsinki declarations. More details regarding DHS ethical standards and data

167 are available online at: http://www.dhsprogram.com.

Patient and public involvement statement

169 Pregnant women were included in this study by providing valuable information. Nevertheless,

170 they have never been involved in the study design, protocol, data collection tools, and reporting

171 disseminating the finding.

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172 **Results**

173 **Socio-demographic and maternal characteristics of the women**

174 A total of 4757 weighted sample women who gave birth in the preceding five years were

175 included for the final analysis. The mean age of the women was 28 years with an interquartile

176 range of (IQR: 38-24). Most (42.83%) of the women were from the rich wealth status. Most

177 (92.89%) of the women were married and half (50.76%) had four or more ANC (Table 2).

178 Table 2. Sociodemographic related characteristics of women in Ethiopia, 2016 (n=4757**)**

Variables	Categories	Frequency(n)	Percentage (%)	weighted % of quality of ANC
Age of women	15-24	1232	25.9	19.99
	25-34	2487	52.29	23.00
	≥ 35	1038	21.81	24.18
Household wealth index	Poor	1727	36.0	13.71
	Middle	993	20.87	17.64
	Rich	2037	42.83	32.26
Educational status of the women	No formal education	2569	54.01	17.07
	Primary	1574	33.10	22.54
	Secondary and higher	613	12.90	44.95
Occupation	Employed	2210	46.46	24.10
	Not employed	2547	53.54	21.07
Current marital status	Unmarried	338	7.11	21.67
	Married	4419	92.89	22.54

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Educational status of the husband	No formal education	1809	40.49	19.56
	Primary	1814	40.59	18.24
	Secondary and higher	846	18.92	38.11
Number of ANC	< 4	2342	49.24	14.79
	≥ 4	2415	50.76	29.93
Birth order	1	1119	23.52	25.88
	2-4	2083	43.79	22.70
	≥ 5	1555	32.69	19.72

179

180 **Quality of ANC and Community level variables**

181 The magnitude of quality of ANC in Ethiopia was 22.48% (95% CI: 21.31, 23.69). Of the six

182 essential components of antenatal care, blood pressure was the most (75.29%) service given

183 for ANC booked women (Fig 1).

184 The majority (81.7%) of the women were rural residents. Most (90.35%) of the women were

185 from large central regions. Majority (70%) of the women were from communities with high

186 proportion of education (Table 3).

187 Table 3. Community related characteristics of women in Ethiopia, 2016 (n=5362)
188

Variables	Categories	Weighted Frequency(n)	Percentage (%)	weighted % of quality of ANC
Residence	Urban	870	18.29	39.42
	Rural	3887	81.71	18.68
Region	Small peripheral	225	4.72	16.28

	Large central	42.98	90.35	21.56
	Metropolitan	234	4.92	45.31
Community level	High	3369	70.83	17.70
education	Low	1388	29.17	24.44
Community level	High	2316	48.68	16.54
poverty	Low	2441	51.32	28.11

189

Factors associated with quality of ANC

191 The null model in the random effects, showed that a significant statistical differences in the

192 odds of quality of ANC with a community variance of 1.35. Moreover, the intra-class

193 correlation coefficient in the null model revealed that the 29.15% of the total variability of

194 quality of ANC accounted for differences between clusters. Additionally, the median odds ratio

195 revealed that there was heterogeneity on quality of ANC among different clusters. Accordingly

196 the odds of quality of ANC was 3.02 times higher among women of higher cluster of quality

197 of ANC than women within lower cluster of quality of ANC. With regard to model comparison,

198 the third model was selected as a final model since it has the lowest (4085.68) deviance. In the

199 final model, after adjusting for the individual and community level variables, education of the

200 women, number of ANC, wealth index, and current marital status were significantly associated

201 factors with quality of ANC.

202 Accordingly, the odds of quality of antenatal care was 1.34(AOR=1.34; 95%CI: 1.06, 1.68)

203 times and 2.46 (AOR=2.46; 95%CI: 1.76, 3.45) times higher among women who had

204 completed primary and secondary education, respectively as compared with women who had

205 no formal education.

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206 Women in the rich and middle wealth status were 1.31 (AOR=1.31; 95%CI: 1.01, 1.72) times

207 and 2.08 (AOR=2.08; 95%CI: 1.59, 2.72) times higher quality of ANC than women of poor

208 wealth status.

209 Married women were 2.34 times more likely to have the quality of ANC than women who had

210 not married (AOR=2.34; 95%CI: 1.08, 5.10).

211 The odds of quality of ANC increased by 2.01 times among women who had four or more

212 ANC as compared with their counter parts (AOR=2.01; 95%CI: 1.67, 2.40) (Table 4).

213 **Table 4:-** Multilevel analysis of factors associated with quality of ANC in Ethiopia, 2016
214 (n=4757)
215

Variables	Categories	Null model	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)	Model 4 AOR (95% CI)
Age	15-24		1		1
	25-34		1.10(0.86,1.42)		1.05(0.81,1.35)
	35 and above		1.23(0.87,1.72)		1.14(0.81,1.61)
Women educational status	No education		1		1
	Primary		1.36(1.09,1.71)		**1.34(1.06,1.68)**
	Secondary and Higher		2.63(1.89,3.67)		**2.46(1.76,3.45)**
Occupation of women	Employed		1.07(0.89,1.28)		1.07(0.89,1.28)
	Not employed		1		1
Wealth index	Poor		1		1
	Middle		1.33(1.03,1.73)		**1.31(1.01,1.72)**
	Rich		2.27(1.78, 2.90)		**2.08(1.59,2.72)**
Current	unmarried		1		1

Marital status	Married	2.28(1.04,4.95)		**2.34(1.08,5.10)**
Husband education	No formal education	1		1
	Primary	0.73(0.59,0.91)		0.72(0.61,1.01)
	Secondary and higher	1.21(0.90,1.63)		1.16(0.86,1.57)
Number of ANC	<4	1		1
	≥4	2.05(1.72,2.45)		**2.01(1.67,2.40)**
Birth order	1	1		1
	2-4	1.09(0.85,1.39)		1.11(0.86,1.42)
	≥5	1.29(0.92,1.81)		1.37(0.97,1.92)
Residence	Rural		1	1
	Urban		2.45(1.62,3.69)	1.38(0.89,2.16)
Regions	Small peripheral		1	1
	Large central		1.59(0.97,2.57)	1.48(0.89,2.46)
	Metropolitan		2.33(1.26,4.31)	1.81(0.94,3.47)
Community level education	Low		1	1
	High		1.21(0.86,1.68)	0.99(0.69,1.42)
Community level poverty	Low		1.52(1.09,2.09)	1.03(0.72,1.46)
	High		1	1
Random effect				
Variance	1.35	1.05	1.06	1.03
ICC (%)	29.15	24.34	24.39	23.71
MOR	3.02	2.64	2.66	2.62

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PCV	*Re*	22.22	21.48	23.7
Model comparission				
Deviance(-2LL)	4655.62	4093.76	4563.94	4085.68

* = P-value < 0.05, ICC = Intra class corrolation cofficent , MOR =Median odds ratio, PCV = proportional

change in variance. AOR=adjusted odds ratio; CI= confidence interval.

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218 **Discussion**

219 According to the World Health Organization guideline recommendation, all pregnant women

220 needed to receive all essential components (advice on birth preparedness plan, blood pressure

221 measurement, blood test, counsel on nutrition, urine test, information on possible

222 complications) of ANC. [22] The study attempted to assess the magnitude and associated factors

223 of the quality of ANC among pregnant women in Ethiopia. The findings of our study will help

224 policy makers and health facilities to develop tailored intervention strategies by considering

225 the level of quality of ANC services and the factors associated with it.

226 The finding of this study, nearly only one in five pregnant women had received quality ANC

227 and education, wealth status, marital status, and number of ANC visits were significantly

228 associated with the quality of ANC.

229 The finding is higher than a study conducted in East Africa 11.16%. [23] This discrepancy could

230 be due to the previous study incorporating different countries, which significantly varied across

231 countries. That may be because of inequalities in access to antenatal care services and the views

232 of populations about the importance of antenatal care. [24] Moreover, in some of the East African

233 countries, there is ongoing conflict and persistent political instability that played an important

234 role in hindering the quality of the ANC; the scholars revealed that lack of safety played a

235 major role in reducing the ANC, especially in remote areas. [25,26]

236 However, this study is also lower than the studies conducted in Ambo, Ethiopia 89%, [27] Jimma,

237 South West Ethiopia 48.3%, [28] Bahir Dar, Ethiopia 52.3%, [29] Nepal 43%, [30] urban Slum

238 Aligarha 66%, [31] Malaysia 50%, [32] and Builsa district, Ghana 85%. [33] The possible explanation

239 could be that most of the indicated studies are facility-based with small sample sizes. The way

240 they operationalized the dependent variable (quality of ANC) could also be the reason for the

241 discrepancy, because the current study assessed the outcome variable only by using six

242 essential components of ANC, whereas the former studies assessed the outcome variable

243 slightly different from the current study. For instance, studies done in Ambo, Ethiopia, Jimma,

244 South West Ethiopia, and Bahir Dar, Ethiopia, quality of care assessed based on the point of

245 view of the provider, manager and the clients. [27-29] Additionally, the discrepancy between this

246 finding and that of studies conducted outside of Ethiopia could be due to socio-demographic

247 and cultural differences.

248 Pregnant women with higher level of education had higher odds of quality of ANC compared

249 to those without formal education. The findings of this study are in agreement with those of

250 studies conducted in Southern Ethiopia, [34] Tanzania, [35] and East Africa. [23] The possible

251 justification could be that pregnant women with higher level of education can easily obtain

252 information from mass media to enhance awareness of pregnant women about the importance

253 of ANC, and adherence to follow-up schedules. [36] Moreover, they can understand health care

254 providers' instructions, education, and counseling due to better communication skills that

255 facilitate interactions with health workers. [37]

256 The likelihood of quality of ANC among pregnant women from households in the middle and

257 rich wealth status was higher than that of pregnant women from poor wealth status households.

258 This finding is supported by studies done in Nepal, [38] Kenya, [39] and East Africa. [23] The possible

259 reason might be the person-centered services provided by healthcare providers at governmental

260 or non-governmental organizations that can increase the quality of ANC for pregnant women

261 from the richest households. In addition, the rich women have a high probability of attending

262 the highest ANC follow-up. [40]

263 The study also showed that married pregnant women were higher odds of quality of ANC

264 compared to their counterparts. This might be due to pregnant married women have a better

265 chance of making complete ANC visits than unmarried pregnant women and get psychological

266 support from the husband and society. [41] Moreover, unmarried pregnant women is usually

267 disgrace. Which in turn affect the quality of ANC. [41]

268 Furthermore, pregnant women who had received at least four ANC visits had the quality of

269 ANC compared with others. This finding agreed with the report from Southern Ethiopia. [17]

270 This could be because pregnant women were not receiving the quality of ANC throughout the

271 subsequent visit, which could be owing to the inconsistent quality of care given by the health

272 professionals. [42,43] In addition, this might also be explained by the gap found in the delivery of

273 drug supplies and equipment. [40]

274 The main strengths of this study were the use of nationally representative data, with a large

275 sample size and the availability of individual and community-level factors. This study also used

276 a multilevel-modeling technique to identify a more valid result that considers the survey data's

277 hierarchical nature. Despite these strengths, it has limitations due to the cross-sectional nature

278 of the EDHS data. It does not show a temporal relationship between independent variables and

279 the outcome variable. There could be recall bias since we used the most recent live birth in the

280 past five years before the survey for the calculation of the quality of ANC. Additionally, due

281 to the use of secondary data, we used only six essential components of ANC to determine the

282 magnitude of quality of ANC

Conclusion

283

284 This study found that nearly only one in five pregnant women received quality antenatal care

285 during pregnancy. Level of education, wealth index, marital status, and number of ANC visits

286 were factors associated with the quality of antenatal care visits. It would be useful to increase

287 financial support strategies that enable pregnant women from poor households to use health

288 services and enhance pregnant women's understanding of the significance of quality of

289 antenatal care through health education targeting women with no education. Emphasis should

290   also be placed on supporting unmarried pregnant women to have quality antenatal care.

291   Ministry of Health, health facility's professional, and community health workers have an

292   important task in raising consciousness of this matter.

293   **Abbreviations**

294   ANC: Antenatal care; AOR: Adjusted Odds Ratio; CSA: Central Statistical Agency; DHS:

295   Demographic Health Survey; EAs: Enumeration Areas; EDHS: Ethiopian Demographic and

296   Health Survey; EPHI: Ethiopian Public Health Institute; FMoH: Federal Ministry of Health;

297   ICC: Intra-class Correlation Coefficient; MOR: Median Odds Ratio; PCV: Proportional

298   Change in Variance; SD: Standard Deviation; WHO: World Health Organization

299   **Consent for publication**

300   It is not applicable for this study since the study was used a secondary data analysis conducted

301   by central statistical agency.

302   **Data sharing statement**

303   The data used for this study will be available with a reasonable request from the

304   corresponding author.

305   **Competing interests**

306   The authors declare that they have no competing interests.

307   **Funding source**

308   No funding was secured for this study.

309   **Authors' contributions**

310   All authors contributed to the preparation of the manuscript. WDN, SMF, DGB, and EAF

311   conceived the idea. WDN extract the data, conducted analysis, and write the original draft of

312   the manuscript, ESS, DBA, RET, FMA, TGA, HBE critically edited, revised and reviewed the

313   manuscript. DGB assisted in the data analysis and interpretation. All of the authors read and

314   approved the final manuscript.

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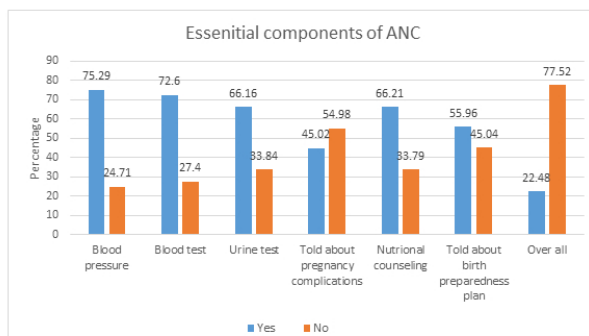41
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428 **Figure legends**

429 Figure 1: Essential components of Antenatal care in Ethiopia, 2016 (n=4757).

24 | P a g e

Essenitial components of ANC

254x142mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Items	Number	Recommendations
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **page 1, line number 1-3**
		(b) provide in the abstract an informative and balanced summary of what was done and what was found **Page 2, line number 34-58**
Introduction		
Background/rational	2	Explain the scientific background and rationale for the investigation being reported **Page 2-4, line number 71-106**
Objective	3	State specific objectives, including any prespecified hypotheses **Page 4, line number 108-110**
Methods		
Study design	4	Present key elements of study design early in the paper **page 5, line number 114-115**
Setting	5	Describer the setting, location, and relevant dates including period of recruitment and data collection **Page number 5, line number 118-121**

Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants **Page 5, line number 125-128**
		Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifier, Give diagnostic, if applicable **Page 5-7, line number 133-145**
Data source and measurement	7	For each variables of interest, give source of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **Page 7, line number 147-150**
Bias	8	Describe any efforts to address potential sources of bias **Page 2 , line number 67**
Study size	9	Explain how the study design was arrived **Page 5, line number 125-126**
Quantitative variables	10	Explain how quantitative variables were handled in the analysis , if applicable describe which groupings chose and why **Page 6-7, line number 143-145**

Statistical methods	11	(a)Describe all statistical methods, including those used to control for confounding **Page 7, line number 146-162**
		(*b*) Describe any methods used to examine subgroups and interactions **NA**
		(*c*) Explain how missing data were addressed **NA**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **NA**
		(*e*) Describe any sensitivity analyses **NA**
Results		
Descriptive data	12	Give characteristics of study participants (eg, demographic, clinical, social) and information on exposure and potential confounders **Page 9-12, line number 172-216**
Outcome data	13	Report numbers of outcome events or summary measures **Page 10, line number 181-183**

Main results	14	(a) Give unadjusted estimates and, if applicable, confounder adjusted estimates and their precision (e.g., 95% confidence interval).Make clear which confounders were adjusted for and why they were included **Page 11-12, line number 191-216**
		(b) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **NA**
Other analysis	15	Report other analyses doing analyses of subgroups and interactions, and sensitive analysis **NA**
Discussion		
Key result	16	Summaries key results with reference to study objectives **Page 15, line number 219-228**
Limitations	17	Discuss limitations of the study, taking into account sources of potential bias or imprecision. discuss both direction and magnitude of any bias **Page 18, page 274-282**
Interpretation	18	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analysis, result from similar studies, and other relevant evidence **Page 17-18, line number 226-273**

For peer review only

Generalizability	19	Discuss the generalizability (external validity) of the study results **page 18, line number 284-292**
Funding	20	Give the source of funding and the role of the funders for the present study and if applicable for the original study on which the present article is based **Page 19, line number 307-308**

Note: An explanation and elaboration article discusses each checklist item and gives methodological background published examples of transport reporting. The STROBE checklist is best used in conjunction with this articles (freely available on the web sites of PloS Medicine at http://www.plosmedicene.org/.Annals of internal medicine http://www.annals.org/, and Epidemiology at http://www.epidem.com/ information on the STROBE initiative is available at www.strobe-statement.org.

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Multilevel analysis of Quality of antenatal care and associated factors among pregnant women in Ethiopia: A community based cross-sectional study

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Abstract

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36 **Objective:** To determine the magnitude of quality of antenatal care and associated factors

37 among pregnant women in Ethiopia.

38 **Design:** A community based cross-sectional study

39 **Setting:** Ethiopia

40 **Participants**: A total of 4757 weighted sample of pregnant women from January 18 to June

41 27, 2016, were included for this analysis

42 **Outcome:** Quality of ANC.

43 **Methods**: Our analysis was based on secondary data using the 2016 Ethiopian Demographic

44 and Health Survey. The quality of ANC was measured when all six essential components, such

45 as blood pressure measurements, blood tests, urine tests, nutrition counseling, birth preparation

46 advice during pregnancy, and information on potential complications, were provided. Stata

47 version 14 software was used for analysis. A multi-level mixed-effect logistic regression

48 analysis was fitted. Adjusted Odds Ratio with 95% confidence intervals was used to show the

49 strength and direction of the association. Statistical significance was declared at a *P* value less

50 than 0.05.

51 **Results:** The magnitude of quality of antenatal care in Ethiopia was 22.48% (95% CI: 21.31,

52 23.69). Educational status; primary (AOR=1.34; 95%CI: 1.06, 1.68) and secondary

53 (AOR=2.46; 95%CI: 1.76, 3.45), middle (AOR=1.31; 95%CI: 1.01, 1.72) and rich (AOR=2.08;

54 95%CI: 1.59, 2.72) wealth status, being married (AOR=2.34; 95%CI: 1.08, 5.10), and four or

55 more antenatal care (AOR=2.01; 95%CI: 1.67, 2.40) were statistically significant associated

56 factors of quality ANC in Ethiopia.

57 **Conclusions:** This study found that nearly only one in five pregnant women received quality

58 antenatal care during pregnancy. To improve the quality of ANC in Ethiopia, Ministry of

59 Health and health facilities are needed to increase financial support strategies that enable

60 pregnant women from poor households to use health services and enhance pregnant women's

61 understanding of the significance of quality of antenatal care through health education.

62 Additionally, Community health workers should also be placed on supporting unmarried

63 pregnant women to have quality antenatal care.

64 **Keywords**: Quality, Antenatal care, factors, Ethiopia.

Strengths and limitations of the study

66 ➢ The study uses nationally representative data and large sample size

67 ➢ This study also used a multilevel-modeling technique to identify a more valid result

68   that considers the survey data's hierarchical nature.

69 ➢ The study has limitations due to the cross-sectional nature of the data, it does not show

70   a temporal relationship between independent variables and the outcome variable.

71 ➢ There could be recall bias, since we used the most recent live birth in the past five years

72   before the survey.

73 ➢ Due to the use of secondary data, we used only six essential components of ANC to

74   determine the magnitude of quality of ANC.

75

Introduction

Women and teens receive care from health professionals during pregnancy to ensure that both mothers and babies experience the most favorable outcomes. Aside from offering health education, screening, diagnosis, and disease prevention, antenatal care (ANC) can save lives. [1,2] Focused ANC primarily helps women to maintain normal pregnancies by detecting preexisting conditions, preventing complications that may arise during childbirth. [3,4] ANC is the main method for improving maternal health outcomes through early detection of pregnancy risks, and complications.[4] Access to care also includes nutrition, vaccinations, medical tests, and therapies. [5] Moreover, women's access to comprehensive maternal health care, from conception to delivery and afterward, it is possible to minimize their risk of death. [1,6]

Understanding and applying different perspectives does not hinder success in achieving quality in healthcare as long as the key principles and concepts of quality are identified and applied.[7] A measure of quality of care is the extent to which people and societies are provided with health services that are consistent with evidence-based professional knowledge and that result in the desired health outcomes. [8]

There was a 38% drop in maternal mortality worldwide between 2000 and 2017. [9] But according to the World Health Organization estimates, approximately 295,000 women died after pregnancy or childbirth since 2017, with 94% of these deaths occurring in low income and lower middle income countries. [9] The maternal mortality rate in Sub-Saharan Africa is also the highest in the world, with 546 maternal deaths per 100,000 live births. [1] In Ethiopia, approximately 14,000 maternal deaths occurred in 2017, resulting in an overall maternal mortality rate of 401 deaths per 100,000 live births. [9] In developing nations, the rate of maternal and neonatal death continues to rise despite improved access to ANC. This shows that even when coverage is high, negative health outcomes are still prevalent. [10]

100   Despite the good intervention to increase the coverage of ANC, coverage alone cannot be a

101   guarantee to achieve the sustainable development goal. Quality of ANC service is an

102   influencing factor for the health of the mother and the survival of newborn care. [11,12] In addition

103   to this, quality of health care services for individuals and population increases the likelihood

104   of desired health outcomes. [8]

105   The Ethiopian government had tried to improve the maternal health care services through

106   giving priority in its political agenda. [13] The government aimed to reduce the maternal mortality

107   below 267 deaths per 100,000 live births.[14] To achieve this goal the country implemented

108   different interventions such as antenatal care, skilled birth services and postnatal care.

109   Additionally, expansion of health centers and hospitals with adequate medical equipment,

110   health extension programs, supporting facilities like private wing and non-governmental

111   organizations are still working to improve the maternal health. [13,14]

112   While Ethiopia has made the aforementioned interventions to reduce pregnancy-related

113   complications, maternal death rates due to these complications remained high. [15-17] Even

114   though multiple studies were conducted in Ethiopia, none of them were representative for the

115   country and are related with factors and coverage of ANC,[12,18-20] rather than quality of ANC.

116   Hence, it is essential to have a clear understanding of this issue in order to implement

117   interventions which would improve the quality of ANC. Therefore the aim of this study was to

118   determine the magnitude of quality of antenatal care and associated factors among pregnant

119   women in Ethiopia.

120

Methods

Study Settings and Data Source

A cross-sectional study of Ethiopian Demographic and Health survey (EDHS) data was used for this study. The survey was conducted by the Central Statistical Agency (CSA) in collaboration with the Federal Ministry of Health (FMoH) and the Ethiopian Public Health Institute (EPHI). EDHS was a national representative sample conducted from January 18 to June 27, 2016. There are nine regional states in Ethiopia (Tigray, Afar, Amhara, Oromia, Benishangul, Gambela, South Nation Nationalities and People Region (SNNPR), Harari, and Somali), and two administrative cities (Addis Ababa and Dire-Dawa), 611 Districts, and 15,000 Kebeles.

We used the women's recode (IR file) data set and extracted the dependent and independent variables. The data set is freely available and possible to download from the link: https://dhsprogram.com/data/available-datasets.cfm. The DHS employs a two-stage stratified sampling technique. Which makes the data nationally representative. [21] A total weighted sample of 4757 pregnant women aged 15-49 years were included in the study. Pregnant women who had not received ANC visits during their recent pregnancy and who did have not all the six components of ANC services were excluded in this study.

The health care system in Ethiopia is structured in a three-tier system: primary, secondary, and tertiary levels of care. The primary level of care including primary hospitals, health centers, and health posts), the secondary level of care is delivered by general hospitals and the tertiary level of health care is given by specialized hospitals. [22]

Variables of the study

Dependent variable: The outcome variable was quality of ANC. The outcome variable is binary, and it is coded as 1 if they had received all the six essential ANC components and 0

145 otherwise. These components were measurement of blood pressure, blood test, urine test,

146 informed on possible complication, counselling on nutrition, and advice on birth preparedness

147 plan ever in their ANC visit. [23] Each component has a binary response (1=yes and 0 = no). The

148 construction of the outcome variable was guided by the WHO ANC guidelines. [24]

149 **Independent variables**

150 Different independent variables were considered in this study to determine factors associated

151 with quality of ANC (Table 1).

152 Table 1. List of variables for the assessment of quality of ANC among pregnant women in

153 Ethiopia.

Variables	Description
Age of the women	15-24, 25-34, and 35-49
Resident	Rural, Urban
Women education Level	No formal education, Primary education, and Secondary and higher education
Women occupation	Not employed, employed
Partner education level	No formal education, Primary education, and Secondary education and higher
Wealth index	As a result of high variability of observation from the original DHS classification of households into five categories using principal component analysis, the wealth index scores were re-categorize into three categories (poor, medium, and rich) by merging poorest with poorer and richest with richer for the ease of interpretation of principal component analysis.

Timing of first ANC in months	≤ 3, > 3
Number of ANC visits	<4, ≥4
Birth order	1, 1-4, and ≥5
Marital status	Married, unmarried
Region	**Small peripheral** (Somali, Afar, Gambela, Benshangul Gumuz)
	Large central (Tigray, Amhara, Oromia, South Nation Nationalities)
	Metropolitan (Addis Ababa, Dire Dawa, Harar)
Distance to the nearest health facility	Big problem, Not big problem
Community level education and community level poverty	Hence, we generate the community-level variables by aggregating the individual-level factors at cluster level and categorizing them as high and low based on the national median value since these were not normally distributed. Community level education was generated by the proportion of households in the educated categories obtained from the highest educational level. Categorized as low if the proportion of women were educated below 50% and high if the proportion is ≥50%. [25]
	Community level Poverty was aggregated by the proportion of households in the poorest and poorer quantile. Aggregated as low if the proportion from a

7 | P a g e

given community is <50% and high if the proportion is ≥50%. [25]

154

Data processing and analysis

156 Stata version 14 statistical software was used for data analysis. All frequency distributions were

157 weighted (v005/1000000) throughout the analysis to ensure that the DHS sample was a

158 representative sample and to obtain reliable estimates and standard errors before data analysis.

159 The first step was a graphical representation of the quality of ANC among pregnant women.

160 Out of 15,683 total eligible households, 7,193 were pregnant in the preceding five year. Of this,

161 2500 pregnant women were excluded because of they had no ANC. Lastly, 4,693 pregnant

162 women in the preceding five years had complete data on quality of ANC and were included in

163 the analysis. Overall, a total weighted sample of 4757 pregnant women were included in this

164 study.

165 The second step was a bivariate analysis that calculated the proportion of quality of ANC across

166 the independent variables with their *p*-values. All the variables having a p-value less than 0.2

167 in bivariable were used for multivariable analysis. For the multivariable analysis, adjusted odds

168 ratios with 95 % confidence intervals and a p-value of less than 0.05 were used to identify

169 associated factors of quality of ANC. In the final step of the analysis, a multilevel logistic

170 regression analysis comprising fixed effects and random effects was done.

171 The results of the fixed effects of the model were presented as adjusted odds ratio (AOR) while

172 the random effects were assessed with intra-class correlation coefficient (ICC). Four models

173 were fitted; null model (model 0) which shows the variations in the quality of ANC in the

174 absence of any independent variables. Model I an adjusted for the individual-level variables,

175 Model II adjusted for the community level variables, and model III adjusted for both individual

176   and community level variables. Simultaneously, model fitness was done using the deviance (-

177   2 log likelihood). Variance inflation factor (VIF) was used to check for multi-collinearity

178   among independent variables and it was found no multicollinearity (mean value for the final

179   model=1.5)

180   **Ethical approval**

181   Not applicable/No human participants included. Consent to participants is not applicable since

182   the data is secondary and is available in the public domain. All the methods were conducted

183   according to the Helsinki declarations. More details regarding DHS ethical standards and data

184   are available online at: http://www.dhsprogram.com.

185   **Patient and public involvement statement**

186   Pregnant women were included in this study by providing valuable information. Nevertheless,

187   they have never been involved in the study design, protocol, data collection tools, and reporting

188   disseminating the finding.

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189 **Results**

190 **Socio-demographic and maternal characteristics of the women**

191 A total of 4757 weighted sample women who gave birth in the preceding five years were

192 included for the final analysis. The mean age of the women was 28 years with an interquartile

193 range of (IQR: 38-24). Most (42.83%) of the women were from the rich wealth status. Most

194 (92.89%) of the women were married and half (50.76%) had four or more ANC. The majority

195 (81.7%) of the women were rural residents. Most (90.35%) of the women were from large

196 central regions. Majority (70%) of the women were from communities with high proportion of

197 education (Table 2).

198 Table 2. Sociodemographic related characteristics of women in Ethiopia, 2016 (n=4757**)**

Variables	Categories	Frequency(n)	Percentage (%)	weighted % of quality of ANC
Age of women	15-24	1232	25.9	19.99
	25-34	2487	52.29	23.00
	≥ 35	1038	21.81	24.18
Household wealth index	Poor	1727	36.0	13.71
	Middle	993	20.87	17.64
	Rich	2037	42.83	32.26
Educational status of the women	No formal education	2569	54.01	17.07
	Primary	1574	33.10	22.54
	Secondary and higher	614	12.90	44.95
Occupation	Employed	2210	46.46	24.10

	Not employed	2547	53.54	21.07
Current marital status	Unmarried	338	7.11	21.67
	Married	4419	92.89	22.54
Number of ANC	< 4	2342	49.24	14.79
	≥ 4	2415	50.76	29.93
Timing of first ANC in months	≤3	1541	32.29	29.55
	>3	3216	67.61	19.09
Birth order	1	1119	23.52	25.88
	2-4	2083	43.79	22.70
	≥ 5	1555	32.69	19.72
Distance to the health facility	Big problem	2397	50.39	18.50
	Not big problem	2360	49.61	24.17
Residence	Urban	870	18.29	39.42
	Rural	3887	81.71	18.68
Region	Small peripheral	225	4.72	16.28
	Large central	4298	90.35	21.56
	Metropolitan	234	4.92	45.31
Community level education	High	3369	70.83	17.70
	Low	1388	29.17	24.44
Community level poverty	High	2316	48.68	16.54
	Low	2441	51.32	28.11

199 **Magnitude of quality of ANC among ANC attendants**

200 The magnitude of quality of ANC in Ethiopia was 22.48% (95% CI: 21.31, 23.69). Of the six

201 essential components of antenatal care, blood pressure was the most (75.29%) service given

202 for ANC booked women. Of the study participants 264 (5.55%) had not get any of the six

203 components of ANC (Table 3).

204 Magnitude of quality of ANC among ANC attendants, Ethiopia, 2016 (Table 3)

ANC components	Categories	Frequency	Percentage
Blood pressure	Yes	3582	75.29
	No	1175	24.71
Blood test	Yes	3454	72.6
	No	1303	27.4
Urine test	Yes	3147	66.16
	No	1610	33.84
Told about pregnancy complications	Yes	2142	45.02
	No	2615	54.98
Nutritional Counseling	Yes	3150	66.21
	No	1607	33.79
Told about birth preparedness plan	Yes	2662	55.96
	No	2095	45.04
Over all ANC quality	Yes	1069	24.48
	No	3688	77.52
Number of	0	264	5.55

components	1	369	7.76
	2	468	9.84
	3	803	16.87
	4	911	19.15
	5	873	18.35
	6	1069	22.48

205

Factors associated with quality of ANC

207 The null model in the random effects, showed that a significant statistical differences in the

208 odds of quality of ANC with a community variance of 1.35. Moreover, the intra-class

209 correlation coefficient in the null model revealed that the 29.15% of the total variability of

210 quality of ANC accounted for differences between clusters. Additionally, the median odds ratio

211 revealed that there was heterogeneity on quality of ANC among different clusters. Accordingly

212 the odds of quality of ANC was 3.02 times higher among women of higher cluster of quality

213 of ANC than women within lower cluster of quality of ANC. With regard to model comparison,

214 the third model was selected as a final model since it has the lowest (4085.68) deviance. In the

215 final model, after adjusting for the individual and community level variables, education of the

216 women, number of ANC, wealth index, and current marital status were significantly associated

217 factors with quality of ANC.

218 Accordingly, the odds of quality of antenatal care was 1.34(AOR=1.34; 95%CI: 1.06, 1.68)

219 times and 2.46 (AOR=2.46; 95%CI: 1.76, 3.45) times higher among women who had

220 completed primary and secondary education, respectively as compared with women who had

221 no formal education.

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222 Women in the rich and middle wealth status were 1.31 (AOR=1.31; 95%CI: 1.01, 1.72) times

223 and 2.08 (AOR=2.08; 95%CI: 1.59, 2.72) times higher quality of ANC than women of poor

224 wealth status.

225 Married women were 2.34 times more likely to have the quality of ANC than women who had

226 not married (AOR=2.34; 95%CI: 1.08, 5.10).

227 The odds of quality of ANC increased by 2.01 times among women who had four or more

228 ANC as compared with their counter parts (AOR=2.01; 95%CI: 1.67, 2.40) (Table 4).

229 **Table 4:-** Multilevel analysis of factors associated with quality of ANC in Ethiopia, 2016
230 (n=4757)
231

Variables	Categories	Null model	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)	Model 4 AOR (95% CI)
Age	15-24		1		1
	25-34		1.10(0.86,1.42)		1.05(0.81,1.35)
	35 and above		1.23(0.87,1.72)		1.14(0.81,1.61)
Women educational status	No education		1		1
	Primary		1.36(1.09,1.71)		**1.34(1.06,1.68)**
	Secondary and Higher		2.63(1.89,3.67)		**2.46(1.76,3.45)**
Occupation of women	Employed		1.07(0.89,1.28)		1.07(0.89,1.28)
	Not employed		1		1
Wealth index	Poor		1		1
	Middle		1.33(1.03,1.73)		**1.31(1.01,1.72)**
	Rich		2.27(1.78, 2.90)		**2.08(1.59,2.72)**
Current	unmarried		1		1

Marital status	Married		2.28(1.04,4.95)		**2.34(1.08,5.10)**
Husband education	No formal education		1		1
	Primary		0.73(0.59,0.91)		0.72(0.61,1.01)
	Secondary and higher		1.21(0.90,1.63)		1.16(0.86,1.57)
Number of ANC	<4		1		1
	≥4		2.05(1.72,2.45)		**2.01(1.67,2.40)**
Birth order	1		1		1
	2-4		1.09(0.85,1.39)		1.11(0.86,1.42)
	≥5		1.29(0.92,1.81)		1.37(0.97,1.92)
Residence	Rural			1	1
	Urban			2.45(1.62,3.69)	1.38(0.89,2.16)
Regions	Small peripheral			1	1
	Large central			1.59(0.97,2.57)	1.48(0.89,2.46)
	Metropolitan			2.33(1.26,4.31)	1.81(0.94,3.47)
Community level education	Low			1	1
	High			1.21(0.86,1.68)	0.99(0.69,1.42)
Community level poverty	Low			1.52(1.09,2.09)	1.03(0.72,1.46)
	High			1	1
Random effect					
Variance		1.35	1.05	1.06	1.03
ICC (%)		29.15	24.34	24.39	23.71
MOR		3.02	2.64	2.66	2.62

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PCV	*Re*	22.22	21.48	23.7
Model comparission				
Deviance(-2LL)	4655.62	4093.76	4563.94	4085.68
Mean VIF	___	1.45	1.2	1.5

* = P-value < 0.05, ICC = Intra class corrolation cofficent; MOR =Median odds ratio; PCV = proportional change

in variance; AOR=adjusted odds ratio; CI= confidence interval; VIF= Variance Inflation Factor

233 **Discussion**

234 According to the World Health Organization guideline recommendation, all pregnant women

235 needed to receive all essential components (advice on birth preparedness plan, blood pressure

236 measurement, blood test, counsel on nutrition, urine test, information on possible

237 complications) of ANC. [24] The study attempted to assess the magnitude and associated factors

238 of the quality of ANC among pregnant women in Ethiopia. The findings of our study will help

239 policymakers and health facilities to develop tailored intervention strategies by considering the

240 level of quality of ANC services and the factors associated with it.

241 According to this study, only one in five pregnant women received quality ANC. The quality

242 of ANC was significantly associated with education, wealth status, marital status, and the

243 number of ANC visits.

244 The finding is higher than a study conducted in East Africa 11.16%. [26] This discrepancy could

245 be due to the previous study incorporating different countries, which significantly varied across

246 countries. That may be because of inequalities in access to antenatal care services and the views

247 of populations about the importance of antenatal care. [27] Moreover, in some of the East African

248 countries, there is ongoing conflict and persistent political instability that played an important

249 role in hindering the quality of the ANC; the scholars revealed that lack of safety played a

250 major role in reducing the ANC, especially in remote areas. [28,29]

251 However, this study is also lower than the studies conducted in Ambo, Ethiopia 89%, [30] Jimma,

252 South West Ethiopia 48.3%, [31] Bahir Dar, Ethiopia 52.3%, [32] Nepal 43%, [33] urban Slum

253 Aligarha 66%, [34] Malaysia 50%, [35] and Builsa district, Ghana 85%. [36] The possible explanation

254 could be that most of the indicated studies are facility-based with small sample sizes. The way

255 they operationalized the dependent variable (quality of ANC) could also be the reason for the

256 discrepancy, because the current study assessed the quality of ANC only by using six essential

257 components of ANC, whereas the former studies assessed the outcome variable slightly

17 | P a g e

258 different from the current study. For instance, studies done in Ambo, Ethiopia, Jimma, South

259 West Ethiopia, and Bahir Dar, Ethiopia, quality of care assessed based on the point of view of

260 the provider, manager and the clients. [30-32] Additionally, the discrepancy between this finding

261 and that of studies conducted outside of Ethiopia could be due to socio-demographic and

262 cultural differences.

263 Pregnant women with a higher level of education had higher odds of quality of ANC compared

264 to those without formal education. The findings of this study are in agreement with those of

265 studies conducted in Southern Ethiopia, [37] Tanzania, [38], and East Africa. [26] The possible reason

266 for this might be that pregnant women with higher levels of education are more likely to find

267 information from mass media to become aware of the importance of ANC and adhere to follow-

268 up schedules. [39] Moreover, they can understand health care providers' instructions, education,

269 and counseling due to better communication skills that facilitate interactions with health

270 workers. [40]

271 The likelihood of quality of ANC among pregnant women from households in the middle and

272 rich wealth status was higher than that of pregnant women from poor wealth status households.

273 This finding is supported by studies done in Nepal, [41] Kenya, [42] and East Africa. [26] The possible

274 reason might be the person-centered services provided by healthcare providers at governmental

275 or non-governmental health facilities can increase the quality of ANC for pregnant women

276 from the richest households. In addition, rich women have a high probability of attending the

277 highest ANC follow-up in private health facilities. [43] Moreover, the economic differences in

278 accessing maternal or reproductive health care, along with other factors, such as satisfaction with

279 service quality, travel time to the hospital, and waiting times, are also determining factors in the quality

280 of ANC. [44,45] Furthermore, income could also influence the health seeking behavior of the

281 mother with poor mothers seeking less health care, this can directly affect the quality of ANC.

282 [46]

18 | P a g e

283   The study also showed that married pregnant women were higher odds of quality of ANC

284   compared to their counterparts. This might be due to pregnant married women having a better

285   chance of making complete ANC visits than unmarried pregnant women and get psychological

286   support from their husband and society. [47] However, those women who are pregnant outside

287   of marriage are often afraid to go out and socialize in the community. This situation makes

288   them less likely to go to ANC which in turn affects the quality of ANC. [47]

289   Furthermore, pregnant women who had received at least four ANC visits had the quality of

290   ANC compared with mothers who had received below four ANC visits. This finding agreed

291   with the report from Southern Ethiopia. [19] This could be probably women who visit more ANC

292   have a greater chance of getting all the components of ANC and are more likely to recognize

293   the quality of ANC. Furthermore, below four ANC visits can compromise the quality of ANC

294   due to inconsistencies in quality care provided by healthcare providers, [48,49] and can also be

295   attributed to gaps in the supply of drugs and equipment. [43]

296   Elsewhere studies in Ghana [50] and Ethiopia [19][51] revealed that women who had resided in rural areas

297   were less likely to have quality ANC. This might be because the health infrastructures in the

298   rural area are less developed and there are fewer trained health workers. Studies in Nigeria [52],

299   and Kenya [42]. also revealed that as the age of women become older they get quality ANC than

300   adolescent and young aged women. It might be because older women understand the

301   importance of ANC visits, and they can benefit from repeated health education and counseling,

302   thus enhancing their understanding of ANC benefits. However, in this study, some

303   sociodemographic characteristics such as residence and age were not statistically significant.

304   This difference might be differences in the approach used in collecting and analyzing data. For

305   instance, the current study uses EDHS data and multilevel approaches of analysis.

306   It is conclusive that we need to do more to improve the quality of ANC. More than three-fourths

307   of mothers actually did not receive quality ANC, and less than a quarter received it with all six

308   essential components (such as, blood pressure measurements, blood tests, urine tests, nutrition

309   counseling, birth preparation advice during pregnancy, and information on potential

310   complications) of ANC.   This means that thousands of mothers are only receiving some of the

311   components of ANC to maintain a healthy pregnancy. Therefore, the Ministry of Health, health

312   facility professionals, and community health workers have an important role in raising

313   consciousness of this matter to counteract the problem.

314   The main strengths of this study were the use of nationally representative data, with a large

315   sample size and the availability of individual and community-level factors. This study also used

316   a multilevel-modeling technique to identify a more valid result that considers the survey data's

317   hierarchical nature. Despite these strengths, it has limitations due to the cross-sectional nature

318   of the EDHS data. It does not show a temporal relationship between independent variables and

319   the outcome variable. There could be recall bias since we used the most recent live birth in the

320   past five years before the survey for the calculation of the quality of ANC. Additionally, due

321   to the use of secondary data, we used only six essential components of ANC to determine the

322   magnitude of quality of ANC. The DHS omitted to provide data regarding screening and

323   treatment of disorders such as HIV, abnormal fetal lie, diabetes, tuberculosis, and malaria, as

324   well as the provision of preventive interventions, such as tetanus immunization and insecticide-

325   treated bed nets which would be relevant if they were incorporated in the construction of quality

326   of ANC. If the aforementioned components were included the estimate might become low.

327   **Conclusion**

328   This study found that nearly only one in five pregnant women received quality antenatal care

329   during pregnancy. Level of education, wealth index, marital status, and number of ANC visits

330   were factors associated with the quality of antenatal care visits. It would be useful to increase

331   financial support strategies that enable pregnant women from poor households to use health

332   services and enhance pregnant women's understanding of the significance of quality of

333   antenatal care through health education targeting women with no education. Emphasis should

334 also be placed on supporting unmarried pregnant women to have quality antenatal care.

335 Ministry of Health, health facility's professional, and community health workers have an

336 important task in raising consciousness of this matter.

Abbreviations

338 ANC: Antenatal care; AOR: Adjusted Odds Ratio; CSA: Central Statistical Agency; DHS:

339 Demographic Health Survey; EAs: Enumeration Areas; EDHS: Ethiopian Demographic and

340 Health Survey; EPHI: Ethiopian Public Health Institute; FMoH: Federal Ministry of Health;

341 ICC: Intra-class Correlation Coefficient; MOR: Median Odds Ratio; PCV: Proportional

342 Change in Variance; SD: Standard Deviation; WHO: World Health Organization

Consent for publication

344 It is not applicable for this study since the study was used a secondary data analysis conducted

345 by central statistical agency.

Data sharing statement

347 The data used for this study will be available with a reasonable request from the

348 corresponding author.

Competing interests

350 The authors declare that they have no competing interests.

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Authors' contributions

354 All authors contributed to the preparation of the manuscript. WDN, SMF, DGB, and EAF

355 conceived the idea. WDN extract the data, conducted analysis, and write the original draft of

356 the manuscript, ESS, DBA, RET, FMA, TGA, HBE critically edited, revised and reviewed the

357 manuscript. DGB assisted in the data analysis and interpretation. All of the authors read and

358 approved the final manuscript.

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22 | Page

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STROBE Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Items	Number	Recommendations
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract **page 1, line number 1-3**
		(b) provide in the abstract an informative and balanced summary of what was done and what was found **Page 2, line number 34-58**
Introduction		
Background/rational	2	Explain the scientific background and rationale for the investigation being reported **Page 2-4, line number 71-106**
Objective	3	State specific objectives, including any prespecified hypotheses **Page 4, line number 108-110**
Methods		
Study design	4	Present key elements of study design early in the paper **page 5, line number 114-115**
Setting	5	Describer the setting, location, and relevant dates including period of recruitment and data collection **Page number 5, line number 118-121**

Participants	6	Give the eligibility criteria, and the sources and methods of selection of participants **Page 5, line number 125-128**
		Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifier, Give diagnostic, if applicable **Page 5-7, line number 133-145**
Data source and measurement	7	For each variables of interest, give source of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group **Page 7, line number 147-150**
Bias	8	Describe any efforts to address potential sources of bias **Page 2 , line number 67**
Study size	9	Explain how the study design was arrived **Page 5, line number 125-126**
Quantitative variables	10	Explain how quantitative variables were handled in the analysis , if applicable describe which groupings chose and why **Page 6-7, line number 143-145**

Statistical methods	11	(a)Describe all statistical methods, including those used to control for confounding **Page 7, line number 146-162**

		(*b*) Describe any methods used to examine subgroups and interactions **NA**
		(*c*) Explain how missing data were addressed **NA**
		(*d*) If applicable, describe analytical methods taking account of sampling strategy **NA**
		(*e*) Describe any sensitivity analyses **NA**
Results		
Descriptive data	12	Give characteristics of study participants (eg, demographic, clinical, social) and information on exposure and potential confounders **Page 9-12, line number 172-216**
Outcome data	13	Report numbers of outcome events or summary measures **Page 10, line number 181-183**

Main results	14	(a) Give unadjusted estimates and, if applicable, confounder adjusted estimates and their precision (e.g., 95% confidence interval).Make clear which confounders were adjusted for and why they were included **Page 11-12, line number 191-216**
		(b) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period **NA**
Other analysis	15	Report other analyses doing analyses of subgroups and interactions, and sensitive analysis **NA**
Discussion		
Key result	16	Summaries key results with reference to study objectives **Page 15, line number 219-228**
Limitations	17	Discuss limitations of the study, taking into account sources of potential bias or imprecision. discuss both direction and magnitude of any bias **Page 18, page 274-282**
Interpretation	18	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analysis, result from similar studies, and other relevant evidence **Page 17-18, line number 226-273**

| Generalizability | 19 | Discuss the generalizability (external validity) of the study results **page 18, line number 284-292** |
| Funding | 20 | Give the source of funding and the role of the funders for the present study and if applicable for the original study on which the present article is based **Page 19, line number 307-308** |

Note: An explanation and elaboration article discusses each checklist item and gives methodological background published examples of transport reporting. The STROBE checklist is best used in conjunction with this articles (freely available on the web sites of PloS Medicine at http://www.plosmedicene.org/.Annals of internal medicine http://www.annals.org/, and Epidemiology at http://www.epidem.com/ information on the STROBE initiative is available at www.strobe-statement.org.

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Multilevel analysis of Quality of antenatal care and associated factors among pregnant women in Ethiopia: A community based cross-sectional study

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Multilevel analysis of Quality of antenatal care and associated factors among pregnant women in Ethiopia: A community based cross-sectional study

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Abstract

Objective: To determine the magnitude of quality of antenatal care and associated factors among pregnant women in Ethiopia.

Design: A community based cross-sectional study

Setting: Ethiopia

Participants: A total of 4757 weighted sample of pregnant women from January 18 to June 27, 2016, were included for this analysis

Outcome: Quality of ANC.

Methods: Our analysis was based on secondary data using the 2016 Ethiopian Demographic and Health Survey. The quality of ANC was measured when all six essential components, such as blood pressure measurements, blood tests, urine tests, nutrition counseling, birth preparation advice during pregnancy, and information on potential complications, were provided. Stata version 14 software was used for analysis. A multi-level mixed-effect logistic regression analysis was fitted. Adjusted Odds Ratio with 95% confidence intervals was used to show the strength and direction of the association. Statistical significance was declared at a *P* value less than 0.05.

Results: The magnitude of quality of antenatal care in Ethiopia was 22.48% (95% CI: 21.31, 23.69). Educational status; primary (AOR=1.34; 95%CI: 1.06, 1.68) and secondary (AOR=2.46; 95%CI: 1.76, 3.45), middle (AOR=1.31; 95%CI: 1.01, 1.72) and rich (AOR=2.08; 95%CI: 1.59, 2.72) wealth status, being married (AOR=2.34; 95%CI: 1.08, 5.10), and four or more antenatal care (AOR=2.01; 95%CI: 1.67, 2.40) were statistically significant associated factors of quality ANC in Ethiopia.

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3   57   **Conclusions:** This study found that nearly only one in five pregnant women received quality
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6   58   antenatal care during pregnancy. To improve the quality of ANC in Ethiopia, Ministry of
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8   59   Health and health facilities are needed to increase financial support strategies that enable
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10   60   pregnant women from poor households to use health services and enhance pregnant women's
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12   61   understanding of the significance of quality of antenatal care through health education.
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15   62   Additionally, Community health workers should also be placed on supporting unmarried
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17   63   pregnant women to have quality antenatal care.
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20   64   **Keywords**: Quality, Antenatal care, factors, Ethiopia.
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23   65   **Strengths and limitations of the study**
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26   66   ➢ The study uses nationally representative data and large sample size
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29   67   ➢ This study also used a multilevel-modeling technique to identify a more valid result
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31   68   that considers the survey data's hierarchical nature.
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33   69   ➢ The study has limitations due to the cross-sectional nature of the data, it does not show
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35   70   a temporal relationship between independent variables and the outcome variable.
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37   71   ➢ There could be recall bias, since we used the most recent live birth in the past five years
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40   72   before the survey.
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42   73   ➢ Due to the use of secondary data, we used only six essential components of ANC to
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44   74   determine the magnitude of quality of ANC.
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76 ## Introduction

77 Women and teens receive care from health professionals during pregnancy to ensure that both

78 mothers and babies experience the most favorable outcomes. Aside from offering health

79 education, screening, diagnosis, and disease prevention, antenatal care (ANC) can save lives.

80 [1,2] Focused ANC primarily helps women to maintain normal pregnancies by detecting

81 preexisting conditions, preventing complications that may arise during childbirth. [3,4] ANC is

82 the main method for improving maternal health outcomes through early detection of pregnancy

83 risks, and complications.[4] Access to care also includes nutrition, vaccinations, medical tests,

84 and therapies. [5] Moreover, women's access to comprehensive maternal health care, from

85 conception to delivery and afterward, it is possible to minimize their risk of death. [1,6]

86 Understanding and applying different perspectives does not hinder success in achieving

87 quality in healthcare as long as the key principles and concepts of quality are identified and

88 applied.[7] A measure of quality of care is the extent to which people and societies are provided

89 with health services that are consistent with evidence-based professional knowledge and that

90 result in the desired health outcomes. [8]

91 There was a 38% drop in maternal mortality worldwide between 2000 and 2017. [9] But

92 according to the World Health Organization estimates, approximately 295,000 women died

93 after pregnancy or childbirth since 2017, with 94% of these deaths occurring in low income

94 and lower middle income countries. [9] The maternal mortality rate in Sub-Saharan Africa is also

95 the highest in the world, with 546 maternal deaths per 100,000 live births. [1] In Ethiopia,

96 approximately 14,000 maternal deaths occurred in 2017, resulting in an overall maternal

97 mortality rate of 401 deaths per 100,000 live births. [9] In developing nations, the rate of maternal

98 and neonatal death continues to rise despite improved access to ANC. This shows that even

99 when coverage is high, negative health outcomes are still prevalent. [10]

3 | P a g e

100   Despite the good intervention to increase the coverage of ANC, coverage alone cannot be a

101   guarantee to achieve the sustainable development goal. Quality of ANC service is an

102   influencing factor for the health of the mother and the survival of newborn care. [11,12] In addition

103   to this, quality of health care services for individuals and population increases the likelihood

104   of desired health outcomes. [8]

105   The Ethiopian government had tried to improve the maternal health care services through

106   giving priority in its political agenda. [13] The government aimed to reduce the maternal mortality

107   below 267 deaths per 100,000 live births.[14] To achieve this goal the country implemented

108   different interventions such as antenatal care, skilled birth services and postnatal care.

109   Additionally, expansion of health centers and hospitals with adequate medical equipment,

110   health extension programs, supporting facilities like private wing and non-governmental

111   organizations are still working to improve the maternal health. [13,14]

112   While Ethiopia has made the aforementioned interventions to reduce pregnancy-related

113   complications, maternal death rates due to these complications remained high. [13,15,16] Even

114   though multiple studies were conducted in Ethiopia, none of them were representative for the

115   country and are related with factors and coverage of ANC,[12,17-19] rather than quality of ANC.

116   Hence, it is essential to have a clear understanding of this issue in order to implement

117   interventions which would improve the quality of ANC. Therefore the aim of this study was to

118   determine the magnitude of quality of antenatal care and associated factors among pregnant

119   women in Ethiopia.

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121   **Methods**

122   **Study Settings and Data Source**

123   A cross-sectional study of Ethiopian Demographic and Health survey (EDHS) data was used

124   for this study. The survey was conducted by the Central Statistical Agency (CSA) in

125   collaboration with the Federal Ministry of Health (FMoH) and the Ethiopian Public Health

126   Institute (EPHI). EDHS was a national representative sample conducted from January 18 to

127   June 27, 2016. There are nine regional states in Ethiopia (Tigray, Afar, Amhara, Oromia,

128   Benishangul, Gambela, South Nation Nationalities and People Region (SNNPR), Harari, and

129   Somali), and two administrative cities (Addis Ababa and Dire-Dawa), 611 Districts, and

130   15,000 Kebeles.

131   We used the women's recode (IR file) data set and extracted the dependent and independent

132   variables. The data set is freely available and possible to download from the link:

133   https://dhsprogram.com/data/available-datasets.cfm. The DHS employs a two-stage stratified

134   sampling technique. Which makes the data nationally representative. [20] A total weighted

135   sample of 4757 pregnant women aged 15-49 years were included in the study. Pregnant women

136   who had not received ANC visits during their recent pregnancy and who did have not all the

137   six components of ANC services were excluded in this study.

138   The health care system in Ethiopia is structured in a three-tier system: primary, secondary, and

139   tertiary levels of care. The primary level of care including primary hospitals, health centers,

140   and health posts), the secondary level of care is delivered by general hospitals and the tertiary

141   level of health care is given by specialized hospitals. [21]

142   **Variables of the study**

143   **Dependent variable:** The outcome variable was quality of ANC. The outcome variable is

144   binary, and it is coded as 1 if they had received all the six essential ANC components and 0

145 otherwise. These components were measurement of blood pressure, blood test, urine test,

146 informed on possible complication, counselling on nutrition, and advice on birth preparedness

147 plan ever in their ANC visit. [22] Each component has a binary response (1=yes and 0 = no). The

148 construction of the outcome variable was guided by the WHO ANC guidelines. [23]

149 **Independent variables**

150 Different independent variables were considered in this study to determine factors associated

151 with quality of ANC (Table 1).

152 Table 1. List of variables for the assessment of quality of ANC among pregnant women in

153 Ethiopia.

Variables	Description
Age of the women	15-24, 25-34, and 35-49
Resident	Rural, Urban
Women education Level	No formal education, Primary education, and Secondary and higher education
Women occupation	Not employed, employed
Partner education level	No formal education, Primary education, and Secondary education and higher
Wealth index	As a result of high variability of observation from the original DHS classification of households into five categories using principal component analysis, the wealth index scores were re-categorize into three categories (poor, medium, and rich) by merging poorest with poorer and richest with richer for the ease of interpretation of principal component analysis.

Timing of first ANC in months	≤ 3, > 3
Number of ANC visits	<4, ≥4
Birth order	1, 1-4, and ≥5
Marital status	Married, unmarried
Region	**Small peripheral** (Somali, Afar, Gambela, Benshangul Gumuz)
	Large central (Tigray, Amhara, Oromia, South Nation Nationalities)
	Metropolitan (Addis Ababa, Dire Dawa, Harar)
Distance to the nearest health facility	Big problem, Not big problem
Community level education and community level poverty	Hence, we generate the community-level variables by aggregating the individual-level factors at cluster level and categorizing them as high and low based on the national median value since these were not normally distributed. Community level education was generated by the proportion of households in the educated categories obtained from the highest educational level. Categorized as low if the proportion of women were educated below 50% and high if the proportion is ≥50%. [24]
	Community level Poverty was aggregated by the proportion of households in the poorest and poorer quantile. Aggregated as low if the proportion from a

given community is <50% and high if the proportion is

≥50%. [24]

154

Data processing and analysis

156 Stata version 14 statistical software was used for data analysis. All frequency distributions were

157 weighted (v005/1000000) throughout the analysis to ensure that the DHS sample was a

158 representative sample and to obtain reliable estimates and standard errors before data analysis.

159 The first step was a graphical representation of the quality of ANC among pregnant women.

160 Out of 15,683 total eligible households, 7,193 were pregnant in the preceding five year. Of this,

161 2500 pregnant women were excluded because of they had no ANC. Lastly, 4,693 pregnant

162 women in the preceding five years had complete data on quality of ANC and were included in

163 the analysis. Overall, a total weighted sample of 4757 pregnant women were included in this

164 study.

165 The second step was a bivariate analysis that calculated the proportion of quality of ANC across

166 the independent variables with their *p*-values. All the variables having a p-value less than 0.2

167 in bivariable were used for multivariable analysis. For the multivariable analysis, adjusted odds

168 ratios with 95 % confidence intervals and a p-value of less than 0.05 were used to identify

169 associated factors of quality of ANC. In the final step of the analysis, a multilevel logistic

170 regression analysis comprising fixed effects and random effects was done.

171 The results of the fixed effects of the model were presented as adjusted odds ratio (AOR) while

172 the random effects were assessed with intra-class correlation coefficient (ICC). Four models

173 were fitted; null model (model 0) which shows the variations in the quality of ANC in the

174 absence of any independent variables. Model I an adjusted for the individual-level variables,

175 Model II adjusted for the community level variables, and model III adjusted for both individual

8 | Page

176 and community level variables. Simultaneously, model fitness was done using the deviance (-

177 2 log likelihood). Variance inflation factor (VIF) was used to check for multi-collinearity

178 among independent variables and it was found no multicollinearity (mean value for the final

179 model=1.5)

180 **Ethical approval**

181 Not applicable/No human participants included. Consent to participants is not applicable since

182 the data is secondary and is available in the public domain. All the methods were conducted

183 according to the Helsinki declarations. More details regarding DHS ethical standards and data

184 are available online at: http://www.dhsprogram.com.

185 **Patient and public involvement statement**

186 Pregnant women were included in this study by providing valuable information. Nevertheless,

187 they have never been involved in the study design, protocol, data collection tools, and reporting

188 disseminating the finding.

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189   **Results**

190   **Socio-demographic and maternal characteristics of the women**

191   A total of 4757 weighted sample women who gave birth in the preceding five years were

192   included for the final analysis. The mean age of the women was 28 years with an interquartile

193   range of (IQR: 38-24). Most (42.83%) of the women were from the rich wealth status. Most

194   (92.89%) of the women were married and half (50.76%) had four or more ANC. The majority

195   (81.7%) of the women were rural residents. Most (90.35%) of the women were from large

196   central regions. Majority (70%) of the women were from communities with high proportion of

197   education (Table 2).

198   Table 2. Sociodemographic related characteristics of women in Ethiopia, 2016 (n=4757**)**

Variables	Categories	Frequency(n)	Percentage (%)	weighted % of quality of ANC
Age of women	15-24	1232	25.9	19.99
	25-34	2487	52.29	23.00
	≥ 35	1038	21.81	24.18
Household wealth index	Poor	1727	36.0	13.71
	Middle	993	20.87	17.64
	Rich	2037	42.83	32.26
Educational status of the women	No formal education	2569	54.01	17.07
	Primary	1574	33.10	22.54
	Secondary and higher	614	12.90	44.95
Occupation	Employed	2210	46.46	24.10

	Not employed	2547	53.54	21.07
Current marital status	Unmarried	338	7.11	21.67
	Married	4419	92.89	22.54
Number of ANC	< 4	2342	49.24	14.79
	≥ 4	2415	50.76	29.93
Timing of first ANC in months	≤3	1541	32.29	29.55
	>3	3216	67.61	19.09
Birth order	1	1119	23.52	25.88
	2-4	2083	43.79	22.70
	≥ 5	1555	32.69	19.72
Distance to the health facility	Big problem	2397	50.39	18.50
	Not big problem	2360	49.61	24.17
Residence	Urban	870	18.29	39.42
	Rural	3887	81.71	18.68
Region	Small peripheral	225	4.72	16.28
	Large central	4298	90.35	21.56
	Metropolitan	234	4.92	45.31
Community level education	High	3369	70.83	17.70
	Low	1388	29.17	24.44
Community level poverty	High	2316	48.68	16.54
	Low	2441	51.32	28.11

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199 **Magnitude of quality of ANC among ANC attendants**

200 The magnitude of quality of ANC in Ethiopia was 22.48% (95% CI: 21.31, 23.69). Of the six

201 essential components of antenatal care, blood pressure was the most (75.29%) service given

202 for ANC booked women. Of the study participants 264 (5.55%) had not get any of the six

203 components of ANC (Table 3).

204 Table 3. Magnitude of quality of ANC among ANC attendants, Ethiopia, 2016

ANC components	Categories	Frequency	Percentage
Blood pressure	Yes	3582	75.29
	No	1175	24.71
Blood test	Yes	3454	72.6
	No	1303	27.4
Urine test	Yes	3147	66.16
	No	1610	33.84
Told about pregnancy complications	Yes	2142	45.02
	No	2615	54.98
Nutritional Counseling	Yes	3150	66.21
	No	1607	33.79
Told about birth preparedness plan	Yes	2662	55.96
	No	2095	45.04
Over all ANC quality	Yes	1069	24.48
	No	3688	77.52
Number of	0	264	5.55

components	1	369	7.76
	2	468	9.84
	3	803	16.87
	4	911	19.15
	5	873	18.35
	6	1069	22.48

205

Factors associated with quality of ANC

207 The null model in the random effects, showed that a significant statistical differences in the
208 odds of quality of ANC with a community variance of 1.35. Moreover, the intra-class
209 correlation coefficient in the null model revealed that the 29.15% of the total variability of
210 quality of ANC accounted for differences between clusters. Additionally, the median odds ratio
211 revealed that there was heterogeneity on quality of ANC among different clusters. Accordingly
212 the odds of quality of ANC was 3.02 times higher among women of higher cluster of quality
213 of ANC than women within lower cluster of quality of ANC. With regard to model comparison,
214 the third model was selected as a final model since it has the lowest (4085.68) deviance. In the
215 final model, after adjusting for the individual and community level variables, education of the
216 women, number of ANC, wealth index, and current marital status were significantly associated
217 factors with quality of ANC.

218 Accordingly, the odds of quality of antenatal care was 1.34(AOR=1.34; 95%CI: 1.06, 1.68)
219 times and 2.46 (AOR=2.46; 95%CI: 1.76, 3.45) times higher among women who had
220 completed primary and secondary education, respectively as compared with women who had
221 no formal education.

222 Women in the rich and middle wealth status were 1.31 (AOR=1.31; 95%CI: 1.01, 1.72) times

223 and 2.08 (AOR=2.08; 95%CI: 1.59, 2.72) times higher quality of ANC than women of poor

224 wealth status.

225 Married women were 2.34 times more likely to have the quality of ANC than women who had

226 not married (AOR=2.34; 95%CI: 1.08, 5.10).

227 The odds of quality of ANC increased by 2.01 times among women who had four or more

228 ANC as compared with their counter parts (AOR=2.01; 95%CI: 1.67, 2.40) (Table 4).

229 **Table 4:-** Multilevel analysis of factors associated with quality of ANC in Ethiopia, 2016
230 (n=4757)
231

Variables	Categories	Null model	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)	Model 4 AOR (95% CI)
Age	15-24		1		1
	25-34		1.10(0.86,1.42)		1.05(0.81,1.35)
	35 and above		1.23(0.87,1.72)		1.14(0.81,1.61)
Women educational status	No education		1		1
	Primary		1.36(1.09,1.71)		**1.34(1.06,1.68)**
	Secondary and Higher		2.63(1.89,3.67)		**2.46(1.76,3.45)**
Occupation of women	Employed		1.07(0.89,1.28)		1.07(0.89,1.28)
	Not employed		1		1
Wealth index	Poor		1		1
	Middle		1.33(1.03,1.73)		**1.31(1.01,1.72)**
	Rich		2.27(1.78, 2.90)		**2.08(1.59,2.72)**
Current	unmarried		1		1

Marital status	Married		2.28(1.04,4.95)		**2.34(1.08,5.10)**
Husband education	No formal education		1		1
	Primary		0.73(0.59,0.91)		0.72(0.61,1.01)
	Secondary and higher		1.21(0.90,1.63)		1.16(0.86,1.57)
Number of ANC	<4		1		1
	≥4		2.05(1.72,2.45)		**2.01(1.67,2.40)**
Birth order	1		1		1
	2-4		1.09(0.85,1.39)		1.11(0.86,1.42)
	≥5		1.29(0.92,1.81)		1.37(0.97,1.92)
Residence	Rural			1	1
	Urban			2.45(1.62,3.69)	1.38(0.89,2.16)
Regions	Small peripheral			1	1
	Large central			1.59(0.97,2.57)	1.48(0.89,2.46)
	Metropolitan			2.33(1.26,4.31)	1.81(0.94,3.47)
Community level education	Low			1	1
	High			1.21(0.86,1.68)	0.99(0.69,1.42)
Community level poverty	Low			1.52(1.09,2.09)	1.03(0.72,1.46)
	High			1	1
Random effect					
Variance		1.35	1.05	1.06	1.03
ICC (%)		29.15	24.34	24.39	23.71
MOR		3.02	2.64	2.66	2.62

15 | P a g e

PCV	*Re*	22.22	21.48	23.7
Model comparission				
Deviance(-2LL)	4655.62	4093.76	4563.94	4085.68
Mean VIF	___	1.45	1.2	1.5

* = P-value < 0.05, ICC = Intra class corrolation cofficent; MOR =Median odds ratio; PCV = proportional change

in variance; AOR=adjusted odds ratio; CI= confidence interval; VIF= Variance Inflation Factor

232

Discussion

According to the World Health Organization guideline recommendation, all pregnant women needed to receive all essential components (advice on birth preparedness plan, blood pressure measurement, blood test, counsel on nutrition, urine test, information on possible complications) of ANC. [23] The study attempted to assess the magnitude and associated factors of the quality of ANC among pregnant women in Ethiopia. The findings of our study will help policymakers and health facilities to develop tailored intervention strategies by considering the level of quality of ANC services and the factors associated with it.

According to this study, only one in five pregnant women received quality ANC. The quality of ANC was significantly associated with education, wealth status, marital status, and the number of ANC visits.

The finding is higher than a study conducted in East Africa 11.16%. [25] This discrepancy could be due to the previous study incorporating different countries, which significantly varied across countries. That may be because of inequalities in access to antenatal care services and the views of populations about the importance of antenatal care. [26] Moreover, in some of the East African countries, there is ongoing conflict and persistent political instability that played an important role in hindering the quality of the ANC; the scholars revealed that lack of safety played a major role in reducing the ANC, especially in remote areas. [27,28]

However, this study is also lower than the studies conducted in Ambo, Ethiopia 89%, [29] Jimma, South West Ethiopia 48.3%, [30] Bahir Dar, Ethiopia 52.3%, [31] Nepal 43%, [32] urban Slum Aligarha 66%, [33] Malaysia 50%, [34] and Builsa district, Ghana 85%. [35] The possible explanation could be that most of the indicated studies are facility-based with small sample sizes. The way they operationalized the dependent variable (quality of ANC) could also be the reason for the discrepancy, because the current study assessed the quality of ANC only by using six essential components of ANC, whereas the former studies assessed the outcome variable slightly

17 | P a g e

258   different from the current study. For instance, studies done in Ambo, Ethiopia, Jimma, South

259   West Ethiopia, and Bahir Dar, Ethiopia, quality of care assessed based on the point of view of

260   the provider, manager and the clients. [29-31] Additionally, the discrepancy between this finding

261   and that of studies conducted outside of Ethiopia could be due to socio-demographic and

262   cultural differences.

263   Pregnant women with a higher level of education had higher odds of quality of ANC compared

264   to those without formal education. The findings of this study are in agreement with those of

265   studies conducted in Southern Ethiopia, [36] Tanzania, [37], and East Africa. [25] The possible reason

266   for this might be that pregnant women with higher levels of education are more likely to find

267   information from mass media to become aware of the importance of ANC and adhere to follow-

268   up schedules. [38] Moreover, they can understand health care providers' instructions, education,

269   and counseling due to better communication skills that facilitate interactions with health

270   workers. [39]

271   The likelihood of quality of ANC among pregnant women from households in the middle and

272   rich wealth status was higher than that of pregnant women from poor wealth status households.

273   This finding is supported by studies done in Nepal, [40] Kenya, [41] and East Africa. [25] Providing

274   healthcare, whether from governmental or non-governmental facilities, with person-centered

275   services (take into account the preferences of pregnant women and respond to their needs

276   accordingly) may be able to improve the quality of ANC for pregnant women from the richest

277   households. [42,43] Moreover, the economic differences in accessing maternal or reproductive

278   health care, along with other factors, such as media exposure and travel time to the health

279   facility, are also determining factors in the quality of ANC. [44,45] Thus, ANC information may

280   be more readily available to rich women from the mass media. Additionally, the cost of

281   traveling to distant health facilities contributes indirectly to the cost of ANC which can be easily

282   afforded by pregnant women from the rich huseholds as compared with their counterparts. [46]

18 | P a g e

283　Furthermore, income could also influence the health seeking behavior of the mother in which

284　women in poor households may be subjected to specific worries and feel inadequate for seeking

285　health care, this can directly affect the quality of ANC. [47,48]

286　The study also showed that married pregnant women were higher odds of quality of ANC

287　compared to their counterparts. This is consistent with previous studies conducted in Ethiopia.

288　[49-51] In comparison to unmarried women, pregnant married women may experience higher

289　quality ANC as a result of better psychological (advise to seek ANC visit for better pregnancy

290　outcome) and economic support from their husbands, the desirability and planndness of their

291　pregnancy, and the community's acceptance and support of their pregnancy status. [52] However,

292　those women who are pregnant outside of wedlock are often afraid to go out and socialize in

293　the community due to community stigmatization and marginalization. [53] This situation makes

294　them less likely to go to ANC visits which in turn affects the quality of ANC. [49,52]

295　Furthermore, pregnant women who had received at least four ANC visits had the quality of

296　ANC compared with mothers who had received below four ANC visits. This finding agreed

297　with the report from Southern Ethiopia [18], and Rwanda.[54]　It might be that women who visit

298　four or more ANC have a greater chance of getting extensive health education sessions, have

299　improved rapport with ANC providers and are more likely to get and recognize quality of ANC

300　and report it positively.[55,56] Furthermore, the frequent contact between the ANC provider and

301　the pregnant woman also promotes a sense of trust and confidence in the services as well as

302　enhances the familiarity of the pregnant woman with the health system. [57], This ensures that

303　women to freely share information with skilled providers and that further ANC components

304　can be served as a result.[54,58]

305　Elsewhere studies in Ghana [59] and Ethiopia [18 60] revealed that women who had resided in rural

306　areas were less likely to have quality ANC. This might be because the health infrastructures in

307 the rural area are less developed and there are fewer trained health workers. Studies in Nigeria

308 [61], and Kenya, [41] also revealed that as the age of women become older they get quality ANC

309 than adolescent and young aged women. It might be because older women understand the

310 importance of ANC visits, and they can benefit from repeated health education and counseling,

311 thus enhancing their understanding of ANC benefits. However, in this study, some

312 sociodemographic characteristics such as residence and age were not statistically significant.

313 This difference might be differences in the approach used in collecting and analyzing data. For

314 instance, the current study uses EDHS data and multilevel approaches of analysis.

315 It is conclusive that we need to do more to improve the quality of ANC. More than three-fourths

316 of mothers actually did not receive quality ANC, and less than a quarter received it with all six

317 essential components (such as, blood pressure measurements, blood tests, urine tests, nutrition

318 counseling, birth preparation advice during pregnancy, and information on potential

319 complications) of ANC. This means that thousands of mothers are only receiving some of the

320 components of ANC to maintain a healthy pregnancy. Therefore, the Ministry of Health, health

321 facility professionals, and community health workers have an important role in raising

322 consciousness of this matter to counteract the problem.

323 The main strengths of this study were the use of nationally representative data, with a large

324 sample size and the availability of individual and community-level factors. This study also used

325 a multilevel-modeling technique to identify a more valid result that considers the survey data's

326 hierarchical nature. Despite these strengths, it has limitations due to the cross-sectional nature

327 of the EDHS data. It does not show a temporal relationship between independent variables and

328 the outcome variable. There could be recall bias since we used the most recent live birth in the

329 past five years before the survey for the calculation of the quality of ANC. Additionally, due

330 to the use of secondary data, we used only six essential components of ANC to determine the

331 magnitude of quality of ANC. The DHS omitted to provide data regarding screening and

20 | P a g e

332   treatment of disorders such as HIV, abnormal fetal lie, diabetes, tuberculosis, and malaria, as

333   well as the provision of preventive interventions, such as tetanus immunization and insecticide-

334   treated bed nets which would be relevant if they were incorporated in the construction of quality

335   of ANC. If the aforementioned components were included the estimate might become low.

Conclusion

337   This study found that nearly only one in five pregnant women received quality antenatal care

338   during pregnancy. Level of education, wealth index, marital status, and number of ANC visits

339   were factors associated with the quality of antenatal care visits. It would be useful to increase

340   financial support strategies that enable pregnant women from poor households to use health

341   services and enhance pregnant women's understanding of the significance of quality of

342   antenatal care through health education targeting women with no education. Emphasis should

343   also be placed on supporting unmarried pregnant women to have quality antenatal care.

344   Ministry of Health, health facility's professional, and community health workers have an

345   important task in raising consciousness of this matter.

Abbreviations

347   ANC: Antenatal care; AOR: Adjusted Odds Ratio; CSA: Central Statistical Agency; DHS:

348   Demographic Health Survey; EAs: Enumeration Areas; EDHS: Ethiopian Demographic and

349   Health Survey; EPHI: Ethiopian Public Health Institute; FMoH: Federal Ministry of Health;

350   ICC: Intra-class Correlation Coefficient; MOR: Median Odds Ratio; PCV: Proportional

351   Change in Variance; SD: Standard Deviation; WHO: World Health Organization

Consent for publication

353   It is not applicable for this study since the study was used a secondary data analysis conducted

354   by central statistical agency.

Data sharing statement

21 | Page

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356   The data used for this study will be available with a reasonable request from the

357   corresponding author.

Competing interests

359   The authors declare that they have no competing interests.

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Authors' contributions

363   All authors contributed to the preparation of the manuscript. WDN, SMF, DGB, and EAF

364   conceived the idea. WDN extract the data, conducted analysis, and write the original draft of

365   the manuscript, ESS, DBA, RET, FMA, TGA, HBE critically edited, revised and reviewed the

366   manuscript. DGB assisted in the data analysis and interpretation. All of the authors read and

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