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Prenatal care utilization in Zimbabwe: Examining the role of community-level factors

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ABSTRACT

This paper assesses the importance of community-level factors on prenatal care utilization in Zimbabwe. The analysis is performed using data from the two most recent rounds of the nationally representative Demographic and Health Survey for Zimbabwe conducted in 2005/06 and 2010/11 linked with other community-level data. We use logistic, generalized linear regressions as well as multilevel mixed models to examine the factors associated with the frequency, timing and quality of prenatal care. Our results suggest that contraceptive prevalence, religious composition, density of nurses, health expenditures per capita and availability of government hospitals in communities are important predictors of prenatal care use in Zimbabwe. These findings have important implications for public health policy in Zimbabwe – a country with unfavorable maternal and child health outcomes.

1. Introduction

Despite notable improvements in prenatal care use over the past two decades [1], poor maternal and child health outcomes continue to be serious challenges in Sub-Saharan Africa (SSA). For instance, while the proportion of pregnant women receiving prenatal care from a skilled health professional rose from 69% in 2006 to 77% in 2013, maternal mortality remained high around 520 deaths per 100,000 live births representing more than 50% of the reported global maternal deaths [2]. Important progress has also been made regarding infant and under-five mortality. For instance, though still unacceptably high, the infant (under-five) mortality rate dropped from 108 (180) deaths per 1000 live births in 1990 to 56 (83) deaths per 1000 live births in 2015 respectively [3].

Numerous studies have linked timely, adequate and high-quality prenatal care use to better maternal and newborn health outcomes [4–7]. Adequate and timely sought prenatal care offers numerous benefits to pregnant women from early detection of complications to nutritional intake advice, behavioral education and preparation for motherhood [8,9]. Most developing countries in Asia and SSA including Zimbabwe follow the four-visit model as recommended by the World Health Organization (WHO) for women with less complicated pregnancies and living in low-income regions [9].

Empirical research on the determinants of prenatal care in SSA and Asia is vast and rapidly growing. This research has established that individual and sociodemographic factors are important predictors of prenatal care use. These factors include but not limited to maternal education, cultural or religious beliefs, maternal employment status, location, and pregnancy desire (i.e. whether the woman wanted the pregnancy at the time she got pregnant) [10–13]. However, little is known about the contribution or influence of community-level factors on the use of antenatal care services in countries with poor maternal and child outcomes such as Zimbabwe.

Building on the above literature, the primary objective of this study is to examine the overall importance of the community-level factors such as religious composition, contraceptive prevalence, density of nurses, hospitals, and health expenditures at the cluster-level on the timing of care, frequency of visits and quality of received prenatal care. Religious beliefs at the community-level are believed to play an essential role in shaping women's attitudes and behavior towards the use of maternal care services [14,15]. Social ties within communities also help influence contraceptive utilization rates [14]. Thus, an understanding of the contribution of community-level factors is imperative for public policy in the design of relevant public health policies. The focus on community factors is prompted by the fact that individuals constitute the

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community, their behavior and beliefs are in turn shaped by the same communities in which they reside [16].

The analysis uses two rounds of the nationally representative Zimbabwe Demographic and Health Survey (ZDHS) to test the influence of community-level factors on the utilization of antenatal care services in Zimbabwe. Zimbabwe is a particularly interesting case to consider for two reasons. First, high prenatal care utilization rates continue to co-exist with unfavorable pregnancy outcomes like high under-five mortality rates [17]. According to the ZDHS, approximately 92% of pregnant women received some form of prenatal care between 2000 and 2011, and yet the average maternal mortality rate stood at 960 deaths per 100,000 live births over the same period. Furthermore, recent official statistics on child mortality reveal that the infant (under-five) mortality increased from 53(77) deaths per 1000 live births in 1990–1994 to 57(84) deaths per 1000 live births in 2010–2011 [18].

Second, a cursory examination of the data reveals that most pregnant women still initiate prenatal care well after the first three months and have inadequate and low quality prenatal care. The ability to provide quality prenatal care services in the country is often lacking due to serious deficiencies in skilled health providers, senior medical staff, functioning laboratory equipment, financial resources for health care delivery, and the availability of necessary health drugs [19]. Thus, even when pregnant women overcome all the constraints associated with the physical access to prenatal care services, they may still face yet other obstacles related to the quality of the services provided. In this context, cluster-level or community-level factors potentially become essential components of the use of prenatal care services.

2. Methods

2.1. Data source

The empirical analysis uses data from two rounds of the nationally representative Zimbabwe Demographic and Health Survey (ZDHS) conducted in 2005/06 and 2010/11. The ZDHS collects detailed health information for women of reproductive ages 15–49 and their children. The survey used a stratified two-stage cluster sample design based on the Zimbabwe population census of 2002. The first stage involved a random sampling of the enumeration areas followed by a random sampling of households (excluding individuals living in institutional facilities such as army barracks, hospitals, police camps, and boarding schools) at the second stage.

Of the 9870 eligible women in the 2005/06 ZDHS, 8907 were successfully interviewed, yielding a response rate of 90% [20]. Among the 9831 eligible women in the 2010/11, 9171 were successfully interviewed, resulting in a response rate of about 93% [18]. The analysis in this study uses the individual woman data file, which contains both parental and household characteristics including detailed prenatal care information for the most recent birth that occurred within the five years before each survey. We supplemented the ZDHS data with health facilities data obtained from the Zimbabwe Statistical Agency (ZIMSTAT) and other country specific reports on health resources.

Since we used a pooled cross-sectional sample, we adjusted the survey weights such that the initial sampling probabilities were preserved in either survey. Then, we re-scaled the sampling weights such that each survey received an equal weight and making the simplifying assumption that the overall population in Zimbabwe did not significantly change to the extent of altering our study conclusions. The final sample weights consist of the original ZDHS weights adjusted to reflect the consequence of pooling across multiple waves. All our estimates especially summary statistics are weighted to be nationally representative.

2.2. Measures of prenatal care

This study considers three outcome variables to measure the frequency, timing and quality of prenatal care. We use the responses to different questions on prenatal care asked during each survey. Each respondent in the ZDHS, who had given birth five years preceding each survey, was asked to provide information regarding her most recent pregnancy. Follow-up questions were asked on who had provided the care, how many visits they had completed and the specific services they had received during each prenatal care visit.

2.2.1. Formal antenatal care use

All the women were first asked a general question regarding the receipt of any prenatal care. Each respondent was asked: "Did you see anyone for prenatal care for this pregnancy?" If yes, each respondent was asked to state whether they had seen a doctor, nurse or midwife, auxiliary midwife, traditional birth attendant, community village health worker or any other person. We use the response to this question to create a binary variable equals 1 if the respondent received some form of prenatal care during pregnancy and 0 otherwise.

2.2.2. Timing of prenatal care

For the subsample of women who sought prenatal care, another follow-up question regarding the timing of care was asked. "How many months pregnant were you when you first received prenatal care for this pregnancy?" Possible responses ranged from 0 to 9 months with 0 being the earliest and 9 the late prenatal care initiators. Globally, prenatal care initiated in the first trimester is the highly recommended option for all pregnant women [9,21]. We created a binary indicator equals 1 if prenatal care was initiated in the first trimester (three months of pregnancy) and 0 otherwise.

2.2.3. Frequency of prenatal care

Respondents who had gone for prenatal care were further asked another question regarding the number of visits they had completed. More specifically, each respondent was asked this question: "How many times did you receive prenatal care for this pregnancy?" The responses ranged from 0 visits to a maximum of 20 visits. We used the response to this question as our measure for the frequency of antenatal care services.

2.2.4. Quality of antenatal care use

Lastly, the subsample of prenatal care users was further asked a series of questions about the specific services they had received during each prenatal care visit. "As part of your prenatal care during this pregnancy, were any of the following services done at least once: (1) was your blood pressure measured? (2) Did you give a urine sample? (3) Did you give a blood sample? (4) during any of your prenatal care visit(s) were you told about things to look out for that might suggest problems with the pregnancy?, (5) during this pregnancy were you given an injection in the arm to prevent the baby from getting tetanus or convulsions after birth?, (6) during this pregnancy, were you given or did you buy any iron tablets or syrup?, (7) during this pregnancy, did you take any drugs to keep you from getting malaria?. Each response was coded as 1 if a specific service was received and 0 otherwise. Following Deb and Sosa-Rubi [22] we then created an index to measure the quality of prenatal care by adding all the "yes" responses for each woman.

2.3. Explanatory variables

The decision to utilize prenatal care services is thought to depend on a set of individual characteristics, household

characteristics, and community-level factors. The individual characteristics included in all our regressions are: the age of the woman at child birth; years of education, employment status (=1 if employed; 0 otherwise) at the time of survey, health insurance status (=1 if insured; 0 otherwise), marital status (=1 if married; 0 otherwise), pregnancy desire (=1 if pregnancy wanted; 0 otherwise), number of births in the last five years, access to information ((=1 if listens to the radio at least once a week; 0 otherwise); (=1 if reads newspapers at least once a week; 0 otherwise)), household size, household wealth (low (=1 if quintile 1 or 2; 0 otherwise); average (=1 if quintile = 3; 0 otherwise); high (=1 if quintile 4 or 5; 0 otherwise)). At the community-level, we included measures for religious composition (% Christians in cluster of residence), contraceptive prevalence (% in cluster), number of nurses per 100,000 capita, health expenditures per capita (in United States dollars), a binary indicator for rural/urban residency, and an indicator for the availability of hospitals in district of residence. We also included an indicator for the year of survey (=1 if surveyed in year 2010/11; 0 otherwise). For the analysis, we converted the number of nurses per 100,000 capita and health expenditures per capita to natural logarithms so as to smoothen the data.

2.4. Econometric analysis

To model the use of prenatal care services, we first estimate a standard logit regression model specified as follows:

$$\ln\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta_1 X_i + \beta_2 V_i + \varepsilon_i \quad (1)$$

where π is the probability that a pregnant woman used prenatal care during her most recent pregnancy and 0 otherwise, $\frac{\pi}{1-\pi}$ is the odds ratio, X_i is a vector of individual and household-level characteristics, V is a vector of community-level features, and ε_i is a disturbance term. Since the timing of prenatal care is measured using a binary indicator taking 1 if care was sought in the first trimester of pregnancy and 0 otherwise, we use Eq. (1) to estimate the factors associated with this decision. Second, we express the frequency of prenatal care visits as a linear function of the predictors and estimate a linear model of the following form:

$$Y_i = \alpha + \delta_1 X_i + \delta_2 V_i + \epsilon_i \quad (2)$$

where Y_i represents the frequency or quality of prenatal care by the i^{th} woman and ϵ_i is an error term. This model is estimated using a generalized linear model (GLM) and heteroskedastic robust standard errors [23]. Since the quality of prenatal care is measured using the prenatal care index ranging from 0 to 7, we use the GLM as specified in Eq. (2). As a robustness check, we also use a two-level mixed logit (for binary indicator variables) and a linear mixed effect model (for continuous outcomes) [24]. Here, children (level one units) are nested in clusters or primary sampling units (level two). To formally test the influence of cluster-level variables, we concentrate on the change in the median odds ratio (MOR) [25] and the intra-class correlation coefficients after including the cluster-level variables. The MOR compares the odds ratios of two individuals with similar explanatory variables and randomly chosen from different clusters [25]. In our case, the MOR is therefore defined as the median odds ratio between a pregnant woman living in a cluster with a higher prenatal care utilization rate and a pregnant woman living in a cluster with a lower probability of prenatal care use. All the analysis was conducted using STATA version 13.0 [26].

3. Results

3.1. Descriptive statistics

Table 1 presents the survey-weighted means of the variables stratified by rural and urban status. The average age at birth is 26.57 years. Many of the women in our sample are married (95%), 42.68% are Christians, 3.19% had no formal education, and only 37.92% were employed at the time of the survey. Regarding health insurance, only 6.71% had some form of health insurance, 59.77% used a modern family planning method, 19.53% indicated they never wanted their pregnancy at the time of conception while 10.86% had previously terminated a pregnancy. Concerning access to information, nearly 37.11% of the women read newspapers at least once a week while 51.64% indicated listening to the radio at least once every week. The average household size was 5.62 people with rural households having larger family sizes than their urban counterparts across the survey years.

Regarding the quality of prenatal care, urban residents receive relatively higher quality prenatal care than their rural counterparts over the two years (4.58 vs. 3.71 in 2005/06 and 4.43 vs. 4.04 in 2010/11 for urban and rural samples respectively). On the average, women in our sample complete at least 4.45 prenatal care visits and receives approximately 4.06 services during prenatal care. The data shows that on each prenatal care visit, each woman is most likely to receive a blood pressure check (84.06%). At the community-level, the density of nurses per 100,000 capita is much higher for urban communities (193.92 in 2005/06 and 190.81 in 2010/11) than rural communities (86.13 in 2005/06 and 99.01 in 2010/11. A similar pattern holds true for health expenditures as well.

3.2. Regression results

Is a set of community-level health characteristics important in influencing the frequency, timing and quality of prenatal care services in Zimbabwe? Tables 2–4 present the odds ratios and 95% confidence intervals from the estimated regression models stratified by rural and urban status. To examine the joint importance of the community-level variables on the use of prenatal care services, we conducted Wald tests (the Wald test assesses the null hypothesis that the beta coefficients of interest are jointly equal to zero) and present the chi-square statistics and their corresponding p-values at the bottom of Tables 2–4.

3.2.1. Frequency of prenatal care

Table 2 displays the results (odds ratios including the 95% confidence intervals) from the models for the use of some form of prenatal care and the frequency of the visits. The results indicate that a one-year increase in the age of the woman increases the odds of having some form of prenatal care by nearly 17.3% while increasing the chance of completing at least one prenatal care visit by about 7.5% (statistically significant at the 1% and 5% levels respectively). The odds ratios for the age squared variable indicate a non-linear relationship between prenatal care use and the age of mother. Our results reveal that a one-year increase in education raises the odds of seeking prenatal care or completing at least one prenatal visit by nearly 7.2% while maternal employment raises the likelihood of seeking prenatal care by about 35.6% among urban residents and statistically significant at the 10% level. Similarly, health insurance coverage positively correlates the frequency of prenatal care use. As expected, highly parous women and those who never wanted their pregnancies at conception were less-likely to frequent prenatal care centers. This result is particularly true for women living in the countryside. Also, being well informed

Table 1
Descriptive statistics for selected variables used in the analysis.

Variables	Overall		ZDHS 2005/06				ZDHS 2010/11			
			Urban		Rural		Urban		Rural	
	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD
Prenatal care variables										
First trimester prenatal care	22.491	41.755	27.841	44.842	24.881	43.240	19.791	39.857	19.392	39.543
Prenatal care visits	4.459	2.523	5.405	3.058	4.394	2.253	4.495	2.761	4.153	2.350
Prenatal care quality index*	4.061	1.760	4.580	1.351	3.708	1.739	4.437	1.724	4.042	1.848
Tetanus vaccinations	80.295	39.779	83.260	37.350	77.910	41.492	82.748	37.797	80.412	39.694
Iron tablets	47.462	49.938	41.498	49.294	44.180	49.669	53.996	49.859	49.967	50.008
Blood pressure check	84.061	36.606	94.537	22.735	85.058	35.656	86.258	34.441	78.254	41.259
Urine sample	59.469	49.098	84.317	36.380	58.135	49.342	64.526	47.861	49.313	50.003
Blood sample test	70.708	45.513	87.753	32.797	55.140	49.744	82.450	38.054	74.199	43.761
Pregnancy complications	51.889	49.967	61.850	48.597	39.040	48.792	62.584	48.409	55.853	49.664
Malaria tablets	12.172	32.699	4.758	21.296	11.300	31.665	11.128	31.459	16.220	36.869
Maternal/household-level variables										
Age at birth*	26.573	6.535	25.379	5.709	26.552	6.871	26.289	5.779	27.095	6.782
Years of education*	8.337	2.930	9.428	2.004	7.117	2.728	10.193	2.441	8.080	2.986
Employed	37.922	48.522	38.952	48.784	37.278	48.362	47.634	49.957	33.500	47.205
Health insurance	6.715	25.029	19.370	39.536	3.134	17.426	12.829	33.450	2.721	16.271
Married	94.926	21.947	93.710	24.289	95.380	20.996	93.638	24.413	95.557	20.608
Pregnancy wanted later	19.529	39.644	17.258	37.804	21.044	40.769	18.665	38.973	19.446	39.583
Terminated pregnancy	10.856	31.110	7.742	26.736	11.962	32.457	10.726	30.952	11.008	31.303
Births in last five years*	1.049	0.665	1.081	0.517	1.236	0.620	0.847	0.659	0.987	0.704
Read newspapers at least once a week	37.106	48.311	71.371	45.221	23.899	42.653	59.989	49.005	26.036	43.889
Listen to radio at least once a week	51.636	49.976	84.087	36.594	38.788	48.735	61.725	48.619	46.930	49.912
Low wealth	42.433	49.426	0.000	0.000	62.247	48.485	0.946	9.685	59.636	49.069
High wealth	39.329	48.850	97.984	14.061	13.133	33.781	91.693	27.606	16.975	37.546
Household size*	5.624	2.695	5.235	2.348	6.233	2.972	4.772	2.175	5.670	2.663
Community & location factors										
Urban resident	30.481	46.035								
Contraceptive prevalence (% in cluster)	59.769	16.048	70.631	15.660	58.582	16.349	61.741	15.426	56.407	14.573
Religious composition (% Christians)	42.676	20.825	58.091	18.101	37.205	20.697	53.416	18.093	37.120	18.400
Nurses per 100,000 capita*	123.415	74.464	193.915	90.331	86.126	37.255	190.815	97.212	99.006	27.854
District hospitals*	18.683	10.901	8.045	12.093	23.119	7.030	10.259	12.557	22.478	6.932
Health expenditures per capita ($ U.S.)*	42.443	35.933	61.358	42.739	56.073	41.098	33.505	28.215	30.080	24.483

Notes: All estimates are weighted to be nationally representative. The means for all binary variables are expressed in percentage terms. All the variables are binary, except for those marked with an asterisk (*). SD = Standard deviation. ZDHS = Zimbabwe Demographic and Health Survey.

elevates the odds of frequenting prenatal care centers among rural pregnant women.

At the community level, contraceptive prevalence highly correlates positively with prenatal care utilization. Specifically, we found that the odds of seeking prenatal care increase by about 3.24 (3.397) times for rural (urban) residents and statistically significant at the 5% level. However, contraceptive prevalence does not significantly drive the frequency of prenatal care visits within communities. Religious composition (% Christian in cluster) plays a huge part amongst rural women as it increases the odds of seeking prenatal care by nearly 2.43 times. The density of nurses in rural communities increases the odds of seeking some prenatal care and yet fails to guarantee a higher frequency of prenatal care visits amongst rural women. The availability of district hospitals particularly in urban communities significantly increases the likelihood of seeking prenatal care. While the community factors are not always statistically significant when considered individually, the joint significance tests point to an overall importance of these factors.

Table 3 presents the odds ratios and their 95% confidence intervals for the model for the timing of prenatal care. The results indicate that rural women, who never wanted their pregnancies at the time of conception, had given birth at least once and living in relatively larger families are less liable to seek prenatal care in the first trimester. For the urban sample, we find a non-linear relationship between the age at birth and timing of prenatal care. A one-year increase in schooling increases the odds of seeking prenatal care in the first trimester by nearly 8.8% among urban residents and about 2.3% overall. Among urban dwellers, health insurance coverage increases the timeliness of prenatal care by nearly 76.9%. The results also show that access to information significantly raises the odds of first trimester prenatal care amongst rural women. Furthermore, increasing health expenditures per capita enhances the chances of timely prenatal care by nearly 29.3% amongst rural residents. Also, communities with district hospitals have better chance of seeking timely prenatal care than their counterparts with none. The chi-square tests for the overall significance of the community-level factors all point to the importance of community factors on the timing of prenatal care.

Table 4 presents the odds ratios for the model for the quality of prenatal care. We find that a one-year increase in the age at birth increases the likelihood of getting a high quality prenatal care by about 1.102 (1.119) times for pregnant women living in rural (urban) areas. Also, maternal schooling positively correlates quality prenatal care among rural and urban pregnant women. Health insurance coverage, being married, access to information via the radio or newspapers and household wealth all increase the odds of receiving a high quality prenatal care.

At the community-level, family planning use, religious composition, density of nurses, health expenditures and access to district hospitals in the cluster of residence all increase the odds of receiving a high quality prenatal care. For instance, we find that the density of nurses in the cluster of residence increases the odds of receiving a high quality prenatal care by nearly 2.767 (2.597) times among rural (urban) residents. The joint significance tests indicate an overall importance of the community health characteristics on

Table 2
The role of community-level factors on the frequency of prenatal care services.

Variables	Rural sample				Urban sample				Overall sample			
	Any care (yes = 1)		Frequency of visits		Any care (yes = 1)		Frequency of visits		Any care (yes = 1)		Frequency of visits	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Age at birth	1.168***	[1.052–1.295]	1.081***	[1.024–1.142]	1.190*	[0.984–1.441]	1.066	[0.887–1.281]	1.173***	[1.070–1.286]	1.075**	[1.014–1.140]
Age at birth squared	0.997***	[0.996–0.999]	0.999**	[0.998–1.000]	0.997*	[0.994–1.000]	0.999	[0.996–1.002]	0.997***	[0.996–0.999]	0.999**	[0.998–1.000]
Education (years)	1.062***	[1.017–1.108]	1.043***	[1.020–1.066]	1.092**	[1.014–1.176]	1.201***	[1.130–1.276]	1.067***	[1.028–1.107]	1.072***	[1.049–1.096]
Employed	0.943	[0.739–1.202]	1.031	[0.917–1.160]	1.356*	[0.954–1.926]	1.167	[0.945–1.440]	1.056	[0.864–1.290]	1.068	[0.964–1.184]
Health insurance	7.252*	[0.978–53.776]	1.810**	[1.143–2.866]	1.289	[0.627–2.649]	1.740***	[1.257–2.410]	1.822*	[0.945–3.513]	2.011***	[1.554–2.602]
Married	1.535*	[0.951–2.477]	1.465***	[1.163–1.844]	1.637	[0.883–3.034]	1.618**	[1.018–2.570]	1.556**	[1.065–2.271]	1.497***	[1.196–1.874]
Pregnancy wanted later	0.780**	[0.625–0.974]	0.834***	[0.737–0.943]	0.713*	[0.485–1.048]	0.939	[0.726–1.213]	0.755***	[0.625–0.912]	0.860***	[0.767–0.963]
Births in last 5 years	0.492***	[0.406–0.596]	0.695***	[0.624–0.773]	0.552***	[0.393–0.775]	0.650***	[0.497–0.849]	0.506***	[0.430–0.596]	0.688***	[0.621–0.763]
Reads newspapers (at least once a week)	1.252	[0.954–1.645]	1.297***	[1.136–1.482]	1.301	[0.869–1.946]	1.285**	[1.030–1.603]	1.265**	[1.005–1.594]	1.334***	[1.186–1.501]
Listen to radio (at least once a week)	1.211*	[0.970–1.511]	1.217***	[1.095–1.352]	1.556**	[1.064–2.278]	1.150	[0.880–1.503]	1.300***	[1.070–1.580]	1.218***	[1.096–1.353]
Household size	0.954**	[0.917–0.993]	0.978**	[0.958–0.999]	0.976	[0.907–1.049]	0.983	[0.938–1.030]	0.964**	[0.931–0.999]	0.978**	[0.959–0.997]
Low wealth (quintiles 1 &2)	0.990	[0.762–1.288]	0.901	[0.781–1.040]	0.746	[0.357–1.557]	0.943	[0.358–2.486]	1.027	[0.801–1.316]	0.961	[0.838–1.103]
High wealth (quintiles 4 & 5)	1.400	[0.922–2.126]	1.042	[0.840–1.291]	1.036	[0.568–1.887]	1.257	[0.832–1.899]	1.060	[0.790–1.423]	1.159*	[0.976–1.378]
Community-level variables												
Family planning (% in cluster)	3.240**	[1.284–8.174]	1.271	[0.828–1.949]	3.397**	[1.259–9.168]	1.859	[0.874–3.955]	3.084***	[1.474–6.453]	1.466*	[0.985–2.182]
Christians (% in cluster)	2.432**	[1.094–5.405]	0.789	[0.571–1.092]	1.986	[0.736–5.360]	1.436	[0.811–2.543]	2.219**	[1.170–4.208]	0.961	[0.719–1.286]
Log (number of nurses)	6.946***	[3.491–13.821]	0.428***	[0.293–0.624]	2.530	[0.831–7.705]	1.227	[0.597–2.520]	5.632***	[3.007–10.547]	0.569***	[0.402–0.804]
Log health expenditures	1.144	[0.906–1.444]	1.237***	[1.094–1.397]	1.785***	[1.190–2.679]	1.310**	[1.030–1.665]	1.284**	[1.048–1.574]	1.269***	[1.134–1.419]
Year of survey is 2010/11	0.480***	[0.347–0.665]	1.076	[0.910–1.272]	0.640*	[0.378–1.083]	0.626***	[0.444–0.882]	0.515***	[0.391–0.678]	0.928	[0.797–1.082]
District hospital					2.497**	[1.080–5.773]	1.295	[0.789–2.124]	5.465***	[3.288–9.083]	1.245	[0.547–0.960]
Observations	5982		5458		2471		2264		8453		7722	
Chi-square statistic (all variables)	162.468		270.312		122.384		258.507		267.807		517.595	
P-value	<0.001		<0.001		0.004		0.076		<0.001		0.000	
Chi-square statistic (community factors only)	33.311		39.271		17.249		9.977		46.298		34.733	
P-value	<0.001		<0.001		0.004		0.076		<0.001		<0.001	

Notes: All estimates are weighted to be nationally representative. The estimates shown are coefficient estimates from the two-part model. ***Significance at 1% level; **significance at 5% level; *significance at 10% level (all are based on robust standard errors). All the chi-square statistics are in comparison to the full model. The reference category for household wealth is quintile 3 (average wealth). CI = Confidence interval. The dependent variables are (1) any care (binary) and (2) total number of prenatal care visits completed for the most recent pregnancy.

the quality of prenatal care as indicated by the chi-square statistics of 33.679 ($p < 0.001$) and 41.617 ($p < 0.001$) for the rural and urban areas respectively.

To check the robustness of our estimates, we estimated a series of two-level mixed logit regression models for binary outcomes and two-level linear mixed effect regressions. The results for these analyses are furnished in Table 5. The odds ratios and the marginal effects from all the models are consistent with our earlier estimates. Thus, our earlier findings are robust to change in the empirical model used. The MORs and ICC all show that cluster-level variables modestly influence the use of prenatal care services in Zimbabwe. For example, the MOR for the model for any prenatal care use declined by nearly 4.29% from the baseline specification (i.e. with no cluster-level variables) to about 2.340 after accounting for cluster-level variables. For frequency of prenatal care, the ICC declined by about 6.38% and showing the influence of cluster-level variables.

4. Discussion

This study sought to assess the importance of community-level factors on the frequency, timing and quality of prenatal care services in Zimbabwe. The sociodemographic factors such as the mother's age at birth, education, and previous birth histories were all important in explaining the factors influencing the use of prenatal care services. Our results also show that family planning prevalence, religious composition, nurses per 100,000 capita, health expenditures per capita and government hospitals in community

Table 3
The role of community-level factors on first trimester prenatal care use.

Variables	Rural sample		Urban sample		Overall sample	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Age at birth	1.054	[0.977–1.138]	1.189**	[1.020–1.385]	1.082**	[1.011–1.158]
Age at birth squared	0.999	[0.998–1.000]	0.997**	[0.994–1.000]	0.999**	[0.997–1.000]
Education (years)	1.007	[0.980–1.034]	1.088***	[1.028–1.151]	1.023*	[0.999–1.048]
Employed	1.066	[0.927–1.226]	1.042	[0.852–1.276]	1.073	[0.958–1.202]
Health insurance	1.291	[0.918–1.817]	1.769***	[1.386–2.258]	1.658***	[1.365–2.015]
Married	1.152	[0.812–1.636]	1.751**	[1.081–2.839]	1.315*	[0.994–1.741]
Pregnancy wanted later	0.873*	[0.745–1.024]	0.985	[0.780–1.245]	0.899	[0.789–1.025]
Births in last 5 years	0.785***	[0.686–0.899]	0.581***	[0.440–0.768]	0.735***	[0.652–0.828]
Reads newspapers (at least once a week)	1.204**	[1.040–1.393]	1.065	[0.845–1.342]	1.157**	[1.024–1.308]
Listen to radio (at least once a week)	1.159**	[1.018–1.320]	1.132	[0.890–1.440]	1.156**	[1.031–1.297]
Household size	0.970**	[0.944–0.998]	1.009	[0.963–1.057]	0.981	[0.959–1.004]
Low wealth (quintiles 1 &2)	0.879	[0.744–1.040]	1.000	[0.196–5.108]	0.919	[0.782–1.079]
High wealth (quintiles 4 & 5)	1.121	[0.909–1.382]	1.315	[0.737–2.345]	1.062	[0.890–1.268]
Community-level variables						
Family planning (% in cluster)	1.136	[0.714–1.807]	0.927	[0.461–1.866]	1.041	[0.704–1.539]
Christians (% in cluster)	1.050	[0.731–1.508]	1.169	[0.680–2.009]	1.045	[0.778–1.404]
Log (number of nurses)	0.836	[0.561–1.245]	1.135	[0.586–2.197]	0.885	[0.630–1.241]
Log health expenditures	1.293***	[1.136–1.473]	1.129	[0.948–1.345]	1.237***	[1.114–1.374]
Year of survey is 2010/11	0.867	[0.722–1.041]	0.679***	[0.510–0.906]	0.810***	[0.695–0.943]
District hospital			1.585*	[0.991–2.535]	1.460***	[1.118–1.907]
Observations	5982		2471		8453	
Chi-square statistic (all variables)	134.341		132.128		241.179	
P-value	0.001		0.001		<0.001	
Chi-square statistic (community factors only)	17.147		16.090		47.319	
P-value	0.002		0.007		<0.001	

Notes: All estimates are weighted to be nationally representative. ***Significance at 1% level; **significance at 5% level; *significance at 10% level (all are based on robust standard errors). All the chi-square statistics are in comparison to the full model. The outcome variable is a binary variable taking 1 if woman sought prenatal care in the first three months of pregnancy and 0 otherwise. CI = Confidence interval.

Table 4
The role of community-level factors on the quality of prenatal care utilization.

Variables	Rural sample		Urban sample		Overall sample	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Age at birth	1.102***	[1.044–1.163]	1.119**	[1.025–1.221]	1.099***	[1.049–1.152]
Age at birth squared	0.999***	[0.998–1.000]	0.998**	[0.997–1.000]	0.999***	[0.998–1.000]
Education (years)	1.085***	[1.062–1.108]	1.055***	[1.022–1.090]	1.079***	[1.059–1.098]
Employed	1.048	[0.940–1.169]	1.138**	[1.014–1.278]	1.058	[0.974–1.150]
Health insurance	1.472***	[1.184–1.830]	1.152**	[1.002–1.326]	1.227***	[1.091–1.380]
Married	1.031	[0.833–1.275]	1.253	[0.957–1.641]	1.110	[0.941–1.309]
Pregnancy wanted later	0.844***	[0.755–0.943]	0.748***	[0.638–0.877]	0.818***	[0.747–0.896]
Births in last 5 years	0.677***	[0.609–0.752]	0.777***	[0.653–0.925]	0.696***	[0.636–0.762]
Reads newspapers (at least once a week)	1.328***	[1.185–1.489]	1.174**	[1.023–1.347]	1.277***	[1.168–1.396]
Listen to radio (at least once a week)	1.157***	[1.048–1.278]	1.257***	[1.067–1.481]	1.204***	[1.105–1.311]
Household size	0.980**	[0.963–0.997]	1.006	[0.977–1.036]	0.985**	[0.970–1.000]
Low wealth (quintiles 1 &2)	0.838***	[0.741–0.947]	0.889	[0.428–1.847]	0.833***	[0.740–0.936]
High wealth (quintiles 4 & 5)	1.136	[0.975–1.325]	1.225	[0.917–1.636]	1.203***	[1.056–1.369]
Community-level variables						
Family planning (% in cluster)	1.517*	[0.971–2.369]	1.548*	[0.954–2.512]	1.562**	[1.107–2.206]
Religious composition (% Christians in cluster)	1.491**	[1.060–2.096]	1.331	[0.931–1.903]	1.497***	[1.147–1.953]
Log (number of nurses)	2.767***	[1.833–4.175]	2.597***	[1.698–3.971]	2.770***	[1.997–3.843]
Log health expenditures	1.101**	[1.008–1.204]	1.114*	[0.993–1.250]	1.111***	[1.034–1.194]
Year of survey is 2010/11	1.199**	[1.018–1.413]	0.956	[0.796–1.148]	1.125*	[0.989–1.279]
District hospital			2.512***	[1.843–3.423]	2.503***	[1.969–3.183]
Observations	5982		2471		8453	
Chi-square statistic (all variables)	503.918		179.449		732.266	
P-value	0.001		0.001		0.001	
Chi-square statistic (community factors only)	33.679		41.617		66.216	
P-value	0.001		0.001		0.001	

Notes: All estimates are weighted to be nationally representative. ***Significance at 1% level; **significance at 5% level; *significance at 10% level (all are based on robust standard errors). All the chi-square statistics are in comparison to the full model. The outcome variable is a continuous index measuring the quality of prenatal care ranging from 0 to 7. CI = Confidence interval.

of residence are all important predictors of the utilization of prenatal care services when considered jointly. These findings are consistent with previous other studies especially for developing countries [4,27].

Our results indicate that high contraceptive prevalence rates positively correlate with prenatal care among rural pregnant women. This result might be explained by the fact that women living in clusters with higher contraceptive prevalence rates are likely

Table 5
Multilevel estimates: Prenatal care utilization in Zimbabwe, 2005–2011.

Variables	Any form of prenatal care				Frequency of visits				First trimester care				Prenatal quality			
	Odds ratio	SE	Odds ratio	SE	Coef	SE	Coef	SE	Odds ratio	SE	Odds ratio	SE	Coef	SE	Coef	SE
Age at birth	1.171**	(0.058)	1.168**	(0.058)	0.100**	(0.031)	0.095**	(0.034)	1.081*	(0.036)	1.078*	(0.036)	0.093***	(0.021)	0.092***	(0.023)
Age at birth squared	0.997**	(0.001)	0.997**	(0.001)	−0.002**	(0.001)	−0.001**	(0.001)	0.999*	(0.001)	0.999*	(0.001)	−0.001***	(0.000)	−0.001***	(0.000)
Education (years)	1.091***	(0.022)	1.089***	(0.022)	0.083***	(0.012)	0.083***	(0.013)	1.021	(0.013)	1.024	(0.013)	0.074***	(0.008)	0.073***	(0.009)
Employed	1.089	(0.111)	1.081	(0.110)	0.157**	(0.057)	0.138*	(0.065)	1.102	(0.063)	1.076	(0.062)	0.036	(0.039)	0.032	(0.040)
Health insurance	1.868*	(0.565)	1.817*	(0.550)	0.684***	(0.114)	0.676***	(0.224)	1.669***	(0.175)	1.682***	(0.177)	0.230**	(0.078)	0.223**	(0.097)
Married	1.784**	(0.343)	1.684**	(0.327)	0.627***	(0.120)	0.573***	(0.214)	1.408*	(0.188)	1.334*	(0.180)	0.147	(0.082)	0.129	(0.094)
Pregnancy wanted later	0.724**	(0.072)	0.731**	(0.073)	−0.259***	(0.063)	−0.259***	(0.048)	0.894	(0.060)	0.892	(0.060)	−0.209***	(0.043)	−0.206***	(0.035)
Births in last 5 years	0.475***	(0.038)	0.497***	(0.042)	−0.656***	(0.054)	−0.583***	(0.032)	0.674***	(0.042)	0.735***	(0.048)	−0.365***	(0.037)	−0.339***	(0.028)
Reads newspapers (at least once a week)	1.259*	(0.147)	1.295*	(0.152)	0.306***	(0.064)	0.312***	(0.088)	1.139*	(0.075)	1.172*	(0.078)	0.239***	(0.044)	0.248***	(0.056)
Listen to radio (at least once a week)	1.326**	(0.133)	1.347**	(0.135)	0.294***	(0.058)	0.292***	(0.078)	1.144*	(0.069)	1.152*	(0.070)	0.182***	(0.040)	0.187***	(0.048)
Household size	0.951**	(0.016)	0.952**	(0.016)	−0.040***	(0.010)	−0.035***	(0.010)	0.978*	(0.010)	0.979	(0.010)	−0.015*	(0.007)	−0.014*	(0.007)
Low wealth (quintiles 1 &2)	1.034	(0.131)	1.035	(0.132)	−0.062	(0.076)	−0.051	(0.072)	0.921	(0.072)	0.913	(0.072)	−0.127*	(0.052)	−0.125*	(0.046)
High wealth (quintiles 4 & 5)	0.991	(0.145)	1.136	(0.183)	0.084	(0.083)	0.091	(0.097)	0.927	(0.077)	1.070	(0.095)	0.207***	(0.058)	0.237***	(0.078)
Year of survey is 2010/11	0.498***	(0.057)	0.432***	(0.080)	−0.491***	(0.062)	−0.485***	(0.065)	0.673***	(0.041)	0.905	(0.101)	0.119**	(0.046)	0.040	(0.078)
Community/cluster−level variables																
Family planning (% in cluster)			2.712**	(1.043)			0.768***	(0.448)			1.019	(0.201)			0.392*	(0.246)
Christians (% in cluster)			1.868*	(0.586)			0.190	(0.203)			1.067	(0.169)			0.346*	(0.190)
Log (number of nurses)			3.932*	(2.094)			0.840**	(0.699)			0.575	(0.199)			0.695***	(0.416)
District hospital			2.177***	(0.401)			0.234*	(0.122)			1.547***	(0.145)			0.294***	(0.098)
Log health expenditures			1.315*	(0.150)			0.269***	(0.074)			1.219***	(0.069)			0.127***	(0.044)
Number of observations	8453		8453		8453		8453		8453		8453		8453		8453	
Mean of the dependent variable	0.926		0.926		4.456		4.456		0.225		0.225		4.060		4.060	
Chi-squared, comparison model	123.294		101.146		83.313		75.276		25.607		21.903		319.074		291.590	
p-value	0.000		0.000		0.000		0.000		0.000		0.000		0.000		0.000	
Intraclass correlation coefficient (ICC)					0.047		0.044						0.101		0.096	
Median Odds Ratios	2.445		2.340						1.434		1.412					
Percent (%) change in MOR or ICC			4.29%				6.38%				1.53%				4.95%	

Notes: ***Significant at 1% level; **significant at 5% level; *significant at 10% level. Reported are the odds ratios from a two-level mixed effect logit regression model and their standard errors shown in parentheses. SE = Standard error, CAOEF = Coefficient or marginal effect. The dependent variables "Any form of prenatal care" and "first trimester care "are binary (1/0) indicator variables while frequency of visits and prenatal quality are continuous variables.

to share other information regarding maternal care including prenatal care use. Alternatively, women are likely to receive prenatal care information during family planning education programs and will likely share this information with their neighbors and friends. The finding that religious composition positively correlates with prenatal care use might be a reflection of the critical role played by faith-based organizations in developing countries in influencing maternal and newborn care services [15]. Religious organizations are believed to offer many other educational programs to women in developing country communities which help raise awareness on the benefits of prenatal care services thus enhancing its use.

This study also found a positive association between health expenditures per capita and the frequency, timing and quality of prenatal care and not on the use of some form of prenatal care. The last result is consistent with the finding of Kruk, Galea [28]. This latter observation might be because some prenatal care use is provided nearly universally. In Zimbabwe, nine out of every ten pregnant women reported having some form of prenatal care for their most recent pregnancy [18]. We also found that per capita health expenditures were associated with timely use of prenatal care among rural women. This finding might be explained by the fact that rising health expenditures per capita possibly imply improvements in government financing which consequently lowers the out-of-pocket expenditures on prenatal care which in turn improves timely access. This result is in-line with the findings in Abrokwah, Moser [29].

5. Conclusions

This study sought to assess the importance of community-level factors on the frequency, timing and quality of prenatal care in Zimbabwe. Though individually not always statistically significant, community-level factors are important predictors of the use of prenatal care services in Zimbabwe when considered jointly. The results underscore the need for public health policymakers to improve health insurance coverage, design community-specific programs to educate women on family planning, and allocate more health resources to communities to improve prenatal care utilization.

Competing interest

The authors declare that they have no competing interests in connection with this manuscript.

Ethics approval

Ethical approval was not necessary for this study. We were granted permission to use the data for the analysis by MEASURE DHS and the Zimbabwe Statistical Agency (ZIMSTAT).

Author contributions

M.M. designed and led the statistical analysis, results interpretation and drafted the manuscript; C.M. helped with the data analysis and interpretations of the results. Both authors approved the final version of the manuscript.

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