Original Article

Exploring factors associated with maternal health care utilization in Chad

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

Author Contributions

Conceptualization: Kim S; Data curation: Kim S; Formal analysis: Kim S; Investigation: Kim S, Kim SY; Methodology: Kim S; Software: Kim S; Validation: Kim S, Kim SY; Writing - original draft: Kim S; Writing - review & editing: Kim SY.

ABSTRACT

Background: Maternal mortality is still one of the top health priorities in many low- and middle-income countries (LMICs). 99% of maternal deaths occur in LMICs, and Chad is one of the countries with the highest burden. Maternal health services, including antenatal, delivery and postnatal care, are proven to be effective for lowering the level of maternal morbidity and mortality, but their usage levels are often suboptimal in LMICs. In this regard, this study aims to explore factors associated with the utilization of maternal health care (MHC) services among Chadian women.

Methods: A composite measure of MHC utilization, encompassing antenatal, delivery, and postnatal stages, has been adaptively constructed to better reflect the level of access to MHC in Chad. This outcome variable has 4-level categories (lowest, mid-low, mid-high, and highest), which incorporates the levels of utilization of prenatal, delivery and postnatal care. Using the data drawn from 2014–2015 Chad Demographic and Health Survey, a multivariate ordered logistic regression was fitted to identify factors affecting the utilization of MHC in Chad.

Results: Only a very marginalized portion (7%) of women reported utilizing all the 3 MHC services. Factors found to have significant associations with MHC utilization were mothers' education, husbands/partners' education and occupation, marriage type, access to media, current use of contraceptives, household wealth level, regions, and place of residence.

Conclusion: Our study suggests that it is imperative to promote overall levels of MHC service utilization in Chad to address the country's very high maternal burden. Efforts for promoting community-level maternal health activities that involve both women and men might help. In a longer-term, future maternal health programs would need to involve more proactively women from lower socioeconomic status and less developed areas tackling within-country health inequalities, while the government strives to improve the country's overall socioeconomic status and health infrastructure.

Keywords: Chad; Maternal health; Prenatal care; Delivery care; Postnatal care

INTRODUCTION

Maternal mortality is one of the most critical health issues in many parts of the world. In 2015, 99% (302,000) of maternal deaths occurred in developing countries, and sub-Saharan Africa (SSA) turned out to be the region with the highest burden, accounting for 66% of total deaths.¹ More surprisingly, 1 per 41 women in low-income countries has a lifetime risk of maternal mortality while 1 per 3,300 women in high-income countries does so, indicating a serious health inequality by national economic status worldwide.^{1,2} However, it is somewhat fortunate that most maternal deaths are preventable. Ways for coping with complications due to pregnancy and childbirth, which are the main causes of maternal mortality, are already well known. Imperatively, all women should have equal access to proper antenatal care (ANC), delivery care (DC), and postnatal care (PNC) in a timely manner.³ Previous studies have demonstrated that appropriate maternal health care (MHC) can contribute to alleviating maternal morbidity and mortality.⁴⁻⁶ For instance, the health conditions of pregnant women could be closely monitored, potential risks for mothers and fetus identified, and thus preventive measures taken beforehand during the ANC sessions.⁷ Furthermore, a large portion of maternal deaths occur within 24 hours of labor and childbirth, thus numerous deaths could be avoided if women were to have access to basic care services during the intrapartum and immediate postpartum periods.^{8,9} Nevertheless, a number of women in developing countries are not able to seek for MHC services as needed, leaving the issue of maternal mortality unsolved or even worsened over time.¹⁰

One of the typical models explaining a pathway to adverse maternal outcomes is “3-delay model”, suggested by Thaddeus and Maine. According to their research, factors influencing service utilization and outcome, such as women's status, distance to health facility, cost of transportation, competence of health personnel and availability of supplies and equipment consequently bring about 3 delays in 1) deciding seek care (phase I), 2) identifying and reaching health facility (phase II), and 3) receiving adequate and appropriate treatment (phase III).¹¹ Following this logic, addressing hurdles which impede mothers' timely care can be an important approach in the formation of strategies to avoid preventable maternal deaths in each country's context. From other studies exploring factors associated with underutilization of MHC, rural residence was sometimes identified as one of the negative predictors disproportionately leading to the lower use of MHC.^{12,14} This could be explained by the limited access and availability of MHC services and lower socioeconomic position in rural areas compared to urban settings. Maternal education found to be one of the significant factors in several literatures,^{13,18} and household wealth also had a non-negligible effect on MCH utilization.^{9,13,14}

Chad suffers from the highest burden of maternal mortality even among SSA countries, with the maternal mortality ratio (MMR) of 856 per 100,000 live births.¹ Notwithstanding this, few studies have examined factors that might lead to such high maternal mortality in the country, by considering the utilization of multiple essential care services in an integrated manner. Furthermore, it should be noted that most studies dealing with the access and use of MHC services in the developing world has used indicators that solely focus on ANC or facility delivery only, rather than devising a more comprehensive indicator that encompasses the entire stages of MHC. It was only very recently that some studies have suggested using a composite measure considering various combinations of ANC, DC, and PNC.^{9,13,15} In this light, our study aims to identify factors associated with MHC utilization during pregnancy, delivery and postnatal period in Chad, using an integrated measure developed by building

upon previous studies, in order to provide empirical evidence and insight that might help ameliorate the health inequality of Chadian women in the foreseeable future.

METHODS

Study setting

Chad is a landlocked country located in north-central Africa, bordered by Libya, Sudan, the Central African Republic (CAR), Cameroon, Nigeria, and Niger. Until recently, this country has been greatly suffered from recurring internal conflicts between the mainly Arab-Muslim north and the Christian south. For this reason, national economy remains underdeveloped, and social infrastructure is left fragile. According to the World Bank, Chad is classified as a low-income group with the GNI per capita of \$640, ranking 176th out of 190 countries as of 2017.¹⁹ Likewise, its latest Human Development Index is estimated at 0.404, having Chad belong to the bottom 5 countries along with Burundi, South Sudan, CAR, and Niger.²⁰

The health system of Chad has not been performing effectively as shown by health indicators such as infant and maternal mortality, health workforce, disease control, and epidemiologic surveillance lagging behind many other nations.²¹ The usage rate of MHC services is also very low; the percentages of women who reported completing at least 4 ANC visits during pregnancy, who delivered at a health facility, and who received the first PNC in the first 2 days after birth, are 31%, 22%, and 16%, respectively.²² This malfunctioning of the health system partly stems from insufficient financing for the health sector, shortage of human resources and equipment, and poor implementation of relevant policies. Despite the government's efforts to improve health status, access to primary care is still problematic for the majority in Chad due to socioeconomic and geographic restrictions.²¹

Data source

The source of data used for this study is the women's questionnaire of the 2014–2015 Chad Demographic and Health Survey (CDHS). Demographic and Health Survey (DHS) employs the model questionnaires to seek for precise and nationally representative data, including variety of topics such as maternal and child health, fertility and family planning, gender, human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS), malaria, nutrition, environmental health, and so forth.

The 2014–2015 CHDS adopted a 2-stage stratified sampling which covers the entire geography of the nation. Two strata, urban and rural, were created initially. In the first stage of selection, 626 primary sampling units or clusters were drawn from the list of enumeration areas of the national census, with probability proportional to size within each stratum. Then, 25 households per cluster in urban areas and 30 households per cluster in rural areas were randomly selected, thereby constituting the sample of 17,965 households (4,075 in urban areas in 163 clusters and 13,890 in rural areas in 463 clusters). Out of 17,422 households identified, 17,233 households in 624 clusters was successfully investigated during the survey. Meanwhile, the total number of women interviewed was 17,719 out of 18,438 eligible women, leading to a response rate of 96%.²²

Study sample selection

The target population of this study are women of reproductive age (15–49 years old) who participated in the 2014–2015 CDHS and delivered at least 1 baby in the past 5 years preceding

Fig. 1. Flow chart of study sample selection.

CDHS = Chad Demographic and Health Survey; ANC = antenatal care; DC = delivery care; PNC = postnatal care; MHC = maternal health care.

the survey. Those who had never been in union were excluded from the list in order to take into account marriage type as well as husbands/partners' characteristics as candidate predictors. Besides, the utilization of MHC services as for only the most recent birth was included. A final sample of 5,312 women (weighted) was identified and considered as the unit of analysis for this study (Fig. 1).

Statistical analysis

Descriptive statistics analysis was firstly conducted to describe the characteristics of the respondents by the level of MHC utilization and selected covariates. Next, a χ^2 test was performed to examine an unadjusted relationship between each independent factor and outcome variable. Finally, multivariate ordered logistic regression was performed to identify factors influencing the level of MHC utilization among Chadian women. More specifically, partial proportional odds model was employed for the analysis.²³ This statistical method was suitable for the study because the 4 levels of the outcome variable are ordinal. A significance level of 0.05 was applied for all analyses, and complex sample design was incorporated during the process to reflect the hierarchical sampling nature of the original survey and to avoid any distortion of the dataset which intends to be nationally representative. Detailed descriptions of the model variables are provided below. All statistical analyses were carried out using STATA software version 15 (StataCorp, College Station, TX, USA).

Dependent variable

As an outcome variable for the present analysis, MHC utilization was adaptively constructed in an ordinal way based on working definitions that collectively reflect the level of prenatal, childbirth and postpartum care, unlike the usual approach of considering each care component separately. Building upon the definitions adapted from the previous study by

Table 1. Classification of 4 levels of maternal health care utilization

Categories of delivery care and PNC	Categories of antenatal care	
	Fewer than 4 visits	4 or more visits
Delivery at health facility = Yes		
First PNC with a skilled provider within 2 days of birth	Mid-high	Highest
Later or no PNC visit	Mid-high	Mid-high
Delivery at health facility = No		
First PNC with a skilled provider within 2 days of birth	Mid-low	Mid-low
Later or no PNC visit	Lowest	Mid-low

PNC = postnatal care.

Larsen et al.,⁹ the level of MHC utilization was classified into 4 different categories—lowest, mid-low, mid-high, and highest (Table 1).

For the composition of this response variable, we firstly established a criterion for dichotomizing the level of each MHC component considered—ANC, DC, and PNC—so that the 4 levels of MHC utilization become ordinal. First, regarding ANC, we used the cutoff of 4 ANC visits in defining the levels of ANC, though 8 visits during pregnancy are recommended nowadays,²⁴ considering the low average number of ANC visits among Chadian women. Next, the level of DC was subdivided into 2 categories as well, facility-based delivery versus delivery outside a facility. We regarded facility delivery as superior to delivery at home or elsewhere based on the evidence from the previous studies.^{8,25} Lastly, PNC was dichotomized with the cutoff of whether women received the first PNC by a skilled provider within 2 days of birth, or later or no checkup at all. Although the WHO advises more than 3 PNC visits after childbirth,²⁶ this recommendation was not able to be reflected in the study because the DHS has no information on the number of PNC contacts received.

Consequently, the highest level of MHC utilization was defined as having 4 or more ANC visits, facility delivery, and the first PNC by a trained personnel for at least 2 days after birth. On the contrary, a woman receiving less than 4 ANC visits, giving birth outside a facility, and having a PNC contact after 2 days of the delivery or not having any PNC was grouped into the lowest level. The remaining 2 levels, mid-low and mid-high, include 3 different combinations of MHC services for each. Acknowledging the fact that delivery in health facilities plays a critical part in bringing positive maternal health outcomes,^{9,16,27} whether or not women delivered at facility was used as a strong cutoff point in distinguishing between the bottom 2 levels (lowest and mid-low) and upper 2 levels (mid-high and highest). That is, we gave more weight to DC than ANC and PNC when coming up with the operational definition of the dependent variable, as Larsen et al.⁹ did in their research. As such, the mid-high level refers to the following cases: 1) having fewer than 4 ANC visits, facility delivery, and the first PNC by a skilled provider within 2 days of birth; 2) having fewer than 4 ANC visits, facility delivery, and the first PNC after 2 days of birth or no PNC at all; and 3) having at least 4 ANC visits, facility delivery, and the first PNC after 2 days of birth or no PNC at all. The mid-low level also embraces 3 cases: 1) having fewer than 4 ANC visits, delivery outside a facility, and the first PNC by a trained workforce within 2 days of birth; 2) having at least 4 ANC visits, delivery outside a facility, and the first PNC by a health provider within 2 days of birth; and 3) having at least 4 ANC visits, delivery outside a facility, and the first PNC after 2 days of birth or no PNC at all.

Explanatory variables

A conceptual framework adapted from Andersen's behavioral model guided the selection of explanatory variables within information available in the original dataset (Fig. 2). The overall

Fig. 2. Conceptual framework of the study.

ANC = antenatal care; PNC = postnatal care; MHC = maternal health care.

hypothesis of this framework is that prescribed variables would affect the utilization of MHC services in Chad. According to Andersen, factors associated with health care utilization can be categorized into the following 3 types: predisposing characteristics, enabling resources and need. Incorporating this rationale, we classified candidate variables into 3 categories as in the conceptual framework.²⁸

As predisposing factors, respondent's age, educational attainment, religion, ethnicity, employment status, husband/partner's educational attainment and occupation, marriage type, access to media, current use of contraceptives, age at first marriage/cohabitation, and level of women's autonomy were selected and accommodated in the statistical model. Women's autonomy variable was created based on the DHS questions asking whether the respondent solely or jointly partakes in the decision-making on her own health care, making large household purchases and/or visits to family or relatives. Enabling factors include wealth index, region, and type of place of residence. Lastly, desire for pregnancy was included as a need factor. All of these predictors were carefully selected based on the findings of the previous literatures exploring the determinants of MHC utilization.^{9,13,15,17}

Ethics statement

As this study is a statistical analysis using publicly available, deidentified secondary dataset, no Institutional Review Board approval is required.

RESULTS

Characteristics of the respondents: descriptive statistics

Table 2 presents the distribution of the characteristics of the respondents, overall and by the level of MHC utilization. Approximately 70% of the respondents included in this study were 20–34 years old. The women's education level was very low in general; approximately two thirds (64%) of the women reported having no education. The overall educational level of the women's husbands or partners was slightly higher than that of their wives; 55% of

Table 2. Characteristics of the respondents by the level of MHC utilization

Characteristics	Overall (n=5,312)	Highest (n=360)	Mid-high (n=805)	Mid-low (n=1,201)	Lowest (n=2,946)
Predisposing factors					
Age (yr)					
15–19	686 (12.9)	43 (12.0)	122 (15.2)	149 (12.4)	371 (12.6)
20–34	3,705 (69.8)	257 (71.4)	538 (66.8)	872 (72.6)	2,039 (69.2)
35–49	921 (17.3)	60 (16.6)	145 (18.0)	180 (15.0)	536 (18.2)
Educational attainment ^a					
No education	3,399 (64.0)	129 (35.8)	362 (45.0)	626 (52.1)	2,282 (77.5)
Primary	1,342 (25.3)	107 (29.8)	240 (29.9)	443 (36.9)	552 (18.7)
Secondary or higher	571 (10.8)	124 (34.4)	203 (25.2)	132 (11.0)	112 (3.8)
Religion ^a					
No religion	156 (2.9)	1 (0.2)	15 (1.8)	39 (3.3)	101 (3.4)
Muslim	2,834 (53.4)	149 (41.5)	355 (44.1)	442 (36.8)	1,887 (64.1)
Christian/Catholic	2,305 (43.4)	210 (58.3)	432 (53.7)	717 (59.7)	945 (32.1)
Animist	17 (0.3)	0 (0.0)	3 (0.3)	3 (0.2)	12 (0.4)
Ethnicity ^a					
Sara	1,510 (28.4)	138 (38.3)	292 (36.2)	472 (39.3)	608 (20.7)
Kanembou	476 (9.0)	20 (5.7)	41 (5.1)	72 (6.0)	342 (11.6)
Arab	565 (10.6)	43 (11.9)	91 (11.2)	82 (6.8)	350 (11.9)
Ouadai	421 (7.9)	19 (5.2)	47 (5.9)	39 (3.2)	316 (10.7)
Gorane	279 (5.3)	12 (3.3)	35 (4.4)	54 (4.5)	178 (6.1)
Other	2,061 (38.8)	128 (35.6)	299 (37.1)	484 (40.3)	1,151 (39.1)
Employment status ^a					
Not employed/housewife	2,592 (48.8)	174 (48.3)	386 (48.0)	486 (40.5)	1,546 (52.5)
Employed	2,720 (51.2)	186 (51.7)	418 (52.0)	716 (59.6)	1,400 (47.5)
Husband/partner's educational attainment ^a					
No education	2,903 (54.6)	85 (23.5)	283 (35.2)	494 (41.1)	2,041 (69.3)
Primary	1,163 (21.9)	102 (28.4)	193 (24.0)	340 (28.3)	528 (17.9)
Secondary or higher	1,247 (23.5)	173 (48.1)	329 (40.8)	368 (30.6)	377 (12.8)
Husband/partner's occupation ^a					
Other	1,926 (36.3)	228 (63.4)	458 (56.9)	447 (37.2)	793 (26.9)
Agriculture	3,386 (63.7)	132 (36.7)	347 (43.1)	754 (62.8)	2,153 (73.1)
Marriage type ^a					
Monogamy	3,495 (65.8)	269 (74.7)	546 (67.8)	809 (67.4)	1,871 (63.5)
Polygamy	1,817 (34.2)	91 (25.3)	259 (32.2)	392 (32.6)	1,075 (36.5)
Access to media ^a					
No	3,873 (72.9)	140 (39.0)	391 (48.6)	828 (68.9)	2,513 (85.3)
Yes	1,439 (27.1)	219 (61.0)	413 (51.4)	373 (31.1)	433 (14.7)
Current use of contraceptives ^a					
No	5,045 (95.0)	299 (83.1)	726 (90.2)	1,151 (95.8)	2,869 (97.4)
Yes	267 (5.0)	61 (16.9)	79 (9.8)	50 (4.2)	77 (2.6)
Age at first marriage/cohabitation ^a					
< 15 years	1,634 (30.8)	98 (27.2)	214 (26.6)	379 (31.5)	944 (32.0)
15–17 years	2,349 (44.2)	141 (39.3)	349 (43.3)	541 (45.0)	1,318 (44.7)
18+ years	1,328 (25.0)	120 (33.5)	242 (30.1)	282 (23.4)	684 (23.2)
Level of women's autonomy ^a					
Low	2,139 (40.3)	116 (32.2)	295 (36.7)	413 (34.4)	1,315 (44.6)
Moderate	2,363 (44.5)	178 (49.5)	348 (43.2)	597 (49.7)	1,240 (42.1)
High	810 (15.3)	66 (18.4)	162 (20.1)	191 (15.9)	391 (13.3)
Enabling factors					
Wealth index ^a					
Poorest	1,080 (20.3)	31 (8.5)	110 (13.6)	245 (20.4)	694 (23.6)
Poorer	1,206 (22.7)	58 (16.2)	130 (16.1)	270 (22.4)	748 (25.4)
Middle	1,130 (21.3)	43 (12.1)	126 (15.7)	292 (24.3)	668 (22.7)
Richer	1,066 (20.1)	60 (16.7)	124 (15.4)	231 (19.2)	651 (22.1)
Richest	830 (15.6)	167 (46.5)	315 (39.2)	164 (13.7)	184 (6.2)

(continued to the next page)

Table 2. (Continued) Characteristics of the respondents by the level of MHC utilization

Characteristics	Overall (n=5,312)	Highest (n=360)	Mid-high (n=805)	Mid-low (n=1,201)	Lowest (n=2,946)
Region ^a					
Batha	229 (4.3)	5 (1.4)	9 (1.2)	22 (1.8)	193 (6.6)
Borkou, Tibesti	23 (0.4)	1 (0.3)	2 (0.3)	3 (0.3)	16 (0.6)
Chari Baguirmi	258 (4.9)	7 (1.8)	20 (2.5)	24 (2.0)	207 (7.0)
Guéra	341 (6.4)	22 (6.1)	39 (4.9)	70 (5.8)	209 (7.1)
Hadjer-Lamis	389 (7.3)	22 (6.0)	17 (2.2)	85 (7.1)	265 (9.0)
Kanem	186 (3.5)	1 (0.3)	9 (1.1)	38 (3.1)	139 (4.7)
Lac	242 (4.6)	3 (0.9)	9 (1.2)	28 (2.3)	202 (6.9)
Logone Occidental	342 (6.5)	43 (11.9)	62 (7.7)	102 (8.5)	135 (4.6)
Logone Oriental	524 (9.9)	43 (12.0)	80 (9.9)	190 (15.8)	211 (7.2)
Mandoul	348 (6.6)	18 (4.9)	96 (11.9)	83 (6.9)	152 (5.2)
Mayo Kebbi Est	390 (7.3)	19 (5.3)	60 (7.5)	116 (9.7)	193 (6.6)
Mayo Kebbi Ouest	333 (6.3)	25 (7.1)	63 (7.9)	96 (8.0)	149 (5.1)
Moyen Chari	261 (4.9)	22 (6.1)	38 (4.7)	72 (6.0)	129 (4.4)
Ouaddaï	297 (5.6)	7 (2.0)	32 (4.0)	32 (2.7)	225 (7.6)
Salamat	103 (1.9)	8 (2.4)	9 (1.1)	14 (1.2)	72 (2.4)
Tandjilé	396 (7.5)	40 (11.2)	59 (7.3)	124 (10.3)	173 (5.9)
Wadi Fira	134 (2.5)	2 (0.6)	6 (0.7)	14 (1.2)	111 (3.8)
N'Djaména	338 (6.4)	65 (18.1)	174 (21.7)	54 (4.5)	45 (1.5)
Barh El Gazal	59 (1.1)	0 (0.1)	3 (0.4)	15 (1.2)	40 (1.4)
Ennedi Est, Ennedi Ouest	20 (0.4)	1 (0.2)	2 (0.2)	3 (0.2)	15 (0.5)
Sila	100 (1.9)	5 (1.4)	16 (2.0)	16 (1.3)	64 (2.2)
Type of place of residence ^a					
Rural	4,350 (81.9)	180 (50.1)	458 (56.9)	1,009 (84.0)	2,703 (91.8)
Urban	962 (18.1)	180 (49.9)	347 (43.1)	192 (16.0)	243 (8.3)
Need factor					
Desire for pregnancy ^a					
Unwanted/mistimed	700 (13.2)	61 (16.9)	145 (18.0)	140 (11.6)	354 (12.0)
Wanted	4,612 (86.8)	299 (83.1)	660 (82.0)	1,062 (88.4)	2,591 (88.0)

Values are presented as number (%).

MHC = maternal health care.

^a $P < 0.01$, These P -values show the results of χ^2 tests, indicating whether each explanatory variable has a statistically significant association with the level of MHC utilization.

the husbands or partners had no education in their life whilst about one fourth received at least secondary level of education. The vast majority (82%) of the respondents were residing in rural areas. About half (51%) of the women were employed, and the rest was either unemployed or housewife. Access to media was highly limited in general; only 27% of the women had some access to newspaper/magazine, radio and/or television. Early marriage was very common; 3 quarters of women (75%) reported that their age at first marriage/cohabitation was under 18. One third of marriages (34%) were polygamous. About 40% of all respondents had a low level of autonomy, indicating that they were never involved in making decisions on their own health care, large household purchases, or visits to family. In the meantime, the proportion of women who always participated solely or jointly in all the 3 decisions was only 15% (high level of autonomy).

Regarding the distribution of the level of MHC utilization, it is notable that the proportion of women who receive 'adequate' MHC services (namely the proportion of women who belong to the 'highest' category, defined by the combination of 4 or more ANC visits, facility delivery and first PNC within 2 days of birth), was only 7%. The percentages of women who belong to the 'mid-high', 'mid-low', and 'lowest' levels were 15%, 23%, and 55%, respectively (Fig. 3). This suggests that the insufficient use of essential care services during the perinatal period is very common among women in Chad.

Fig. 3. Distribution of MHC utilization levels among women in Chad.

ANC = antenatal care; PNC = postnatal care; MHC = maternal health care.

It is also noteworthy that the distribution of the respondents' characteristics by the level of MHC utilization was often disproportionate. For example, the proportion of women with no education was the highest (78%) in the lowest group and vice versa. Also, the percentage of respondents with no access to media varied across the level of MHC utilization; it was 85% among the women in the lowest level but was 39% in the groups of women who belong to the highest level. Another example is that, while a very small portion of women (5%) were using contraceptives, the rate in the highest level (17%) was much higher than the average.

The results of χ^2 tests show that all independent factors, except maternal age, have a statistically significant association with the outcome variable (Table 2).

Factors associated with the level of MHC utilization: results of a multivariate ordered logistic regression analysis

Table 3 provides the results of the multivariate ordered logistic regression analysis for identifying factors that might influence the utilization of MHC services in Chad. Key findings of the analysis are as follows:

Firstly, many of the predisposing factors included in the conceptual framework showed a significant association with MHC utilization. Particularly, respondents' education level, husband/partners' educational attainment and occupation, marriage status, access to media, and current use of contraceptives were all found to be statistically significantly ($P < 0.01$) associated with the level of MHC utilization. Specifically, the higher the women's educational attainment, the greater the effect of education observed. Mothers with at least primary education are more likely to pursue the higher level of MHC utilization than those with no education background. Women's age, religion and ethnicity were not found to be significantly associated with the level of utilization of MHC services. Also, no significant association was identified between women's employment status and their utilization of MHC. Compared to women who married or cohabitated with uneducated partners, those living with educated men were more likely to show higher level of MHC utilization. Similarly, husbands' or partners' occupations were found to be influencing factors; women whose husbands are engaged in the agricultural sector were less likely to seek MHC services than women whose husbands have occupations of higher earnings. Polygamous marriage also showed a strong association; women involved in polygamy tended to have a lower level of MHC utilization than those in monogamy. Moreover, women who are exposed to media at any degree appeared to pursue a higher level of MHC utilization, compared to those with no access to

Table 3. Results of multivariate ordered logistic regression presented with AOR and 95% CI

Characteristics	Lowest vs. mid-low, mid-high, highest	Lowest, mid-low vs. mid-high, highest ^c	Lowest, mid-low, mid-high vs. highest ^c
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Predisposing factors			
Age (ref. 15–19 yr)			
20–34	1.01 (0.80–1.27)	0.79 (0.58–1.08)	0.99 (0.70–1.41)
35–49	1.16 (0.89–1.51)		
Educational attainment (ref. no education)			
Primary	1.33 (1.10–1.60) ^b		
Secondary or higher	2.10 (1.58–2.79) ^b		
Religion (ref. no religion)			
Muslim	1.54 (0.85–2.79)		
Christian/Catholic	1.57 (0.92–2.70)		
Animist	0.80 (0.20–3.30)	1.15 (0.13–10.04)	0.00 (0.00–0.00)
Ethnicity (ref. Sara)			
Kanembou	1.02 (0.57–1.83)		
Arab	0.87 (0.52–1.43)	1.49 (0.87–2.53)	1.21 (0.67–2.20)
Ouadai	0.52 (0.29–0.95) ^a	1.08 (0.59–2.00)	1.03 (0.48–2.23)
Gorane	1.46 (0.73–2.92)		
Other	0.87 (0.57–1.33)		
Employment status (ref. not employed/housewife)			
Employed	1.16 (0.96–1.39)		
Husband/partner's educational attainment (ref. no education)			
Primary	1.68 (1.34–2.09) ^b		
Secondary or higher	1.63 (1.30–2.03) ^b		
Husband/partner's occupation (ref. other)			
Agriculture	0.61 (0.51–0.74) ^b		
Marriage type (ref. monogamy)			
Polygamy	0.81 (0.70–0.95) ^b		
Access to media (ref. No.)			
Yes	1.65 (1.32–2.08) ^b		
Current use of contraceptives (ref. No.)			
Yes	1.35 (0.92–1.99)	2.06 (1.48–2.86) ^b	2.59 (1.51–4.44) ^b
Age at first marriage/cohabitation (ref. < 15 years)			
15–17 years	0.95 (0.78–1.15)		
18+ years	1.03 (0.83–1.29)		
Level of women's autonomy (ref. low)			
Moderate	1.04 (0.89–1.23)		
High	1.11 (0.87–1.41)		
Enabling factors			
Wealth index (ref. poorest)			
Poorer	1.21 (0.97–1.52)		
Middle	1.39 (1.14–1.70) ^b		
Richer	1.51 (1.17–1.95) ^b		
Richest	2.33 (1.68–3.23) ^b		
Region (ref. Batha)			
Borkou, Tibesti	0.55 (0.20–1.48)		
Chari Baguirmi	1.20 (0.52–2.73)	2.22 (0.93–5.30)	2.24 (0.76–6.61)
Guéra	1.96 (0.89–4.34)		
Hadjer-Lamis	1.96 (0.78–4.90)	1.56 (0.63–3.87)	3.90 (1.20–12.69) ^a
Kanem	0.95 (0.39–2.31)		
Lac	0.84 (0.29–2.45)		
Logone Occidental	3.37 (1.48–7.71) ^b		
Logone Oriental	4.01 (1.81–8.90) ^b		
Mandoul	4.50 (1.89–10.68) ^b	7.37 (2.76–19.71) ^b	2.57 (0.76–8.71)
Mayo Kebbi Est	3.62 (1.65–7.95) ^b		
Mayo Kebbi Ouest	3.60 (1.45–8.90) ^b		
Moyen Chari	2.25 (0.94–5.38)		
Ouaddaï	2.05 (0.83–5.04)		

(continued to the next page)

Table 3. (Continued) Results of multivariate ordered logistic regression presented with AOR and 95% CI

Characteristics	Lowest vs. mid-low, mid-high, highest	Lowest, mid-low vs. mid-high, highest ^c	Lowest, mid-low, mid-high vs. highest ^c
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Salamat	1.76 (0.70–4.41)	2.55 (1.13–5.71) ^a	4.60 (2.02–10.48) ^b
Tandjilé	3.53 (1.53–8.15) ^b		
Wadi Fira	1.26 (0.56–2.83)		
N'Djaména	3.02 (1.25–7.32) ^a	4.24 (1.86–9.69) ^b	1.55 (0.69–3.47)
Barh El Gazal	1.01 (0.39–2.60)		
Ennedi Est, Ennedi Ouest	0.69 (0.26–1.79)		
Sila	3.82 (1.59–9.14) ^b		
Type of place of residence (ref. rural)			
Urban	2.22 (1.58–3.12) ^b		
Need factor			
Desire for pregnancy (ref. unwanted/mistimed)			
Wanted	1.21 (0.96–1.53)		

AOR = adjusted odds ratio; CI = confidence interval.

^a $P < 0.05$; ^b $P < 0.01$; ^cIn the present study, a multivariate ordered logistic regression was fitted based on the partial proportional odds model. The third and fourth columns present additionally calculated AORs for some variables that do not meet the proportional odds assumption.

media. Women who are currently using contraceptives were more likely to report a higher level of utilization of MHC services. On the other hand, age at first marriage/cohabitation and level of women's autonomy were not found to be a significant predictor. Secondly, all the enabling factors were found to have a significant association with the level of MHC utilization. The effect of household wealth was significantly strong; women from higher quintiles of wealth were more likely to display a higher level of MHC utilization than those from poor households. Amongst the regions, Logone Occidental, Logone Oriental, Mandoul, Mayo Kebbi Est, Mayo Kebbi Ouest, Salamat, Tandjilé, N'Djaména, and Sila were significantly associated with the level of MHC utilization. It was verified that women living in these regions, which are all situated in the southern part of the country, tend to show a relatively higher level of utilization of MHC services. Type of place of residence also appeared to have a strong influence. Mothers residing in rural areas were less likely to exhibit a higher level of MHC utilization than urban dwellers. Finally, the sole need factor, desire for pregnancy, did not show a significant association with the outcome variable.

DISCUSSION

Our study attempted to explore factors that may affect the level of MHC utilization among Chadian women, using the most recent, nationally representative DHS data. Building upon previous studies, we developed an adaptive composite measure that might better reflect the level of utilization in less-developed countries. The findings of our study provide useful information on the current status of MHC in the country, filling the knowledge gap in the literature. According to the results of our analysis, the level of MHC utilization in Chad is far from the WHO's minimum recommendations. Only a very marginalized portion (7%) of women were found to have at least 4 ANC visits, deliver at facilities, and make their first PNC visit within 2 days of childbirth, positioned in the “highest” level as per the definition in the study. Other similar researches provide comparable results in that 19% of rural women in Tanzania were counted as the highest level of MCH utilization.⁹ Islam and Masud¹³ also found that about 18% of mothers in Bangladesh benefitted from 4 or more ANC visits, facility deliveries, and at least 1 PNC contact. This clearly indicates that the Chadian government should make their utmost efforts to increase the level of access and utilization of maternal care services throughout the country, by prioritizing MHC in their policy formation,

implementation and supervision until their national commitments and targets for maternal health to be realized.

In this sense, our study has several policy implications. First, the results of the multivariate regression analysis confirmed that an educated mother is more likely to use the higher level of MHC utilization compared to a mother with no education, being consistent with previous studies.^{13,18} Specifically, the odds of utilizing a higher level of utilization are 1.33 times and 2.1 times greater among women with primary and at least secondary education respectively, than uneducated women. The education level of male spouses also has a significant effect on women's service utilization. Compared to women having partners with no education, women whose partners attained at least primary education are around 1.6 times more likely to benefit from the higher level of MHC utilization, also in agreement with the results of the existing literatures.^{13,15} These findings highlight the role of national education system in promoting more utilization of MHC and other health services. In other words, strengthening the formal educational sector in Chad could be a reasonable approach to enhancing the quality of life among the general population, due to better health conditions through the appropriate use of the needed care and treatment. Considering the substantial time and resources required for this to be happening, informal education such as literacy programs could be designed and delivered to women and their husbands in the meantime, especially for under-privileged areas where formal educational opportunities are scarce and more discriminatory.

Second, our results show that type of marriage (i.e., polygamy vs. monogamy) and use of contraceptives have significant associations with the level of MHC utilization. For example, women having a polygamous marriage are about 20% less likely to show a higher level of utilization than women who are married or cohabitated only 1 partner. A study from Gambia shows that women in polygamous unions have much trouble in receiving the timely care due to their lack of money to pay for medical and transport expenses, which are not likely to be supported by their polygamous partners.²⁹ Our study also found that the use of contraceptives increases the chance of pursuing a higher level of utilization of MHC services in Chad. Using contraceptive methods, on the other hand, could imply that women have some knowledge of family planning and other primary care services. By bringing these 2 elements together, health education or campaigns underscoring the importance of MHC targeting both sexes will likely be an effective strategy for improving the health of mothers through the increased level of MHC utilization. Such health promotion interventions might affect men's perceptions about maternal and women's health needs and motivate them to support their wives' access to utilization of essential care during pregnancy, delivery and postpartum period. Male champions of change could be selected within communities to work as an influencer and peer educator for other husbands, especially for those in polygamous relationships. This will in turn create an enabling environment for women to visit health services with less hurdles and to benefit from necessary health care services without delay. Furthermore, all these efforts for raising awareness could be facilitated by the existing community health volunteers who are invaluable resources already put in place. Their knowledge and skills will also help mothers seek for basic care services and counseling more easily at the community level.

Third, respondents who have some access to media such as newspaper/magazine, radio and/or television are 1.65 times more likely to have a higher level of MHC utilization than women lacking access to any media, as reported in the previous studies.^{13,15,17} This implies that increasing access to media among women and general populations has potential to be

another effective strategy for encouraging more utilization of MHC services in Chad. That is, campaigns through mass-media to convey key information on maternal health and family planning in accordance with other health programs, will contribute to raising awareness on the importance and necessity of the use of essential maternal health services by all women in the country.

Next, our study also identifies a high level of inequalities in the level of MHC utilization by place of residence (i.e., urban vs. rural). Women living in urban areas are 2.22 times more likely to practice a higher level of MHC utilization than rural residents. This warrants the need for attention to urban-rural disparities as well in developing future policies or programs for improving maternal health in Chad. Overall, our study emphasizes that future maternal health programs must involve women with lower socioeconomic status from less developed areas even within the country, while the government strives to improve the country's socioeconomic status in the longer term. As short-term solutions, technical education, vocational training, income-generation as well as other capacity building interventions could be arranged and implemented for increasing household's ability to pay for the service fees and transportation expenses to be incurred when visiting health facilities. These programs might also work as one of the key contributors to improving the average income of households as well as the health status of women and other family members in the future.

Summing up all the above implications, our study provides insights into future efforts to address the severe maternal disease burden in Chad. The government of Chad has set up an agenda to achieve the reduction of MMR to 500 per 100,000 live births by 2030.³⁰ This effort will likely be highly challenging, however, given the limited health financing and infrastructures available in the country.

Whilst making progress in reinforcing the overall health system in Chad, in the short term, it might help to promote maternal health activities, involving both women and men, at the community level, in order to raise awareness for both women and men on the timing of care, danger and labor signs, ways for self-care and family planning, immediate postpartum problems and basic newborn care. Home visits could be implemented regularly by community health volunteers and sometimes with nurses in order to allow the least privileged women to receive the minimum care services while pregnant or a short time after childbirth. Furthermore, social mobilization events celebrating international occasions such as World Health Day could be organized in underserved areas and facilitated as a platform to deliver health education and mobile health services such as ANC counseling, maternal and child immunizations, HIV/AIDS testing, deworming and provision of vitamin supplements.

Lastly, our study also highlights area of future study. It would be necessary to conduct further studies that incorporate health system and service delivery factors beyond individual-level factors (e.g., accessibility to health facilities, availability of maternal services, and staff and quality of care) into the analytic framework so that more comprehensive understanding of determinants affecting the level of MHC utilization will be sought and thereby provide better insights into the design of health policies and interventions targeting for mothers in Chad.

Our study has several limitations. First, due to the nature of questionnaire method employed by DHS, the survey entirely depended on self-reported responses. For this reason, recall bias may have been introduced to some extent, meaning that data might not perfectly describe the reality of women's utilization of MHC services. Second, women who had already died during

the pregnancy or childbirth were not possibly included in the study due to the retrospective nature of the data collection method. Third, although the country's health system might also do an important role in determining the level of MHC utilization, this aspect was not able to be incorporated since DHS in general lacks system-related variables, such as distance from home to facility, availability of equipment and skilled personnel, and quality of care. This limitation might have led to misspecification to some extent. To partially overcome this limitation, future research might consider combining information related to the health system from other data sources at the community and/or regional level. Lastly, due to the cross-sectional nature of our study design and the dataset, our findings cannot provide information on causality or complex relationships among variables that are found to be associated with MHC utilization. Further studies with a more advanced study design might help reveal causality or mediation/moderation effects. Qualitative approaches also could help obtain a deeper understanding of women's perceptions, behaviors and knowledge related to the utilization of MHC services in Chad.

Despite the limitations, our study has strengths and significance in that it has applied a more comprehensive measure of MHC utilization that collectively considers access to prenatal, perinatal, and postnatal care, rather than indicators solely focused on ANC or facility delivery, in examining factors influencing the level of MHC utilization in Chad. To our knowledge, this study is the first to examine factors associated with the level of MHC utilization in Chad, using a composite measure for MHC services at different stages of childbearing. The findings of our study could help develop public health programs or policies aiming to increase the coverage of effective maternal care throughout all stages of maternal care and thereby address the issues of maternal morbidity and mortality in Chad.

In conclusion, through the application of a composite outcome variable measuring the level of MHC utilization, our study has identified significant predictors associated with the utilization of essential care services in Chad from the perspective of the continuum of care. Women's education, husband/partners' educational attainment and occupation, marriage type, access to media, current use of contraceptives, household wealth and place of residence were found to have significant association with the degree to which mothers took advantage of available maternal services during prenatal, labor and postnatal periods.

Overall our study suggests that it is imperative to promote the overall utilization of MHC services in Chad to address such high maternal mortality burden in the country. In the short term, efforts for promoting maternal health activities at the community level that involve both women and men might be effective in addressing the maternal health problem. In a longer-term, future maternal health programs would need to more proactively involve women from lower socioeconomic status and less developed areas to tackle within-country health inequalities, while the government strives to improve the country's overall socioeconomic status and health infrastructure.

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