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Title

Determinants of the quality of childbirth care along the continuum in limited resource settings: a structural equation modeling analysis of cross-sectional data from Burkina Faso and Côte d'Ivoire.

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Abstract

Introduction: Despite important increase in in-facility births, perinatal mortality rates have remained high and slow to decrease in many developing countries. This situation is attributed to the poor quality of childbirth care. The reason why women delivering in health facilities do not always receive standards of care are unclear. We assessed the determinants of the quality of childbirth care along the continuum of care using different approaches.

Methods: A health facility-based cross-sectional study with a direct observation of health care workers' practices while caring for mother-newborn pairs was carried out in Burkina Faso and Côte d'Ivoire. The performance of a set of Essential Best Practices (EBPs) was assessed in each birth event at admission, pre-pushing and immediate post-partum stages. A quality score, in the form of the additive sum of EBPs effectively delivered was computed for each stage. We used negative binomial regression models and a structural equation modeling analysis to respectively assess the determinants of the quality of care at each stage and the relationships between the quality delivered at the different stages.

Results: a total of 532 and 627 mother-newborn pairs were included respectively in Burkina Faso and Côte d'Ivoire. In both countries, the quality of delivery care varies significantly at all stages between health districts. The quality of predelivery care was consistently higher in referral hospitals as compared to primary health care facilities (IRR=1.02; $p<0.05$ and IRR=1.10; $p<0.05$ respectively for Burkina Faso and Côte d'Ivoire). The quality at admission was poorer in nurses as compared to midwives in Burkina Faso (IRR=0.81; $p<0.001$). The quality at admission and pre-delivery stages were positively correlated with the immediate post-partum quality ($\beta=0.48$; $p<0.001$ and $\beta=0.29$; $p<0.001$ respectively).

Conclusion: Quality improvement strategies must target both providers and health facilities and different inputs are needed depending on the stage in the continuum of care.

Key words: continuum of childbirth, quality of care, Burkina Faso, Côte d'Ivoire

Background

Timely utilization of health facilities for childbirth services has been strongly advocated for through the past two decades in low- and middle-income countries (LMIC)[1,2] where maternal and newborn death tolls remain unacceptably high despite recent improvements. This is because non-access or delay in access to proven and well-recognized effective interventions needed to prevent or adequately manage obstetrics complications were identified as major contributing factors to poor childbirth outcomes[3,4]. The promotion of institutional childbirths as a strategy to reduce poor maternal and newborn childbirth outcomes relies on the postulate that such interventions are readily available in health facilities and would be effectively deliver condition on the utilization of health care services. Health facility utilization alone, however, has proved not enough[5–7]. The quality of the care received by the dyad mother and newborn during the course of childbirth in the health facilities is also crucial and as facility utilization is rising, it is gradually being recognized as a missing link in the path towards ending preventable maternal and child deaths in LMIC where the quality of care is reputed most often suboptimal[8,9]. In-facility morbidity and mortality outcomes depend heavily on the quality of health care received by services users as it conditions the effective delivery of the interventions that meet their health needs[10]. The quality of childbirth health care services does not only improve the medical outcomes of childbirth but is also a key factor for improving and maintaining an optimal level of services utilization. Indeed, previous studies in sub-Saharan Africa (SSA) have reported that women future decisions on whether to use or not health facilities for delivery depend on their previous use experience[11,12]. Those that were not satisfied with the services received are less likely to sustain their services utilization[13]. Because access alone is no longer sufficient, access to quality essential health services by 2030 is one of the targets (SDG target 3.8) of the United

93 Nations' (UN) Sustainable Development Goal 3 (SDG 3) that aims at promoting measures to
94 ensure healthy lives and well-being for all at all ages[14]. The quality of care is complex and
95 encompasses various approaches and dimensions including structure, process and outcomes,
96 each of which requires equal attention in the efforts to improve the quality[15]. The World
97 Health Organization (WHO) defines the quality of care as "the extent to which healthcare
98 services provided to individuals and patient populations improve desired health outcomes. In
99 order to achieve this, health care needs to be safe, effective, timely, efficient, equitable, and
100 people-centered"[16]. Stemming from this definition is the need to account for both clinical
101 and non-clinical indicators when assessing the quality of care. Structural aspects of the quality
102 and health care outcomes including fatalities and users' satisfaction are frequently used to
103 assess the quality of maternity care in SSA[17,18]. Process indicators may however more
104 reflect the quality of the care received and provide more information on areas needing
105 improvement[19]. A list of process indicators , suitable for assessing the quality of maternity
106 care in SSA and that combine the measurement of both clinical and non-clinical actions, was
107 recently published[20]. Previous studies using these indicators have reported sub-optimal
108 quality of delivery care[21,22]. While the scarcity of resources is a known obstacle to the
109 delivery of high-cost interventions, it does not always fully explain the non-provision of low
110 cost, yet effective interventions. There is a need for further understanding of the factors that
111 favor or hamper the delivery of low cost and easy to perform interventions during the course
112 of childbirth to inform quality improvement strategies. Previous studies have too-often
113 investigated the quality of Emergency obstetric and Newborn Care (EmONC) only or the
114 quality of EmONC and routine care at a specific point (intrapartum or immediate postpartum
115 only) during the course of childbirth [27,28,31]and seldomly investigated the quality of
116 routine care along the continuum of care[21,26]. In this study we investigated the

determinants of the quality of childbirth care using different approaches. The quality of delivery care was assessed using quality indicators that assess the performance of basic clinical and non-clinical actions that are expected at specific points in time (admission, pre-delivery and soon after delivery) during the course of childbirth and the results were reported elsewhere[22]. Here we report on the determinants of the quality of care using typical regression methods along with a structural equation modeling analysis. The later method allows us among other advantages to account for the specificities of the indicators used to measure the quality of care at each point instead of treating them as all equal in weight and to further explore the relationships along the continuum of care where the quality at a later stage may depend on the quality received at previous stages.

Methods

Data

The study was conducted in selected health regions of Burkina Faso and Côte d'Ivoire (one in each country) where the research teams have locations and could easily conduct the field activities. Both regions (Central-North in Burkina Faso and Agnéby-Tiassa-Mé in Côte d'Ivoire) have their capital cities located approximately 100 km away from the respective country capital cities and have similar healthcare delivery systems with on top one regional hospital, followed by district hospitals (six in Burkina and seven in Côte d'Ivoire), each serving a health district comprised of several primary healthcare facilities (PHCFs). A facility based cross-sectional study consisting in the direct observation of childbirth practices was conducted in a sample of PHCFs and referral hospitals (regional or district hospital) in each country. We first randomly selected five health districts. The district hospitals of the selected health districts

141 along with the regional hospital were systematically included in the study in each country. In
142 the catchment area of each selected health district, up to 15 eligible PHCFs were randomly
143 selected to be included in the study. Eligible PHCFs were those with a minimum average
144 caseload of 1.5 childbirths per day as reported in the health records of the same period in the
145 previous year (during the last quarter of 2017). Details on the sample size calculation were
146 reported elsewhere[22]. In these health facilities, data collectors of medical background
147 (medical students and midwives) and who had undergone a two-day training including in
148 study-room role plays and a field testing of the study tools, were appointed in the delivery
149 room to directly observe and document healthcare providers' adherence to a set of signal
150 functions while caring for pregnant women and their future newborns at four critical points:
151 admission, before the woman starts pushing (pre-delivery), immediately post-partum (soon
152 after delivery up to ≤ 1 h), and before discharge from the health facility. Data of the first three
153 pause-points are reported in the current study. Health care providers who were in their
154 qualifying internship period in the health facility were excluded from the observations.
155 Pregnant women aged <18 years and those admitted at an advanced stage of the labour (third
156 stage) with frequent (≤ 5 -min apart) and intense uterine contractions that would prevent them
157 from providing valid informed consent were also excluded from the study. The data collection
158 took place from 12 November to 20 December 2018 and lasted for up to five days in each
159 health facility. Observations were conducted every day of the week and at any time without
160 discontinuation, provided an eligible pregnant woman was present in the delivery room. A
161 data collector could observe all or part of the pause-points for each birth event. However,
162 data pertaining to the same critical juncture were fully collected by the same data collector.
163 Thus, once a data collector had initiated the observation for a given pause-point, he/she could
164 get off work only after having filled in all the items pertaining to that pause point.

Measures

Quality indicators

The quality of delivery care was assessed using a set of 30 signal functions and tracers derived from the WHO Safe Childbirth Check-list (WHO-SCC) [23] complemented through a review of a list of validated and recommended signal functions for SSA[20]. A total of twelve (12) quality indicators (Yes/No) were assessed in each childbirth event at the admission and initial examination stage: the provider washes his/her hands before examination, the provider wears sterile gloves before vaginal examination, the provider asks for historic of vaginal bleedings during the pregnancy, the provider asks for historic of vision blurred, the provider checks the woman HIV status or performs an HIV test where missing, the provider measures the woman blood pressure, the provider takes the woman pulse, the provider measures the temperature, the provider uses a partograph to monitor the labor where indicated, the provider assesses the woman for need of referral to higher level of care, the provider encourages the companion/husband to assist to the childbirth and the provider informs husband/companion to call in case a complication occurs. Eight similar Yes/No indicators were assessed at the pre-delivery stage (before pushing): sterile gloves readily available, soap and clean water are readily available, providers prepares a prefilled syringe with uterotonics for Active Management of the Third Stage of Labor (AMTSL), clean towel is readily available, sterile blade or scissor is readily available, provider prepares a face mask for neonatal resuscitation, the provider has a suction device readily available, and an assistant birth attendant was identified and ready to intervene if needed.

At the third pause-point, the performance of the following ten (10) signal functions (Yes/No) was assessed: the provider correctly clamps or ties the cord, the provider immediately dries the newborn with clean towel, the provider assesses the mother for vaginal and perineal

lacerations, the provider assesses the placenta for completeness, the provider takes the mother vital signs (blood pressure, pulse) within 15 min of the delivery, the providers palpates the uterus within 15 min of the delivery, the mother is encouraged to initiate breastfeeding within 1 hour of the delivery, the skin-to-skin contact is initiated within 1 hour of the delivery and the providers informs companion and or woman to call in case of complications.

Determinants of the quality of care

Quality determinants were categorized into three groups: user, provider and health facility characteristics. Data was collected on the following user's characteristics: maternal age, maternal educational level (none, primary and secondary/tertiary), the number of ever pregnancies that the woman has had in her entire reproductive life and the attendance of at least of four Antenatal Care (ANC) visits during the pregnancy. The cut-off of four ANC visits was used because this was in line with the recommendations per official guidelines in both countries at the time of the data collection. provider's characteristics included the qualification of the health care worker that attends to the childbirth event (midwives, nurses or other auxiliary staffs), the age and gender of the provider, and his total number of years of working experience. Other auxiliary staffs include nurse and midwife' assistants and were found only in Burkina Faso. The following health facility's characteristics were included in the study: facility type (primary health care facility versus referral hospital), the availability of clean running water, the availability of electricity, the health district it belongs to, and the residential location of the health facility (rural versus urban).

Statistical analyses

212 We performed three series of analyses. In the descriptive statistics we used proportions and
213 means plus standard deviations to respectively describe qualitative and quantitative variables.
214 Univariate analysis included the use of chi2 test or the independent t-test to compare
215 proportions and means. In the second phase, we carried out negative binomial regressions to
216 identify the determinants of the quality of delivery care for each of the three pause-points and
217 per country. The dependent variable for the negative binomial regression models was a quality
218 score that resulted from the additive combination of the dichotomized quality indicators
219 pertaining to each stage. This quality score had a maximum of 12, 8 and 10 for respectively
220 the admission, pre-delivery and soon after delivery phases. The minimum score being 0 for all
221 stages. The negative binomial regression model was preferred to Poisson regression because
222 of its robustness to overdispersion. The analyses performed at this stage were based on
223 complete case analysis. A missing data category was however included in the models of Côte
224 d'Ivoire for the variable maternal education that had 13% of missingness. In the third set of
225 analyses, we used the structural equation modeling (SEM) technique to identify in addition to
226 the determinants of the quality of care, the interrelationships between quality of care in the
227 different phases along the continuum of care. Our model for the continuum of childbirth care
228 includes the three critical points in childbirth care: Initial examination (Admission), Before the
229 woman starts pushing for delivery (Before pushing) and the immediate postpartum (Soon
230 after birth). The quality at each of these points might have been influenced by both health
231 facility and provider's characteristics. The quality at a given stage is also susceptible of having
232 been influenced by the quality at early stages. The SEM technique allows the assessment of
233 the latent variables corresponding to the quality of care at each stage using the observed
234 dichotomized indicators (measurement component of the model) and the effects of the
235 quality at an earlier phase to the quality at a later phase (structural component of the model).

Groups comparison of countries allowing the structural paths coefficients to vary did not show a significant difference between the two models and we finally retained a unique SEM model for both countries. Root Mean Square Error of approximation and Comparative Fit Index were used to check the overall fit of the final SEM model. The Root Mean Square Error of approximation (RMSEA) of 0.06 indicated a close to perfect goodness-of-fit. Traditionally, RMSEA below 0.08 shows a satisfactory fit and RMSEA below 0.05 is a perfect fit. Most of the observed indicators were significant at $p < 0.05$. [24]. All the analyses were performed using Stata 15.1 and significance was considered if $p < 0.05$. Because data were clustered within health facilities, we used robust standard errors.

Results

Background characteristics

A total of 532 and 627 pregnant women were included in the admission phase of the study respectively in Burkina Faso and Côte d'Ivoire. Once included in the study (pause-point I), a woman and thereafter her newborn were observed through the subsequent pause-points (II and III) unless they were referred to another health facility or transferred to a different service. The mean age of women was 25 years in Burkina and 26.5 years in Côte d'Ivoire ($p < 0.001$). The vast majority (87.63%) of the childbirth events were attended to by midwives in Côte d'Ivoire and that proportion mounts to just more than half (57.99%) in Burkina Faso ($p < 0.001$). The providers' mean years of working experience was greater in Côte d'Ivoire as compared to Burkina Faso. Details information of the characteristics of the women, providers and health facilities are presented in Table1.

Table 1: Backgrounds characteristics of study populations

		Burkina Faso n (%) N=532	Côte d'Ivoire n (%) N=627	P-value (Chi2 or t-test)
User's characteristics				
Maternal age: mean (sd)		25.08 (6.08)	26.47 (6.33)	<0.001
Maternal education				
	<i>None</i>	432 (85.48)	309 (53.26)	<0.001
	<i>Primary</i>	58 (8.78)	181 (26.26)	
	<i>Secondary/tertiary</i>	42 (5.74)	98 (13.16)	
	<i>Missing</i>	-	39 (7.31)	
Number of ever pregnancies: mean (sd)		1.10 (0.84)	1.17 (0.75)	0.147
Four ANC visits-Yes		309 (57.45)	328 (54.30)	0.402
Provider's characteristics				
Qualification				
	<i>Midwives</i>	347 (57.99)	575 (87.63)	<0.001
	<i>Nurses</i>	56 (13.36)	52 (12.37)	
	<i>Other auxiliary staffs</i>	129 (28.65)	-	
Gender				
	<i>Male</i>	154 (32.59)	42 (10.21)	<0.001
	<i>Female</i>	378 (67.41)	585 (89.79)	
Provider's age: mean (sd)		33.64(4.55)	37.57 (4.82)	<0.001
Years of working experience		4.32 (4.18)	6.32 (5.09)	<0.001
Facility's characteristics				
Urban location of the health facility		141 (9.97)	284 (29.14)	<0.001
Rural location of the health facility		391 (90.03)	343 (70.86)	<0.001
Facility has clean water (pipe)-Yes		291 (46.64)	420 (58.96)	0.001
Health districts				
	<i>Kaya/Agboville</i>	101 (20.59)	118 (21.86)	
	<i>Boulsa/Akoupé</i>	109 (20.59)	135 (10.99)	
	<i>Kongoussi/Tiassalé</i>	118 (22.05)	121 (21.86)	
	<i>Barsalogho/ALEPE</i>	102 (17.66)	120 (21.86)	
	<i>Tougouri/Adzopé</i>	102 (19.12)	133 (23.42)	

Negative binomial regression

Burkina Faso

The qualification of the provider along with his age and gender showed significant association in multivariable analysis with the quality of care at admission. After adjusting for other factors, nurses and auxiliary staffs had lesser quality rates (IRR=0.81 - 95% CI (0.72-0.90); $p<0.001$ and IRR=0.88 - 95%CI (0.80-0.96); $p<0.01$, respectively) at admission as compared to midwives. The quality at admission was also lesser in female provider (IRR=0.89 - 95%CI (0.82-0.96); $p<0.01$) and greater as the provider's age increases (IRR=1.01-95%CI (1.01-1.02); $p<0.01$). The Quality of pre-delivery showed association with facility's characteristics. Referral hospitals had higher quality of pre-delivery care (IRR=1.02 - 95%CI (1.01-1.18); $p<0.05$) and it was lower in rural health facilities (IRR=0.92-95%CI(0.86-0.99); $p<0.05$). The quality of immediate postpartum care was positively associated with the age of the provider (IRR=1.01 - 95%CI(1.00-1.02); $p<0.01$).

Côte d'Ivoire

There were important differences in quality of care at both stages between health districts. Referral hospitals had higher quality of pre-delivery care (IRR=1.10 – 95%CI(1.01-1.20); $p<0.05$) and lower quality of immediate postpartum care (IRR=0.84(0.77-0.93) as compared to primary health care facilities. Providers' years of working experience was positively correlated with the quality of immediate post-partum care (IRR=1.01 – 95%CI (1.00-1.02); $p<0.05$). The crude and adjusted incidence rate ratios of the quality of care at all three stages in both Burkina Faso and Côte d'Ivoire are presented in table 2.

Insert table 2 here

The figure 1 presents the standardized parameter estimates for quality of care at the three phases. Two indicators had strong loadings on the quality of care at the admission stage: the provider encourages the companion to assist to the delivery ($\beta = 0.62; p < 0.001$) and the provider measures the woman temperature ($\beta = 0.66; p < 0.001$). The indicators with higher loadings on the quality of pre-delivery care were the readily availability of a suction device ($\beta = 0.71; p < 0.001$) and the availability of a face mask for neonatal resuscitation ($\beta = 0.64; p < 0.001$). The two indicators with the higher loadings on the quality of care at the immediate postpartum stage were respectively the early initiation of skin-to-skin contact ($\beta = 0.77; p < 0.001$) and the early initiation of breastfeeding ($\beta = 0.66; p < 0.001$). The results of the measurement part of the SEM model are presented in table 3.

Table 3: standardized parameter estimates of the measurement indicators of the SEM model

Codes	Explanations (labels)	Standardized parameter estimate (Se)	t-value
Admission	Quality of initial assessment		
Wshd	Washes his/her hands before examination	0.42 (0.04)	11.56 ***
Vgbld	Asks for vaginal bleedings	0.47 (0.03)	13.64 ***
Vblur	Asks for vision blurred	0.40 (0.04)	11.22 ***
bldp	Measures blood pressure	0.25 (0.04)	6.85***
part	Uses partograph where indicated	0.52 (0.03)	15.68 ***
Temp	Takes temperature	0.66 (0.03)	18.69 ***
P_attd1	Companion encouraged to assist to childbirth	0.62 (0.05)	13.06 ***
P_call1	Informs companion/woman to call if complications	0.41 (0.03)	13.50 ***
Before_pushing	Before pushing or before caesarian section		
q75a	Sterile gloves readily available	0.08 (0.04)	2.38 **
q75c	Soap and clean water readily available	-0.16 (0.03)	-4.87 ***
q76b	Sterile blade or scissor readily available	0.26 (0.04)	7.52 ***
mask	Face mask readily available	0.64 (0.04)	14.82 ***
asp	Suction device readily available	0.71 (0.05)	14.94 ***
Soon_after_birth	Immediate postpartum (within one hour)		

q83r	Clamps or ties cord correctly	0.38 (0.03)	11.63 ***
q84r	Immediately dries the baby with clean towel	0.19 (0.04)	5.16 ***
placenta	Assesses for placenta completeness	0.40 (0.03)	13.09 ***
q90r	Takes mother vital signs within 15 minutes after	0.41 (0.06)	7.09 ***
q91r	Palpates uterus within 15 minutes after birth	0.60 (0.06)	10.83 ***
q95r	Initiates breastfeeding within 1 hour	0.66 (0.02)	26.16 ***
q96r	Skin-to-skin contact initiated within 1 hour	0.77 (0.02)	31.25 ***
q97r	Informs companion/woman to call if complications	0.14 (0.03)	4.62 ***
Provider Provider's indicators			
q53_b	Age of the provider	0.98 (0.00)	1144.20 ***
q53_c	Years of working experience of the provider	0.73 (0.01)	49.03 ***
attendant	Qualification of the provider	-0.07 (0.03)	-2.30 *
Facility Health facility indicators			
q3	Health district of the facility	0.94 (0.002)	375.30 ***
q7	The health facility has electricity	0.05 (0.03)	1.52
q10	Hands washing devices/facilities available	-0.27 (0.03)	-9.50 ***

301 *p<0.05. **p<0.01 ***p<0.001

302

303 The results of the structural part of the SEM model are presented in table 4. The structural

304 path relationship from facility characteristic latent (Facility) to initial examination latent

305 (Admission, ($\beta = -0.66; p < 0.001$)) and to pre-delivery care latent (Before_Pushing, ($\beta =$

306 $-0.73; p < 0.001$) are negative and statistically significant. On the other hand, the structural

307 path relationship from facility characteristic latent (Facility) to immediate post-partum latent

308 (Soon_after_birth, $\beta = 0.05; p = 0.55$) was positive and not statistically significant.

309 Concerning the structural path relationships from the provider latent, the path relationship to

310 initial examination latent (Admission, $\beta = 0.11; p < 0.001$) and to the to pre-delivery care

311 latent (Before_Pushing, ($\beta = -0.10; p < 0.01$) were significant. Along the continuum of

312 care, the quality of care at the admission (Admission, $\beta = 0.48; p < 0.001$) and pre-delivery

313 (Admission, $\beta = 0.29; p < 0.001$) stages have positive and statistically significant association

314 with the quality of care at immediate post-partum stage. The quality of care at initial

assessment, in contrast, had a negative and non-statistically significant association (Admission, $\beta = -0.07$; $p = 0.18$) with the quality of pre-delivery care.

Table 4: Standardized estimates of the paths relationships of the quality of care along the continuum.

	Standardized coefficient (std error)	t-value
PATHS		
Provider —> Admission	0.11 (0.04)	3.58 ***
Provider —> Before_pushing	-0.10 (0.04)	-2.89 **
Provider —> Soon_after_birth	0.05 (0.03)	1.40
Facility —> Admission	-0.66 (0.03)	-21.40 ***
Facility —> Before_pushing	-0.73 (0.06)	-11.70 ***
Facility —> Soon_after_birth	0.05 (0.09)	0.59
Admission —> Before_pushing	-0.07 (0.05)	-1.33
Admission —> Soon_after_birth	0.48 (0.06)	3.48 ***
Before_Pushing —> Soon_after_birth	0.29 (0.08)	4.58 ***

Discussion

All women and their newborns should receive adequate care during the intrapartum and immediate postpartum periods to avert perinatal mortality. With the increased recognition that health facility utilization for delivery does not always equate with the receipt of a quality care[9], there are increasing initiatives aiming to measure the quality of care received by the dyad mother and newborn during the course of in-facilities childbirths and its determinants[25–29]. Because the quality of care has several dimensions, studies have used different approaches and quality outcomes including facilities readiness, outcomes of care and users' satisfaction. More studies using process indicators are however still needed as they directly relate to the process of care and are more likely to provide insights into the areas needing improvement[19,30]. Because obstetric complications are unpredictable and will occur in a relative few proportion of women, the quality of routine care does matter. Routine

334 care is what is received by the vast majority of women and their newborns and its quality is
335 critical in preventing complications[32]. In this study we used a list of validated process
336 indicators for SSA to assess the determinants of the quality of routine care in two LMICs[20].
337 In our results, the quality of care at both stages tend to be lower for nurses and auxiliary staffs
338 as compared to midwives. The results were however not statistically significant in Côte
339 d'Ivoire. Similar results have been reported previously and may be the reflect of the
340 differences in midwifery skills between midwives and other cadre of health workers who are
341 not in first intention trained to provide childbirth care[21,28]. The results were not significant
342 in Côte d'Ivoire probably because of the distribution of the variable qualification of the
343 provider in our data (around 90% were midwives) that may have hampered the investigation
344 of its full effects on the quality of care. The quality of immediate postpartum care significantly
345 increases with provider's years of working experience in Côte d'Ivoire data. More experienced
346 health workers are also more likely to have benefited from quality improvement initiatives
347 (in-service trainings, supportive supervisions etc.) that have reinforced their skills and
348 competences[31]. Worthy of note were the results on the type of facility in our study. While
349 the quality of pre-delivery care was significantly higher in referral hospitals as compared to
350 primary health care facilities in both countries, there was either no difference in the quality of
351 initial assessment and immediate postpartum care, or the difference was in favor of primary
352 health care facilities (postpartum care in Côte d'Ivoire). The difference in performance at the
353 different stages between referral and primary health facilities is probably the reflect of the
354 difference between the inputs used to define quality care at different stages. Indeed, the
355 quality indicators at the pre-delivery stage are more focused on the readily availability for use
356 by the health care providers of childbirth consumables, while the indicators at the initial
357 examination and postpartum stages are rather more focused on the assessment of the actual

performance of clinical actions or the quality of inter-personal communication. The SEM analysis showed that while health facility's characteristics and provider's characteristics were significant predictors of the quality of care at both Admission and pre-pushing stages, they were not associated with the quality of immediate post-partum care which was positively correlated with both the quality at Admission and pre-pushing stages. In both countries, quality improvement strategies have recently put emphasis on training of maternity care providers. The strong and significant correlations between health facilities and the quality of childbirth care at admission and pre-delivery stages in our findings, underscore the importance of enabling environment to the quality of care and suggest that quality improvement interventions should not only target health care providers. The relationship between quality at pre-delivery stage and the quality of care at immediate postpartum stage was positive and significant as was reported in a previous similar study[21]. Despite the difference between the quality inputs for the different stages, these inputs are provided by the same teams of health workers working in the same working environments making the correlation between the quality at a given phase and the quality at the next phase, obvious and relevant to account for in the regression models[33].

Study strengths and limitations

The assessment of the quality of care in our study was based on a list of process indicators that have been validated for settings similar to ours. We used different analytical approaches that have among other the advantage of acknowledging the multidimensionality of the quality of care by allowing it to vary across different points in time along the continuum of care instead of treating the quality as a unique score with no distinction between initial

examination, pre-delivery and immediate postpartum periods[26]. The quality determinants were investigated for each period separately and altogether for all periods. Because of the direct observation of the practices, we cannot rule out the Hawthorne effect, that is despite mitigating measures, some provider might have modified their practices under observation. Data were collected by eight data collectors in each country and are thus subject to an inter-rater reliability bias even though they were trained to standardize the processes. Finally, our study did not include data on some quality improvement initiatives that were found relevant in previous studies: existence of quality improvement guidelines in the health facility, in-service trainings of providers and supportive supervisions received.

Conclusion

Ensuring that all women and newborns have access to quality care along the continuum of childbirth care is critical for ending preventable perinatal deaths. Both facility and provider levels quality improvement strategies are needed to impact the whole continuum of care. Stage specific inputs are needed to improve the quality of delivery care along the continuum and the quality of the delivery care at an earlier stage is correlated to the quality at a subsequent stage.

List of abbreviations

AMSTL: Active Management of the Third Stage of Labor

ANC: Antenatal Care visit

EBP: Essential Best Practice

EmONC: Emergency Obstetric and Newborn Care

HRP: Human Reproduction Program

405 ICMJE: International Committee of Medical Journal Editors
406 IRR: Incidence Rate Ratio
407 LMIC: Low-Middle Income Countries
408 PHCF: Primary Health Care Facility
409 SCC: Safe Childbirth Checklist
410 SDG: Sustainable Development Goals
411 SEM: Structural Equation Modeling
412 SSA: Sub-Saharan Africa
413 RMSEA: Root Mean Square Error of Approximation
414 UN: United Nations
415 WHO: World Health Organization

416

417 **Declarations**

418 *Ethics approval and consent to participate*

419

420 The research protocol obtained ethical approvals from the national ethics review committees
421 of Burkina Faso (reference number 2017-4-043) and Côte d'Ivoire (161-18/MSHP/CNE SVS-
422 Kp). It was also approved by the ethics review committee of the WHO (protocol ID
423 ERC.0002951). Written informed consent was obtained from all study participants. To the best
424 of our knowledge, all the methods were performed in accordance with relevant guidelines
425 and regulations.

426 *Consent for publication*

427 Not applicable.

428

429 *Availability of data and materials*

430 The datasets used in the current study are available from the corresponding author on
431 reasonable request

432 *Competing interests*

433 The authors declare that they have no competing interests

434

435

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439 *Authors' contributions*

440 All authors meet the criteria recommended by the International Committee of Medical Journal
441 Editors (ICMJE). All authors made substantial contributions to conception and design,
442 acquisition of data or analysis and interpretation of data. SK, TM, RKK and MLA conceived the
443 study design. TM analyzed the data and proposed the first draft of the paper. BIM and AD
444 provide insights into the data analysis and interpretation. SK, MLA, RKK, MWY, BIM, and AD
445 revised and contributed to the successive drafts and have all approved the final version of the
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451

452 **Figure 1:** This figure depicts the structural equation model for the analysis of the determinants
453 of the quality of childbirth care along the continuum. The measurement component of the
454 model has two parts: the latent endogenous quality variables (Admission, before pushing,
455 Soon after birth) and their respective observed indicators variables and the latent exogenous
456 variables: provider and facility variables along equally with their observed indicator variables.
457 The structural component is composed of the relationships between the latent exogenous and
458 latent endogenous variables. The standardized coefficients are presented on the path

459

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Table 2: Crude and adjusted incidence rate ratios for quality of care at admission, pre-delivery and immediate post-partum and per country

Crude Incidence rate ratio (IRR, 95% confidence interval)				Adjusted Incidence rate ratio (IRR, 95% confidence interval)		
Burkina Faso						
Variables	Admission (n=532)	Before pushing	Soon after birth	Admission	Before pushing	Soon after birth
User characteristics						
Maternal age	0.99(0.99-1.01)	0.99(0.99-1.00)	0.99(0.99-1.00)	0.99(0.98-1.00)	0.99(0.99-1.01)	0.99(0.99-1.00)
Maternal education (ref=None)						
<i>Primary</i>	1.06(0.94-1.19)	0.93(0.86-1.01)	0.97(0.90-1.05)	1.04(0.93-1.16)	0.93(0.86-1.02)	0.95(0.89-1.02)
<i>Secondary/tertiary</i>	1.07(0.96-1.18)	1.02(0.93-1.13)	1.01(0.91-1.11)	0.92(0.81-1.04)	0.98(0.89-1.09)	0.95(0.86-1.04)
Number of ever pregnancies	0.98(0.94-1.03)	0.99(0.97-1.02)	0.97(0.94-0.99)	1.00(0.94-1.07)	0.99(0.96-1.03)	0.99(0.94-1.03)
Four ANC visits (ref=No)	1.02(0.95-1.10)	1.01(0.96-1.06)	1.01(0.96-1.06)	1.00(0.94-1.07)	1.02(0.98-1.06)	1.09(0.97-1.05)
Provider characteristics						
Qualification (ref= midwives)						
<i>Nurses</i>	0.91(0.81-1.03)	1.04(0.97-1.11)	0.98(0.92-1.04)	0.81(0.72-0.90) ***	0.99(0.93-1.05)	0.96(0.91-1.03)
<i>Other auxiliary staffs</i>	0.94(0.86-1.03)	0.97(0.92-1.02)	0.97(0.91-1.03)	0.88(0.80-0.96) **	0.96(0.91-0.99)*	0.95(0.89-1.00)
Gender (ref=Male)	0.94(0.87-1.07)	0.93(0.90-0.98)**	0.96(0.92-1.01)	0.89(0.82-0.96) **	0.99(0.94-1.04)	0.98(0.92-1.03)
Provider’s age	1.02(1.01-1.03)***	1.01(1.00-1.01)**	1.01(0.99-1.01)	1.01(1.01-1.02) **	1.00(0.99-1.01)	1.01(1.00-1.02)**
Years of working experience	1.02(1.01-1.02)***	1.01(1.00-1.01)*	1.01(1.00-1.01)***	1.00(0.99-1.01)	1.00(0.99-1.01)	-
Facility characteristics						
Referral hospital (ref= PHCF)	1.11(1.04-1.19)**	1.15(1.09-1.20)***	0.98(0.93-1.04)	1.07(0.96-1.20)	1.02(1.01-1.18)*	0.96(0.90-1.03)
Rural location (ref= urban)	0.88(0.81-0.95)**	0.91(0.86-0.97)**	0.90(0.86-0.95)***	1.02(0.90-1.16)	0.92(0.86-0.99)*	0.97(0.91-1.02)
Full staff on duty at childbirth (ref= No)	1.06(0.99-1.15)	1.01(0.96-1.06)	1.02(0.97-1.08)	1.02(0.95-1.10)	1.02(0.97-1.07)	1.02(0.98-1.08)
Facility has clean water (pipe)	1.12(1.05-1.21)**	0.93(0.89-0.97)**	0.99(0.95-1.04)	1.03(0.95-1.11)	0.95(0.92-0.99)*	0.99(0.94-1.03)
Health districts (ref=Kaya)						
<i>Boulsa</i>	0.93(0.84-1.01)	1.13(1.06-1.20)***	0.94(0.88-1.01)	0.94(0.85-1.04)	1.14(1.07-1.21) ***	0.96(0.89-1.04)
<i>Kongoussi</i>	0.68(0.61-0.76)***	1.06(1.01-1.12)*	0.98(0.94-1.03)	0.66(0.59-0.75) ***	1.06(0.99-1.12)	0.99(0.93-1.05)
<i>Barsalogho</i>	0.76(0.69-0.84)***	1.06(0.99-1.14)	0.94(0.89-0.99)*	0.75(0.66-0.85) ***	1.07(1.00-1.14) *	0.95(0.88-1.02)
<i>Tougouri</i>	0.74(0.68-0.81)***	0.83(0.77-0.88)***	0.79(0.74-0.84)***	0.75(0.68-0.83) ***	0.85(0.79-0.91) ***	0.81(0.75-0.87)***
Côte d’Ivoire						

Variables	Crude Incidence rate ratio (IRR, 95% confidence interval)			Adjusted Incidence rate ratio (IRR, 95% confidence interval)		
	Admission (n=627)	Before pushing	Soon after birth	Admission	Before pushing	Soon after birth
User characteristics						
Maternal age	0.99(0.99-1.00)	0.99(0.99-1.00)	0.99(0.99-1.00)	0.99(0.99-1.00)	1.00(0.99-1.01)	0.99(0.99-1.00)
Maternal education (ref=None)						
<i>Primary</i>	0.96(0.88-1.04)	0.98(0.92-1.04)	0.94(0.89-0.99)*	1.00(0.94-1.08)	0.98(0.92-1.04)	0.96(0.91-1.01)
<i>Secondary/tertiary</i>	0.96(0.87-1.06)	1.04(0.95-1.13)	0.88(0.82-0.96)*	1.02(0.92-1.15)	1.10(1.01-1.21)*	0.96(0.88-1.04)
Number of ever pregnancies	0.99(0.94-1.05)	0.99(0.97-1.02)	1.01(0.98-1.05)	1.02(0.97-1.07)	0.95(0.90-0.99)*	1.05(1.00-1.09)*
Four ANC visits (ref=No)	1.03(0.95-1.12)	0.99(0.94-1.04)	1.02(0.97-1.07)	1.03(0.96-1.10)	0.95(0.86-1.01)	1.03(0.98-1.08)
Provider characteristics						
Qualification (ref= midwives)						
<i>Nurses</i>	0.91(0.79-1.05)	0.92(0.85-0.99)*	0.89(0.82-0.97)**	0.93(0.77-1.12)	0.94(0.80-1.11)	0.92(0.78-1.08)
<i>Other auxiliary staffs</i>						
Gender Female(ref=Male)	1.08(0.91-1.27)	1.12(1.03-1.22)*	1.14(1.03-1.28)**	1.04(0.83-1.32)	1.18(0.93-1.48)	1.19(0.97-1.47)
Provider's age	0.99(0.98-1.00)	1.01(1.00-1.01)*	1.00(0.99-1.01)	1.01(0.99-1.02)	1.00(0.99-1.01)	1.00(0.99-1.01)
Years of working experience	0.99(0.98-1.01)	1.01(1.00-1.01)**	1.00(0.99-1.01)	1.00(0.99-1.01)	1.00(0.99-1.01)	1.01(1.00-1.02)*
Facility characteristics						
Referral hospital (ref= PHCF)	0.82(0.74-0.91)***	1.10(1.04-1.15)***	0.88(0.82-0.94)***	0.77(0.68-0.87)	1.10(1.01-1.20) *	0.84(0.77-0.93)***
Rural location (ref= urban)	0.96(0.87-1.05)	0.99(0.94-1.04)	0.98(0.94-1.03)	1.02(0.96-1.09)	1.05(0.99-1.12)	0.99(0.94-1.06)
Full staff on duty at childbirth (ref= No)	1.04(0.94-1.14)	0.97(0.92-1.03)	0.98(0.94-1.03)	1.02(0.95-1.09)	1.00(0.93-1.07)	1.01(0.94-1.08)
Facility has clean water (pipe)	1.05(0.96-1.15)	1.01(0.95-1.06)	0.96(0.91-1.01)	1.05(0.98-1.13)	1.06(0.99-1.13)	1.03(0.97-1.09)
Health districts (ref= Adzopé)						
<i>Akoupé</i>	0.85(0.77-0.93)***	1.12(1.03-1.22)**	0.95(0.88-1.03)	0.86(0.78-0.95)**	1.17(1.07-1.28) **	0.95(0.87-1.03)
<i>Alepé</i>	1.24(1.14-1.35)***	1.04(0.94-1.15)	1.15(1.07-1.24)***	1.30(1.18-1.43) ***	1.11(1.00-1.23)*	1.19(1.11-1.29)***
<i>Tiassalé</i>	1.03(0.88-1.21)	1.17(1.07-1.28)***	1.29(1.19-1.41)***	1.06(0.84-1.34)	1.31(1.15-1.49) ***	1.37(1.20-1.55)***
<i>Agboville</i>	0.88(0.82-0.96)**	1.21(1.11-1.31)***	1.01(1.01-1.15)*	0.85(0.78-0.94) **	1.23(1.13-1.33) ***	1.01(0.92-1.10)

*p<0.05 **p<0.01. ***p<0.001

Figures

Figure 1

standardized parameter estimates of the quality of care along the continuum of care (see table3 for codes labels and explanations).