

RESEARCH ARTICLE

Adherence to standards of first-visit antenatal care among providers: A stratified analysis of Tanzanian facility-based survey for improving quality of antenatal care

Deogratus Bintabara^{1,2}, Keiko Nakamura^{1*}, Julius Ntwenya², Kaoruko Seino^{1,3}, Bonaventura C. T. Mpondo⁴

1 Department of Global Health Entrepreneurship, Division of Public Health, Graduate School of Tokyo Medical and Dental University, Tokyo, Japan, **2** Department of Public Health, College of Health Sciences, The University of Dodoma, Dodoma, Tanzania, **3** Department of Environmental Health Sciences, School of Public Health, University of Michigan, Ann Arbor, Michigan United States of America, **4** Department of Internal Medicine, College of Health Sciences, The University of Dodoma, Dodoma, Tanzania

* nakamura.ith@tmd.ac.jp



OPEN ACCESS

Citation: Bintabara D, Nakamura K, Ntwenya J, Seino K, Mpondo BCT (2019) Adherence to standards of first-visit antenatal care among providers: A stratified analysis of Tanzanian facility-based survey for improving quality of antenatal care. PLoS ONE 14(5): e0216520. <https://doi.org/10.1371/journal.pone.0216520>

Editor: Toshiyuki Ojima, Hamamatsu Ika Daigaku, JAPAN

Received: February 15, 2018

Accepted: April 23, 2019

Published: May 13, 2019

Copyright: © 2019 Bintabara et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Data are available from 2014–2015 Tanzania Service Provision Assessment (TSPA) Survey data-sets which can be accessed upon request from Demographic and health Survey Program repository: <http://dhsprogram.com/data/availabledatasets.cfm>. The authors did not have special access privileges.

Funding: The authors received no specific funding for this work.

Abstract

Introduction

Despite the benefits of early antenatal care visits for early prevention, detection, and treatment of potential complications in pregnancy, a high level of provider adherence to first-visit antenatal care standards is needed. However, little information is available regarding provider adherence to antenatal care in Tanzania. This study was performed to assess provider adherence to first-visit antenatal care standards and to apply stratified analysis to identify associated factors in Tanzania.

Methods

Data from the 2014–2015 Tanzania Service Provision Assessment Survey were used in this study. Provider adherence to first-visit antenatal care standards was measured using 10 domains: client history; aspects of prior pregnancies; danger signs of the current pregnancy; physical examination; routine tests; HIV testing and counseling; maintaining a healthy pregnancy; iron/folate supplements; tetanus toxoid vaccination, and preparation for delivery. A composite score was then created in which the highest quantile (corresponding to $\geq 60.5\%$) considered to provider adhering to first-visit antenatal care standards. Initially, a series of unadjusted logistic regression analyses according to the type of facility and managing authority were performed separately at each level (i.e., facility, provider, and client). Thereafter, all variables with $P < 0.2$ were fitted into the respective stratified multivariable logistic regression analysis using a 5% significance level.

Results

A total of 1756 first-visit antenatal care consultations performed by 822 providers in 648 health facilities were analyzed. The overall median [Interquartile range, IQR] adherence to

Competing interests: The authors have declared that no competing interests exist.

first-visit antenatal care was relatively low at 47.1% [35.7%–60.5%]. After adjusting for selected variables from each level in specific strata, at dispensary; female providers [AOR = 5.5; 95% CI, 1.8–16.4], at health centre; performance of quality assurance [AOR = 2.2; 95% CI, 1.3–3.9], at hospital; availability of routine tests [AOR = 2.5; 95% CI, 1.3–4.8] and basic medicine [AOR = 2.8; 95% CI, 1.4–5.7], at public facilities; availability of medicine [AOR = 1.8; 95% CI, 1.1–3.2] and receiving refresher training [AOR = 1.8; 95% CI, 1.1–3.1], and at private facility; receiving external fund from government [AOR = 3.0; 95% CI, 1.1–8.4] were significantly associated with better adherence to first-visit antenatal care standards.

Conclusions

The study highlighted the important factors, including the provision of refresher training, regular distribution of basic medicines, and diagnostics equipment which may influence provider adherence to first-visit ANC standards.

Introduction

Over the past 25 years, the maternal mortality ratio (MMR) has been decreasing in almost all Millennium Development Goal (MDG) regions [1]. However, low and middle-income countries (LMIC) still account for nearly 99% of the global MMR, with Sub-Saharan Africa (SSA) contributing approximately 66% of all such mortalities [1,2]. In Tanzania, the reported MMR is still high (556 maternal deaths per 100 000 live births) and the decreasing trend has remained unchanged over the past decade [3,4]. This high MMR is far from the operational targets set by Tanzania's Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) through the National Road Map Strategic Plan of 2008, which aimed to accelerate reduction to 193 maternal deaths per 100 000 live births by the end of 2015 [5]. This high MMR has raised concerns regarding whether Tanzania will achieve Sustainable Development Goal (SDG) 3 by the end of 2030, which seeks to ensure healthy lives and promote wellbeing for people of all ages, while addressing major health priorities, including maternal and child health [6].

Several reports have suggested that antenatal care (ANC) has no or only a minimal direct effect on reducing MMR [7–9]. However, there is new evidence that ANC does play an important role in minimizing maternal and neonatal mortality [10,11]. Therefore, the World Health Organization (WHO) has promoted a focused ANC model that was developed in the 1990s [12,13] as a strategy to reduce the burden of maternal and perinatal mortality, especially in LMIC [14,15]. This model places a great deal of emphasis on the quality of clinical services, with the recommendation that all pregnant women should attend a minimum of four ANC visits and receive structured preventive interventions during each visit [16–18]. However, secondary analysis of previously collected data indicated that the model including four ANC visits is associated with higher rates of perinatal death than ANC model requiring at least eight visits [19]. Based on these and other findings, the WHO developed the new 2016 ANC model, which recommends a minimum of eight ANC visits consisting of one visit in the first trimester, two visits in the second trimester, and five visits in the third trimester [20].

Despite these new WHO ANC recommendations, the MoHCDGEC policy in Tanzania is still implementing the previous model requiring four focused ANC visits [21,22]. Implementation of the focused ANC model since 2002 in Tanzania has helped to increase ANC coverage,

which has exceeded 90% for at least two decades in this country. In 2016, about 98% of women age 15–49 years received ANC from a skilled provider during the pregnancy of their most recent birth [3,4]. However, despite the explained benefits of early and frequent ANC visits to increase the likelihood of early prevention, detection, and treatment of potential pregnancy complications [23], the proportions of pregnant women beginning ANC in their first trimester (24%), those who complete four or more ANC visits (51%), and births assisted by skilled providers (64%) are still unsatisfactory [4]. Improving the quality of the first ANC visit, thus reaching almost all pregnant women in Tanzania, will help to increase their level of satisfaction, and therefore provide motivation to attend follow-up visits.

Although a complex issue, several measures are available for assessing the quality of health care that can be divided into three broad categories: structure attribute, which can be used to assess the characteristics of care settings; process attribute, involving assessment of the services provided to patients; and outcome attribute, that evaluates patient health resulting from the care provided [24,25]. There have been a number of reports involving the assessment of ANC quality using one or all of these measures [26–28]. Furthermore, there is the minimal usage of the process attribute measure, which includes direct observation of items or consultations and has been mentioned as the gold standard, to assess the quality of care [29]. Although this attribute can be used to determine whether the services provided to patients are consistent with the routine standard of clinical care until recently assessment of ANC quality has mostly focused on quantifiable issues, such as the number of visits and the timing of the first visit [30]. There is, therefore, a paucity of data regarding the quality of health services received by pregnant women at a single point of contact with health providers, especially with regard to the first ANC visit, as it tends to cover almost all pregnant women in many low-resource countries, such as Tanzania.

There have been a number of studies to assess the quality of ANC in Tanzania based on timing, the number of ANC visits, availability of basic equipment, or client satisfaction [31–33]. However, only a few studies assessed the quality of ANC based on the process attribute measure [34–36]. But these studies did not assess factors associated with the quality of services offered by ANC providers. Furthermore, limited empirical evidence is available regarding the extent to which providers adhere to the first-visit ANC standards and associated factors in Tanzania. Therefore, the present study was performed to assess the adherence to first-visit ANC standards among providers and to perform stratified analysis to identify factors associated with service provider adherence to first-visit ANC standards across different strata of health facilities (dispensary/clinic, health center, hospital) and health facility managing authority (public and private). The findings of the present study will help to improve provider adherence to the first-visit ANC and to ensure that all pregnant women receive good quality care.

Materials and methods

Data source

Data from the 2014–2015 Tanzania Service Provision Assessment (TSPA) Survey were used in the present study. The TSPA Survey was performed by Tanzania's National Bureau of Statistics (NBS) in collaboration with the Office of the Chief Government Statistician (OCGS), Zanzibar, the MoHCDGEC, Tanzania Mainland, and the Ministry of Health (MOH), Zanzibar. Technical support for the survey was provided by ICF International under the Demographic and Health Survey (DHS) program. The survey was designed to provide information on the quality, service readiness and availability of basic and essential health care services. The survey also assessed the presence and functioning of components essential for quality service delivery for

child health, maternal and newborn care, family planning, antenatal care, sexually transmitted infections, HIV/AIDS and non-communicable diseases.

Study sample and sampling procedure

The 2014–2015 TSPA was a sample survey of all formal sector health facilities in Tanzania. The MoHCDCGEC in Tanzania mainland and MOH in Zanzibar provided lists of all hospitals, health centers, dispensaries, and clinics, which were compiled into a national master facility list (sampling frame). A nationally representative sample of 1200 facilities was selected from this national master facility list by random stratified sampling according to health facility type, managing authority, and region. Further details about the TSPA survey sampling procedures are available online [37]. However, for the purpose of our research, the analysis was restricted to health facilities with at least one first ANC visit consultation. Therefore, facilities that reported providing ANC services, selected to participate for ANC observation, were open on the day of the interview, and agreed to participate were eligible and were included in this study. Facilities that did not fulfill the inclusion criteria were excluded from the study: 157 did not provide ANC services, 216 were not selected for ANC observation, 167 did not have first ANC visit observations, seven refused to participate, four were closed on the day of the interview, and one could not be reached. After excluding all facilities that did not fulfill the inclusion criteria, 648 health facilities that corresponded to 1756 first ANC visits performed by 822 health providers were included in this study (Fig 1).

In each selected facility, clients were identified and systematically selected for observation based on the number of clients present at each service site on the day of the visit. In cases where many clients were present and eligible for observation, a maximum of five clients for each provider and a maximum of 15 observations for each selected facility were selected by systematic random sampling [36].

Data collection and processing

The 2014–2015 TSPA used four main data collection tools: a Facility Inventory; a Health Provider Interview questionnaire; Observation Protocols and Exit Interview questionnaire. The data for the original survey was collected between October 20, 2014, and February 21, 2015, and some facilities that were not interviewed previously were revisited between March 2 and 13, 2015. Data collection were performed by health workers who were selected after a series of training, practicals, and examinations to qualify as interviewers. The information collected from each questionnaire was stored in different files except Observation Protocols and Exit Interview that were stored in the same file. The data in these three files were edited, cleaned, and recoding was performed for variables of interest. The files were then linked into a new dataset using the facility and provider identification as a unique identifiers. The survey final report, which is available online, provides more descriptions of the TSPA survey design, sampling procedures, and data collection [36].

Definitions of variables

Outcome variable. Provider adherence to first-visit ANC standards was determined based on the responses documented by an observer/interviewer regarding whether each of the required services was performed during the first ANC visit. Interviewers were required to note whether providers discussed or performed 53 items grouped into 10 domains related to first-visit ANC services as proposed by MoHCDCGEC and other surveys in Tanzania [21,36,38]. These domains, which were determined by the survey designers, included: client history (four items); aspects of prior pregnancies (10 items); danger signs of the current pregnancy (seven

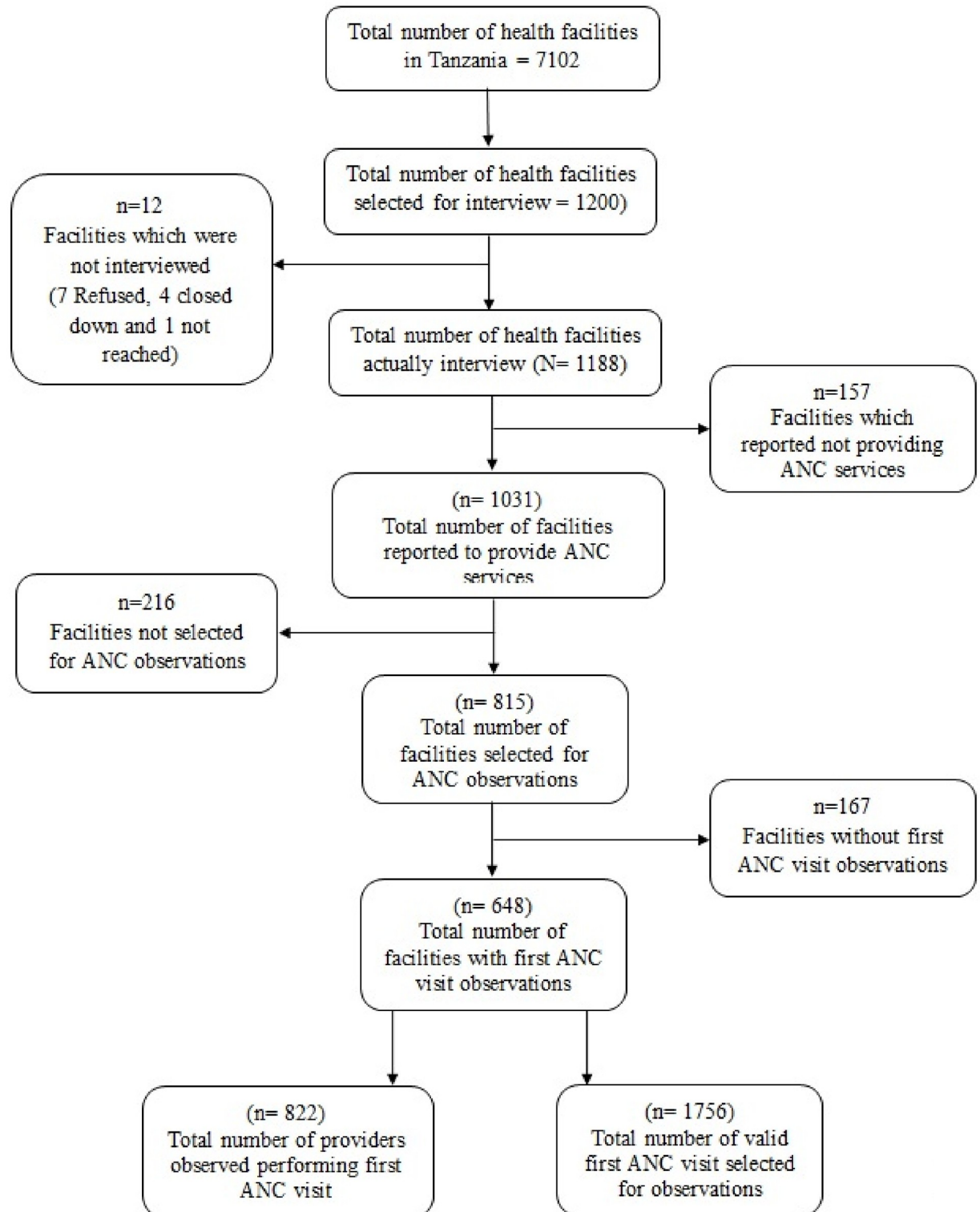


Fig 1. Selection procedure for the sampling units included in this analysis.

<https://doi.org/10.1371/journal.pone.0216520.g001>

items); physical examination (eight items); routine tests (four items); HIV testing and counseling (five items); maintaining a healthy pregnancy (three items); iron/folate (FeFo) supplements (four items); tetanus toxoid vaccination (three items); and preparation for delivery (five items). For each directly observed visit, the responses for all items in these ten domains were aggregated to calculate the adherence score as the percentage of actions completed among the total items assessed [39]. Each domain accounted for 10% as the target was 100% (i.e., 100%/10). The percentage of each item within the domain was equal to 10% divided by the number of items in that domain. A similar approach involving assigning an equal weight for each domain and the indicators within it has been used in other studies in different fields [40,41]. The ANC adherence score for each observation was then calculated by summing the percentages. This approach has also been used elsewhere [40]. Based on previous reports, all observations were classified into the highest quantile (corresponding to $\geq 60.5\%$) of the score as providers that adhered to ANC standards [42]. The items in each domain are listed and the measurement process is summarized in more details in [S1 Table](#).

Independent variables. The independent facility variables were facility location, managing authority, facility type, quality assurance (i.e., any quality assurance activities carried out during the past year), external sources of funding, basic equipment, routine tests, basic medicines, and ANC guidelines. The independent provider variables were sex, cadre, working experience, ANC refresher training, and supportive supervision. Independent client variables were age and level of formal education. These variables are summarized in [S2 Table](#).

Statistical analysis

In descriptive analyses, categorical variables were summarized using weighted frequencies and proportions (Tables 1 and 2, and [S2 Table](#)), while continuous variables were summarized using the median and interquartile range (IQR) (Table 3 and Fig 2). Stratified descriptive analyses were performed to assess the differences in availability of ANC services according to facility type and managing authority. Furthermore, a series of individual unadjusted logistics regression analyses were constructed across different strata of health facilities (dispensary/clinic, health center, hospital, public) and health facility managing authority (public or private) to identify factors separately at each level—facility (1a, 2a, 3a, 4a, and 5a), provider (1b, 2b, 3b, 4b, and 5b), and client (1c, 2c, 3c, 4c, and 5c)—that were associated with provider adherence to first-visit ANC standards. Thereafter, all independent variables that showed an association with $P < 0.2$ at any of defined strata of facility type and/or managing authority were eligible for inclusion in multivariable logistics regression analyses 1d, 2d, 3d, 4d, and 5d, respectively, adjusting for all three level factors. All models were fitted using a stepwise (backward) elimination method and $P < 0.05$ was taken to indicate statistical significance. The odds ratio (OR) and 95% confidence interval (95% CI) for each variable were computed and used to measure the association with the outcome variable. As the original TSPA survey used a random stratified sampling method, this approach may over- or underestimate the sample within the strata. Therefore, all analyses took this complex survey design into account. All statistical analyses were performed using Stata 14 (StataCorp, College Station, TX).

Ethical considerations

This study was based on analysis of existing public domain survey (TSPA 2014–2015) datasets that are freely available online with all identifying information removed. The original survey was approved by the Ethics Committee of the ICF Macro at Calverton in the USA and by the National Institute of Medical Research Ethics Committee in Tanzania. Therefore, ethical

Table 1. Baseline characteristics, facility, provider, and client distributions in TSPA 2014–15.

Variable	n (%)
Facility characteristics (n = 648)	
Facility location (Rural)	510 (78.7)
Facility type	
Clinic & dispensary	519 (80.1)
Health centre	94 (14.5)
Hospital	35 (5.4)
Managing authority (Public)	535 (82.6)
Quality assurance (Performed < 1 year)	126 (19.4)
External source of funding (Government)	431 (66.5)
Provider characteristics (n = 822)	
Provider's sex (Female)	697 (84.8)
Cadre (Nurse)	776 (94.4)
Refresher training on ANC (Received)	367 (44.6)
Supportive supervision	
Not received	148 (18.0)
Received < 3 months	555 (67.5)
Received > 3 months	119 (14.5)
Working experience	
< 2 years	327 (39.8)
2–5 years	185 (22.5)
> 5 years	310 (37.7)
Client characteristics (n = 1756)	
Age	
< 20 years	332 (18.9)
20–35 years	1235 (70.3)
> 35 years	189 (10.8)
Education level	
None	409 (23.3)
Primary	1084 (61.7)
secondary and above	263 (15.0)

<https://doi.org/10.1371/journal.pone.0216520.t001>

approval for this analysis was deemed unnecessary. Informed consent was requested and obtained from participants before the interview.

Results

Background characteristics of facilities, providers, and clients

Table 1 summarized the background characteristics of the health facilities, health providers, and clients included in the survey. More than two-thirds of the 648 health facilities were located in rural settings, and more than 80% were publicly owned facilities. About 95% of all 822 health providers were nurses, while less than half had received ANC refresher training within the previous 24 months. Nearly three-quarters of 1756 observed first-visit ANC consultations involved women between the ages of 20 and 35 years. For stratified descriptive statistics, see S2 Table.

Availability of ANC services

Table 2 shows the distribution of ANC service availability according to facility type and managing authority. The availability of ANC guidelines and at least one staff member who received

Table 2. Percentage distribution of ANC service availability according to facility type and managing authority in TSPA 2014–2015 (n = 648).

Variable	Type of facility			Managing authority		Total n (%)
	Dispensary n (%)	Health centre n (%)	Hospital n (%)	Public n (%)	Private n (%)	
Staff and training						
Presence of guidelines ^t	278 (53.6)	68 (72.3)	26 (74.3)	308 (57.6)	64 (56.6)	372 (57.4)
Availability of trained staff ^t	327 (63.0)	75 (79.8)	31 (88.6)	352 (65.8)	81 (71.7)	433 (66.8)
Equipment						
Blood pressure apparatus ^{t m}	399 (76.9)	81 (86.2)	33 (94.3)	414 (77.4)	99 (87.6)	513 (79.2)
Diagnostics						
Hemoglobin test	81 (15.6)	26 (27.7)	9 (25.7)	95 (17.8)	21 (18.6)	116 (17.9)
Urine for protein test	71 (13.7)	19 (20.2)	8 (22.9)	76 (14.2)	22 (19.5)	98 (15.1)
Medicines and commodities						
Iron tablets	466 (89.8)	83 (88.3)	33 (94.3)	489 (91.4)	93 (82.3)	582 (89.8)
Folic acid tablets ^m	481 (92.7)	84 (89.4)	32 (91.4)	503 (94.0)	94 (83.2)	597 (92.1)
Sulfadoxine+Pyrimethamine (SP)	267 (51.4)	49 (52.1)	21 (60.0)	286 (53.5)	51 (45.1)	337 (52.1)
Tetanus toxoid vaccine ^t	446 (85.9)	86 (91.5)	34 (97.1)	466 (87.1)	100 (88.5)	566 (87.3)
Insecticide-treated bed nets	30 (5.8)	12 (12.8)	3 (8.6)	37 (6.9)	8 (7.1)	45 (6.9)
Total	519	94	35	535	113	648

Note:

^t = P < 0.05 according to the type of facility.

^m = P < 0.05 according to managing authority.

^{t m} = P < 0.05 according to both type of facility and managing authority.

The P-values presented here were obtained with the Chi-square test.

The items presented here were assessed in the ANC service area.

<https://doi.org/10.1371/journal.pone.0216520.t002>

Table 3. Overall and domain-specific scores of provider adherence to first-visit ANC standards in TSPA 2014–2015.

Variable	Median (IQR)% All pregnant women (n1756)	Median (IQR)% Women ≥ 2 pregnancies (n = 1301)
Client history	75.0 (50.0–75.0)	75.0 (50.0–75.0)
Aspects of prior pregnancies	10.0 (0.0–30.0)	20.0 (10.0–40.0)
Danger signs of the current pregnancy	42.9 (0.0–57.1)	42.9 (0.0–57.1)
Physical examination	50.0 (37.5–75.0)	50.0 (37.5–75.0)
Routine tests	25.0 (0.0–100.0)	25.0 (0.0–100.0)
HIV Testing and Counseling	80.0 (40.0–100.0)	80.0 (40.0–100.0)
Maintain health pregnancy	33.3 (0.0–66.7)	33.3 (0.0–66.7)
Iron/ Folate (FeFo) supplementation	75.0 (50.0–75.0)	75.0 (50.0–75.0)
Tetanus toxoid injection	33.3 (33.3–66.7)	33.3 (33.3–66.7)
Preparation for delivery	40.0 (20.0–80.0)	40.0 (0.0–80.0)
Adherence score quantile		
Low	31.0 (24.8–35.3)	31.2 (25.6–35.9)
Second	45.7 (42.8–47.9)	45.7 (43.1–47.9)
Third	54.6 (52.5–57.5)	54.7 (52.7–57.5)
High	68.0 (63.7–74.2)	68.2 (63.7–74.4)
Overall score	47.1 (35.7–60.5)	47.8 (36.3–60.7)

<https://doi.org/10.1371/journal.pone.0216520.t003>

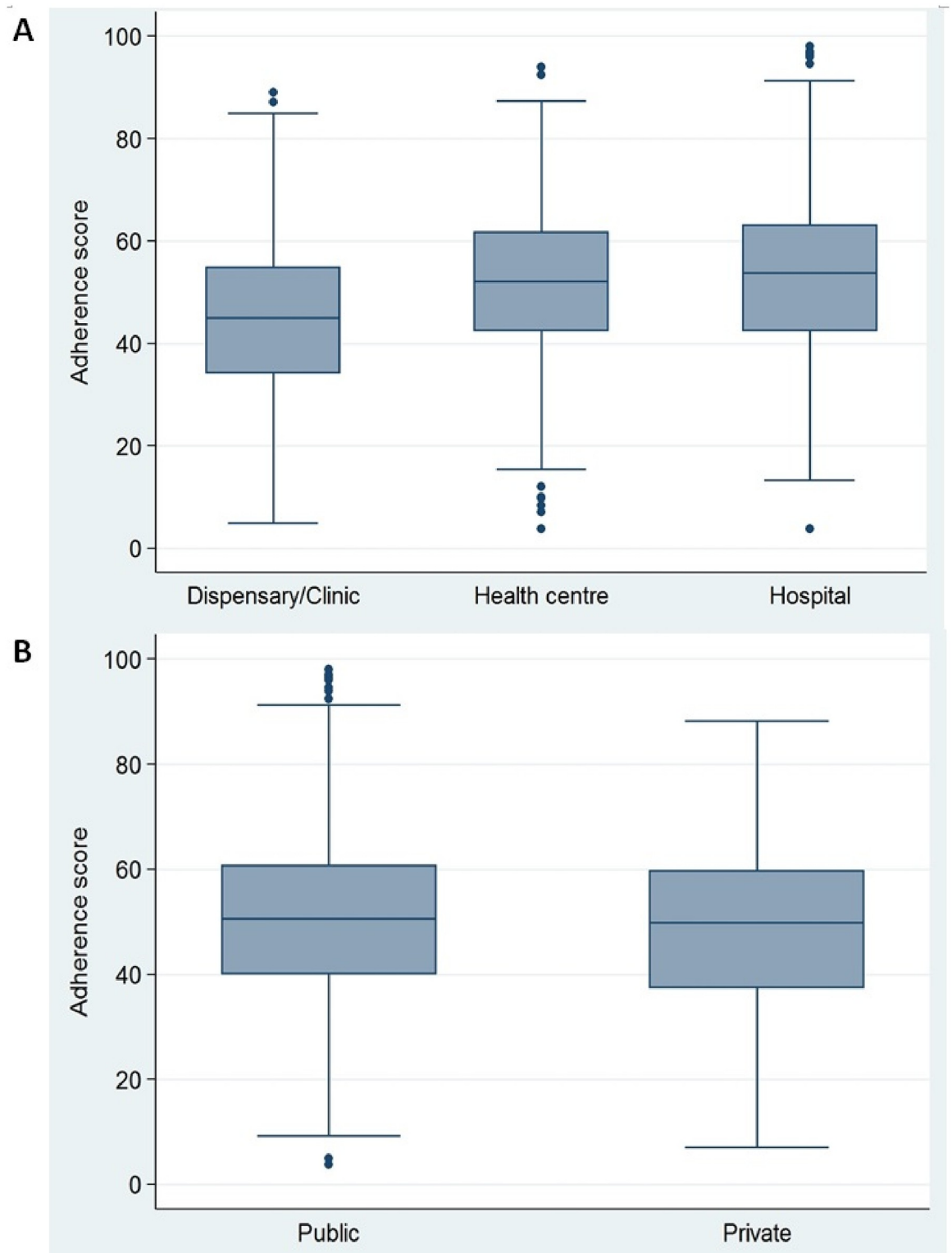


Fig 2. Distribution of adherence scores for observed first-visits ANC in TSPA 2015–2016 ($n = 1756$). (A) Provider adherence to first-visit ANC standards according to facility type. (B) Provider adherence to first-visit ANC standards according to managing authority. Boxes show the limits of 25th and 75th percentiles. Horizontal lines inside the boxes show the median values. Bars show the lower and upper limits of 95% CI. The dots show outliers.

<https://doi.org/10.1371/journal.pone.0216520.g002>

refresher training were significantly low at the dispensary/clinic level ($P < 0.05$). However, the availability of diagnostic tools (Hb and urine tests) was low across all facility and managing authority types. The overall availability of basic medicines was high, with folic acid tablets being more prominent at private facilities and tetanus toxoid vaccine more prevalent at hospitals ($P < 0.05$).

Provider adherence to first-visit ANC standards

[Table 3](#) shows the median (IQR) of the 10 predetermined domains used to assess overall adherence to first-visit ANC standards among health providers. Although the overall median adherence score was relatively low (47.1%), providers had high adherence in some separate individual domains, such as client history (75.0%), discussion or provision of FeFo supplements (75.0%), and HIV testing and counseling (80.0%). When the adherence score was disaggregated according to facility type and managing authority, the overall median adherence score was low for dispensaries/clinics ([Fig 2A](#)), while there was no significant difference between public and private facilities ([Fig 2B](#)).

Factors associated with provider adherence to first-visit ANC standards

[Table 4](#) shows the results of a series of stratified logistics regression models to examine the associations between selected independent variables and adherence with first-visit ANC standards. At the dispensary level (model 1a–c) and the corresponding model 1d that adjusted for all selected factors from all three facility levels, the odds of adherence to first-visit ANC standards were five and three times higher among females and clinician providers compared to males and nurses, respectively. At the health centre level (model 2a–c) and the corresponding model 2d that adjusted for all selected factors from all three facility levels, the odds of adherence to ANC standards were two times higher among providers in the facilities that regularly performed quality assurance. At the hospital level, model 3a–c and the corresponding model 3d that adjusted for all selected factors, the odds of adherence to ANC standards were two and three times higher for providers in the facilities that performed routine tests and had basic medicines, respectively, and also five times higher for providers with less than 2 years of working experience compared to those with more than 2 years of experience. In publicly owned facilities, model 4a–c and the corresponding model 4d that adjusted for all selected factors, the odds of adherence to first-visit ANC standards were four times higher among female providers and two times higher among providers who had received refresher training and those in facilities that had basic medicines. In privately owned facilities, model 5a–c and the corresponding model 4d that adjusted for all selected factors, the odds of adherence to ANC standards were three times higher among privately owned facilities that received some funding from the government compared to those had not received such funding. Furthermore, in all strata except at the health center level, the odds of adherence to ANC standards were higher when providers provided services for women between 20 and 35 years old.

Discussion

The results presented here indicated an unsatisfactory level of provider adherence to first-visit ANC standards in Tanzania. In addition, at the dispensary level, the type of cadre and client age, at health centre; quality assurance, at hospital; availability of routine tests and basic medicines were significant determinants of provider adherence to first-visit ANC standards. Furthermore, at public facilities; the presence of staff who received ANC refresher training, and at private facilities; receiving external funding from the government and clients' education level also were associated with provider adherence to first-visit ANC standards.

Table 4. Stratified logistics regression models for factors associated with adherence to first-visit ANC standards in TSPA 2014–2015 (n = 1756).

Variable	Facility type						Managing authority			
	Dispensary/Clinic		Health center		Hospital		Public		Private	
	OR [95%CI]		OR [95%CI]		OR [95%CI]		OR [95%CI]		OR [95%CI]	
	Model 1a	Model 1d	Model 2a	Model 2d	Model 3a	Model 3d	Model 4a	Model 4d	Model 5a	Model 5d
Facility factors										
Facility location										
Urban (versus rural)	1.6 [0.6–3.9]		0.9 [0.5–2.0]		1.2 [0.6–2.3]		1.4 [0.8–2.5]		1.3 [0.6–2.9]	
Quality assurance										
Performed (versus not performed)	2.0 [0.7–5.8]	1.7 [0.6–5.4]	2.3 [1.3–4.1]	2.2 [1.3–3.9]	0.3 [0.1–0.8]	0.3 [0.2–1.0]	1.9 [1.0–3.7]	1.8 [1.0–3.3]	1.2 [0.4–3.6]	
ANC guideline										
Available (versus not available)	0.7 [0.3–1.8]		1.0 [0.4–2.0]		1.5 [0.7–3.3]		1.0 [0.5–2.0]		0.5 [0.2–1.2]	0.5 [0.2–1.2]
Basic equipment										
Available (versus not available)	1.2 [0.4–3.2]		0.9 [0.4–2.0]		1.7 [0.7–4.4]		1.1 [0.5–2.5]		1.6 [0.4–6.8]	
Routine tests										
Available (versus not available)	0.4 [0.1–4.4]		1.3 [0.6–2.8]		2.3 [1.2–4.5]	2.5 [1.3–4.8]	1.2 [0.6–2.7]		1.0 [0.4–2.4]	
Basic medicines										
Available (versus not available)	2.2 [1.1–4.8]	2.2 [1.0–4.8]	1.2 [0.7–2.2]		2.6 [1.3–5.3]	2.8 [1.4–5.7]	1.8 [1.1–3.2]	1.8 [1.1–3.2]	2.4 [1.0–5.4]	
External fund										
Government (versus non-government)	1.3 [0.6–2.9]		0.7 [0.4–1.4]		3.5 [1.1–11.4]	2.4 [0.9–6.4]	1.0 [0.6–1.9]		3.0 [0.9–9.8]	3.0 [1.1–8.4]
Provider factors	Model 1b		Model 2b		Model 3b		Model 4b		Model 5b	
Provider's sex										
Female (versus male)	6.0 [2.1–17.5]	5.5 [1.8–16.4]	1.7 [0.6–4.8]		0.9 [0.3–3.1]		4.4 [1.9–10.5]	3.8 [1.6–9.0]	1.5 [0.3–8.4]	
Cadre										
Nurse (versus clinician)	0.3 [0.1–0.9]	0.3 [0.1–0.9]	1.3 [0.2–7.4]		15.0 [1.8–126.9]	7.9 [0.9–71.3]	0.4 [0.2–1.1]	0.4 [0.1–1.0]		
Refresher training										
Received (versus not received)	1.7 [0.9–3.5]	1.9 [0.9–4.0]	1.7 [0.9–3.1]	1.4 [0.8–2.4]	1.6 [0.8–3.1]	1.7 [0.8–3.6]	1.7 [1.0–2.9]	1.8 [1.1–3.1]	1.2 [0.5–2.7]	
Supportive supervision										
Not received	1.0		1.0		1.0		1.0		1.0	
Received < 3 months	1.6 [0.5–4.9]		1.0 [0.5–2.1]		0.9 [0.4–1.9]		1.1 [0.6–2.2]		1.3 [0.4–4.5]	
Received > 3 months	1.2 [0.3–4.3]		1.1 [0.4–2.9]		0.9 [0.4–2.1]		1.0 [0.4–2.3]		0.8 [0.2–3.1]	
Working experience										
< 2 years	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	
2–5 years	0.5 [0.2–1.3]	0.5 [0.2–1.3]	0.8 [0.3–1.9]		0.2 [0.1–0.7]	0.2 [0.1–0.6]	0.5 [0.2–1.0]	0.5 [0.2–1.0]	0.8 [0.2–3.3]	
> 5 years	0.4 [0.2–0.9]	0.5 [0.2–1.0]	0.7 [0.3–1.3]		0.8 [0.4–1.7]	0.8 [0.3–1.8]	0.7 [0.4–1.2]	0.6 [0.3–1.1]	0.6 [0.3–1.5]	
Client factors	Model 1c		Model 2c		Model 3c		Model 4c		Model 5c	
Age										
< 20 years	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
20–35 years	2.3 [1.1–5.1]	2.7 [1.2–6.0]	1.4 [0.8–2.3]		2.1 [1.2–3.9]	2.1 [1.1–4.1]	1.9 [1.2–3.3]	2.0 [1.2–3.4]	3.3 [1.5–7.4]	3.0 [1.3–6.9]
> 35 years	1.6 [0.5–4.9]	2.0 [0.6–6.4]	1.1 [0.5–2.6]		1.1 [0.4–2.9]	1.0 [0.4–2.7]	1.2 [0.6–2.4]	1.2 [0.6–2.7]	5.5 [1.5–19.7]	3.6 [0.8–16.1]
Education level										
None	1.0	1.0	1.0		1.0	1.0	1.0	1.0	1.0	1.0
Primary	1.9 [0.9–4.1]	1.8 [0.8–4.0]	0.9 [0.5–1.7]		0.7 [0.4–1.5]	2.1 [1.1–4.1]	1.4 [0.9–2.3]	1.3 [0.8–2.2]	2.8 [1.1–7.0]	2.5 [0.9–6.7]
secondary and above	2.2 [0.8–5.8]	1.8 [0.6–5.4]	1.2 [0.6–2.4]		0.7 [0.3–1.5]	1.0 [0.4–2.7]	2.1 [1.2–3.9]	1.6 [0.9–3.0]	2.3 [0.8–6.6]	3.0 [1.0–9.3]

Note: All ORs in models 1d, 2d, 3d, 4d, and 5d were adjusted ORs. Each variable in these models had been adjusted by all other variables within that model.

<https://doi.org/10.1371/journal.pone.0216520.t004>

This unsatisfactory level of provider adherence to first-visit ANC standards in Tanzania was consistent with earlier studies conducted in Zambia and Nigeria [43,44]. The similarity of these findings may have been because both the present and previous studies analyzed nationally representative data that were collected and managed by the DHS program, so these studies had similar designs and methodologies. In this stratified analysis, when the adherence to first-visit ANC was compared across type of facility, the findings indicated that providers at higher level facilities (hospitals or health centers) showed greater adherence to ANC standards than

those in lower level facilities (dispensaries or clinics). This was similar to the findings of previous studies conducted in Nigeria [44], Nepal [45] and Ghana [46–48]. The greater adherence in higher level facilities may be because these facilities are well equipped with large numbers of health workers and the ready availability of basic medicines [49–51]. However, adherence was consistent across the type of managing authority.

Despite the inadequate overall level of adherence to first-visit ANC, there was a substantial difference in performance across individual domains. In contrast to a previous study in Tanzania, the results of the present study indicated a high level of adherence by providers in the domains of client history taking and HIV testing and counselling [52].

The availability of basic routine diagnostic tests is important for providing high-quality ANC services [53]. Although more than half of the consultation providers adhered to the aspect of performing or referring pregnant women for routine diagnostic tests, few facilities reported having tests for haemoglobin (Hb) and urinary protein. This discrepancy may have been because some providers discuss the importance of having routine tests with the client although such tests were not available within the facility. Therefore, the provider may request that the client undergo the test at another health facility. This finding was consistent with those of previous studies conducted in other SSA countries indicating the inadequate availability of recommended routine diagnostic tests, including those for Hb level and urinary protein, during ANC visits [43–45,47,54,55].

A physical examination and the provision of supplements to pregnant women are recommended for pregnant women in LMIC [56]. The present study indicated relatively high levels of provider adherence in the domains of physical examination and the provision of supplements to pregnant women during ANC visits. This can be explained as the physical examinations required during the first visit involve simple and relatively inexpensive equipment, such as a tape measure to determine fundal height, manual abdominal palpations, and a fetal-scope to determine fetal heart rate in cases where gestational age is 16 weeks or longer. These findings were consistent with those of previous studies performed in Uganda [57], Nigeria [58], and India [59].

Assessment of danger signs and education of women regarding obstetric complications are important components of ANC [60,61]. Both the previous and new WHO ANC models recommend that counseling and assessment of danger signs should be conducted during each ANC visit [20]. However, previous studies performed in Tanzania indicated that the majority of pregnant women were unaware of danger signs related to pregnancy despite having attended ANC visits [62–64]. In the present study, less than half of the observed ANC consultations assessed danger signs and counseled women on danger signs. Similar findings were reported in another study performed in Tanzania [65]. The poor adherence of providers in this important domain may result in a low level of awareness among women regarding obstetric danger signs, and therefore expose them to high risks of maternal complications [57].

In the present study, we analyzed a range of factors postulated to be associated with adherence to first-visit ANC standards using separate stratified regression models according to facility type and managing authority. The results obtained from these models indicated that good adherence to first-visit ANC was strongly associated with providers at health centers that regularly performed quality assurance at least on an annual basis. This may have been because quality assurance was accompanied by continuous monitoring and persistent feedback to improve services, thus guaranteeing and maintaining a high standard of service provided by the health-care system [66,67]. Hence emphasize should be made to promote the regular performance of quality assurance in order to improve the provider adherence to first-visit ANC standards. In addition, providers at hospitals and public facilities that had access to basic medicine and hospitals that had performed routine tests showed stronger associations with adherence to first-

visit ANC standards. This was consistent with the necessity of basic inputs, such as supportive equipment and appropriate medicines, to provide high-quality services [68]. In addition, providers at private facilities that received some extra incentives from the government were strongly associated with adherence to ANC standards. Most of these facilities are operated under the Public-Private Partnerships (PPP) for Health. Through this framework, private facilities operate as public facilities and receive financial incentives and other supplies from the government to provide ANC services without charge. Therefore, providers within these facilities are more likely to adhere to ANC standards than those in completely private facilities that are operated on a for-profit basis [69].

In contrast to evidence suggesting that ANC can be managed effectively by providers other than clinicians in low-risk pregnancies [70], the present study highlighted that clinicians at lower level facilities performed better with regard to adherence to first-visit ANC standards than other providers. This may have been because the shortage of sufficient personnel at lower level facilities in Tanzania resulted into some preventive services, such as ANC, being provided by nurse auxiliaries (attendants) [71]. Despite this, nurse auxiliaries receive only minimal pre-service training of 1 year and they are also excluded from refresher training due to the MoHCDGEC plan to phase out these personnel. Therefore, they have been reported as showing the least adequate adherence to ANC guidelines [71,72]. Efforts should be made to provide more competent health professionals through competency-based approach training to overcome the health workforce shortage in low resource settings, such as Tanzania [73,74].

Refresher training for health care providers creates the opportunity to receive the up-to-date information and skills required to provide quality health care [75,76]. The results of the present study support the suggestion that refresher training guarantees better ANC care [77,78]. This may be because refresher training improved the health care providers' knowledge and level of confidence, as these are important components in the provision of quality health services [79,80]. Such personnel may have been more likely to adhere to ANC standards of care than those who had not received refresher training or had received such training more than the 2 years previously. In contrast to our findings, a previous study using pooled data from eight countries, including Tanzania, suggested that refresher training for providers did not significantly improve the quality of ANC in that region [81].

Several studies have highlighted the impact of client characteristics on the adherence of providers to standards of care [48,82,83]. The results of the present study indicated that across almost all strata, adherence to first-visit ANC standards was better when providers attended women between 20 and 35 years old. This was similar to the findings of a previous study performed in Ghana [84]. Furthermore, our findings were consistent with those of previous studies indicating that older age was associated with higher quality ANC services [29,45], although our findings were not statistically significant.

The observed similarities between the findings of the current study and those reported in previous researches were due to the similarities in study design (both used cross-sectional survey) such as studies conducted in Uganda, Nigeria, and India [57–59]. Also, the observed difference between the findings of the current study and those from previous studies conducted in Tanzania may have been due to differences in sample size and number of regions included, i.e., the present study included all 30 regions of Tanzania and large sample, while the previous study included only one region [52]. In addition, the other study used some of the data (e.g., in TSPA 2006) which were collected more than 10 years ago [81]. This time difference may explain the changes in some of the aspects such as refresher training initiatives that prioritize competencies rather than the acquisition of knowledge through short-term lectures and seminars [73,74].

If all these factors identified in this study will be addressed properly, it will provide a good start for Tanzania and other countries with similar settings to adopt and implement the new WHO 2016 ANC model in order to improve quality of ANC.

The strength of the present study was that it used the TSPA 2014–2015 dataset, which is a comprehensive national dataset, suggesting that our findings accurately reflect the current situation regarding the quality of first-visits ANC in the study setting. In addition, the present study took into account multi-level factors (facility, provider, and client) and applied stratified analysis to identify targets for policy interventions.

Nevertheless, this study also had some limitations due to its cross-sectional nature, meaning that causality could not be inferred and the results should, therefore, be interpreted with caution. Based on our selection criteria, in the majority of health facilities, only one first-visit ANC was observed. This may have compromised the representativeness of all other possible first-visits ANC at these facilities. The use of stepwise elimination methods based on the highest *P*-value to fit the final models of logistic regression analysis may have undermined the validity of the final inferences. The use of an arbitrary approach to calculate the adherence score and the cut-off point set $\geq 60.5\%$ to dichotomize the outcome variable may have resulted in misclassification of provider adherence status. Finally, although the direct observation technique used in this study is regarded as the gold standard for assessing the quality of care, this technique is susceptible to observation biases as well as the Hawthorne effect, i.e., the alteration of behavior by the subjects of a study due to their awareness of being observed [85].

Conclusions

The results of the present study highlighted important factors, such as refresher training, regular distribution of basic medicines, the performance of quality assurance, and diagnostics equipment, influencing provider adherence to first-visit ANC standards. The new WHO 2016 ANC model emphasizes increasing the number of ANC visits to provide respectful, individualized, and personal care at each visit. The goals of this model could be reached in Tanzania by implementation together with efforts to improve the availability of ANC services, especially in lower-level and publicly owned facilities.

Supporting information

S1 Table. A summary for the measurement of outcome variable.
(DOCX)

S2 Table. A summary for the measurement of independent variables.
(DOCX)

Acknowledgments

We would like to acknowledge ICF International, Rockville, Maryland, USA, through the DHS program for giving us permission and access to the TSPA 2014–2015 dataset.

Author Contributions

Conceptualization: Deogratius Bintabara, Keiko Nakamura, Julius Ntwenya, Kaoruko Seino, Bonaventura C. T. Mpondo.

Data curation: Deogratius Bintabara, Julius Ntwenya, Bonaventura C. T. Mpondo.

Formal analysis: Deogratius Bintabara, Keiko Nakamura.

Investigation: Deogratius Bintabara, Julius Ntwenya, Bonaventura C. T. Mpondo.

Methodology: Deogratius Bintabara, Keiko Nakamura, Julius Ntwenya, Kaoruko Seino, Bonaventura C. T. Mpondo.

Project administration: Deogratius Bintabara, Keiko Nakamura, Kaoruko Seino.

Resources: Keiko Nakamura, Kaoruko Seino.

Supervision: Keiko Nakamura, Kaoruko Seino.

Visualization: Deogratius Bintabara, Keiko Nakamura.

Writing – original draft: Deogratius Bintabara, Julius Ntwenya, Bonaventura C. T. Mpondo.

Writing – review & editing: Deogratius Bintabara, Keiko Nakamura, Kaoruko Seino.

References

1. World Health Organization (WHO). Trends in Maternal Mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Geneva; WHO; 2015. <http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/>. Accessed 6 Nov 2018.
2. Alkema L, Chou D, Hogan D, Zhang S, Moller A, Gemmill A, et al. Global, Regional, and National Level and Trends in Maternal Mortality between 1990 and 2015, with Scenario Based Projections to 2030: A Systematic Analysis by The UN Maternal Mortality Estimation Inter Agency Group. 2015; 6736: 13.
3. National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011. Tanzania Demographic and Health Survey 2010. Dar es Salaam, Tanzania: NBS and ICF Macro. 2011: <https://dhsprogram.com/pubs/pdf/FR243/FR243%5B24June2011%5D.pdf>. Accessed 6 Nov 2018.
4. Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF. Tanzania Demographic and Health Survey. MoHCDGEC. 2016. <https://dhsprogram.com/pubs/pdf/FR321/FR321.pdf>. Accessed 6 Nov 2018.
5. Ministry of Health and Social Welfare (MoHSW). The National Road Map Strategic Plan to Accelerate Reduction of Maternal, Newborn and Child Deaths in Tanzania (2008–15). 2008. <http://www.who.int/pmnch/countries/tanzaniamapstrategic.pdf> Accessed 6 Nov 2018.
6. United Nations (UN). The Sustainable Development Goals Report 2016. United Nations. UN; 2016. https://www.un-ilibrary.org/economic-and-social-development/the-sustainable-development-goals-report_d3229fb0-en Accessed 6 Nov 2018.
7. Koblinsky M, Tinker A. Programming for Safe Motherhood: a guide to action. Health Policy Plan. 1994; 9: 252–266. PMID: [10137741](https://pubmed.ncbi.nlm.nih.gov/10137741/)
8. McDonagh M. Is antenatal care effective in reducing maternal morbidity and mortality? Health Policy Plan. 1996; 11: 1–15. PMID: [10155875](https://pubmed.ncbi.nlm.nih.gov/10155875/)
9. Oyerinde K. Can Antenatal Care Result in Significant Maternal Mortality Reduction in Developing Countries? J Community Med Health Educ. 2013;3.
10. Darmstadt GL, Bhutta ZA, Cousens S, Adam T, Walker N, De Bernis L. Evidence-based, cost-effective interventions: How many newborn babies can we save? Lancet. 2005; 365: 977–988. [https://doi.org/10.1016/S0140-6736\(05\)71088-6](https://doi.org/10.1016/S0140-6736(05)71088-6) PMID: [15767001](https://pubmed.ncbi.nlm.nih.gov/15767001/)
11. Adam T, Lim SS, Mehta S, Bhutta ZA, Fogstad H, Mathai M, et al. Cost effectiveness analysis of strategies for maternal and neonatal health in developing countries. BMJ. 2005; 331: 1107. <https://doi.org/10.1136/bmj.331.7525.1107> PMID: [16282407](https://pubmed.ncbi.nlm.nih.gov/16282407/)
12. World Health Organization (WHO). WHO Recommendation on Antenatal care for positive pregnancy experience. WHO. 2016; <http://apps.who.int/iris/bitstream/10665/250796/1/9789241549912-eng.pdf> Accessed 6 Nov 2018.
13. Smith A, McCormick M, Shapiro S. Antenatal care. Lancet. 1986; 327: 1331–1332. [https://doi.org/10.1016/S0140-6736\(86\)91254-7](https://doi.org/10.1016/S0140-6736(86)91254-7)
14. Abou-Zahr Carla Lidia / Wardlaw T. Antenatal care in Developing Countries: Promises, achievements and missed opportunities: an analysis of trends, levels and differentials, 1990–2001. Anal trends, levels Differ 1990–2001. 2003;
15. Di Mario S, Basevi V, Gori G, Spetoli D. What is the effectiveness of antenatal care? (Supplement). 2005; 25.

16. Villar J, Ba'aqeel H, Piaggio G, Lumbiganon P, Belizán JM, Farnot U, et al. WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. *Lancet*. 2001; 357: 1551–1564. PMID: [11377642](#)
17. JHPIEGO. Maternal and Neonatal Health. Focused antenatal care: planning and providing care during pregnancy. JHPIEGO. 2004. http://pdf.usaid.gov/pdf_docs/Pnada620.pdf. Accessed 6 Nov 2018.
18. Carroli G, Villar J, Piaggio G, Khan-Neelofur D, Gülmezoglu M, Mugford M, et al. WHO systematic review of randomised controlled trials of routine antenatal care. *Lancet*. 2001; 357: 1565–1570. [https://doi.org/10.1016/S0140-6736\(00\)04723-1](https://doi.org/10.1016/S0140-6736(00)04723-1) PMID: [11377643](#)
19. Vogel JP, Habib NA, Souza JP, Gülmezoglu AM, Dowswell T, Carroli G, et al. Antenatal care packages with reduced visits and perinatal mortality: a secondary analysis of the WHO Antenatal Care Trial. *Reprod Health*. 2013; 10: 19. <https://doi.org/10.1186/1742-4755-10-19> PMID: [23577700](#)
20. World Health Organization (WHO). WHO Recommendation on Antenatal care for positive pregnancy experience. WHO. 2016. http://www.who.int/reproductivehealth/publications/maternal_perinatal_health/anc-positive-pregnancy-experience/en/ Accessed 6 Nov 2018.
21. The United Republic of Tanzania (URT); Ministry of Health and Social welfare. Focused, antenatal care, malaria and syphilis in pregnancy: Orientation package for service providers. URT. 2002. http://pdf.usaid.gov/pdf_docs/pnaea268.pdf. Accessed 6 Nov 2018.
22. Kearns Annie, Hurst Taylor, Caglia Jacquelyn LA. Focused antenatal care in Tanzania. Harvard. 2014. <https://cdn2.sph.harvard.edu/wp-content/uploads/sites/32/2014/09/HSPH-Tanzania5.pdf>. Accessed 6 Nov 2018.
23. Kanyangarara M, Munos MK, Walker N. Quality of antenatal care service provision in health facilities across sub-Saharan Africa: Evidence from nationally representative health facility assessments. *J Glob Health*. 2017; 7. <https://doi.org/10.7189/jogh.07.021101> PMID: [29163936](#)
24. Donabedian A. The quality of care. How can it be assessed? 1988. *Arch Pathol Lab Med*. 1997; 121: 1145–1150.
25. Morris C, Bailey K. Measuring Health Care Quality : An Overview of Quality Measures. 2014. http://familiesusa.org/sites/default/files/product_documents/HSIQualityMeasurement_Brief_final_web.pdf. Accessed 6 Nov 2018.
26. Rahman El Gammal HAAA. Dimensions of quality of antenatal care service at suez, egypt. *J Fam Med Prim care*. 2014; 3: 238–242.
27. Duysburgh E, Williams A, Williams J, Loukanova S, Temmerman M. Quality of antenatal and childbirth care in northern Ghana. *BJOG*. 2014; 121: 117–126. <https://doi.org/10.1111/1471-0528.12905> PMID: [25236645](#)
28. Heredia-Pi I, Servan-Mori E, Darney BG, Reyes-Morales H, Lozano R. Measuring the adequacy of antenatal health care: a national cross-sectional study in Mexico. *WHO Bulletin*. 2016; 94: 452–461. <https://doi.org/10.2471/BLT.15.168302> PMID: [27274597](#)
29. Kruk ME, Chukwuma A, Mbaruku G, Leslie HH. Variation in quality of primary-care services in Kenya, Malawi, Namibia, Rwanda, Senegal, Uganda and United Republic of Tanzania. *Bull World Heal Organ*. 2017; 95: 408–418.
30. Abou-Zahr I, Lidia C, Wardlaw Tessa M. Antenatal Care in Developing Countries Promises, achievements and missed opportunities. 2003; 1–36. 25/12/2014
31. Mrisho M, Obrist B, Schellenberg JA, Haws RA, Mushi AK, Mshinda H, et al. The use of antenatal and postnatal care: perspectives and experiences of women and health care providers in rural southern Tanzania. *BMC Pregnancy Childbirth*. 2009; 9: 10. <https://doi.org/10.1186/1471-2393-9-10> PMID: [19261181](#)
32. Gross K, Alba S, Glass TR, Schellenberg JA, Obrist B. Timing of antenatal care for adolescent and adult pregnant women in south-eastern Tanzania. *BMC Pregnancy Childbirth*. 2012; 12: 16. <https://doi.org/10.1186/1471-2393-12-16> PMID: [22436344](#)
33. Gupta S, Yamada G, Mpembeni R, Frumence G, Callaghan-Koru JA, Stevenson R, et al. Factors Associated with Four or More Antenatal Care Visits and Its Decline among Pregnant Women in Tanzania between 1999 and 2010. Noor AM, editor. *PLoS One*. 2014; 9: e101893. <https://doi.org/10.1371/journal.pone.0101893> PMID: [25036291](#)
34. Boller C, Wyss K, Mtasiwa D, Tanner M. Quality and comparison of antenatal care in public and private providers in the United Republic of Tanzania. *Bull World Health Organ*. 2003; 81: 116–122. PMID: [12751419](#)
35. Sarker M, Schmid G, Larsson E, Kirenga S, De Allegri M, Neuhann F, et al. Quality of antenatal care in rural southern Tanzania: a reality check. *BMC Res Notes*. 2010; 3: 209. <https://doi.org/10.1186/1756-0500-3-209> PMID: [20663202](#)

36. Ministry of Health and Social Welfare (MoHSW) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF International 2015. Tanzania Service Provision Assessment Survey (TSPA) 2014–15. Dar es Salaam, Tanzania, and Rockville, Maryland, USA: MoHSW, MoH, NBS, OCGS, ICF International. 2015. <https://dhsprogram.com/pubs/pdf/SPA22/SPA22.pdf>. Accessed 6 Nov 2018.
37. World Health Organization (WHO). Service Availability and Readiness Assessment (SARA): An annual monitoring system for service delivery: Implementation Guide Version 2.2. WHO. 2016. http://www.who.int/healthinfo/systems/sara_introduction/en/7 Accessed 6 Nov 2018.
38. von Both C, Fleßa S, Makuwani A, Mpembeni R, Jahn A. How much time do health services spend on antenatal care? Implications for the introduction of the focused antenatal care model in Tanzania. *BMC Pregnancy Childbirth*. 2006; 6: 22. <https://doi.org/10.1186/1471-2393-6-22> PMID: 16796749
39. Leslie HH, Malata A, Ndiaye Y, Kruk ME. Effective coverage of primary care services in eight high-mortality countries. *BMJ Glob Heal*. 2017; 2: e000424.
40. Bintabara D, Nakamura K, Seino K. Determinants of facility readiness for integration of family planning with HIV testing and counseling services: evidence from the Tanzania service provision assessment survey, 2014–2015. *BMC Health Serv Res*. 2017; 17: 844. <https://doi.org/10.1186/s12913-017-2809-8> PMID: 29273033
41. Bintabara D, Mpondo BCT. Preparedness of lower-level health facilities and the associated factors for the outpatient primary care of hypertension: Evidence from Tanzanian national survey. Musinguzi G, editor. *PLoS One*. 2018; 13: e0192942. <https://doi.org/10.1371/journal.pone.0192942> PMID: 29447231
42. Heredia-Pi I, Servan-Mori E, Darney G, Reyes-Morales H, Lozano R. Measuring the adequacy of antenatal health care: a national cross-sectional study in Mexico. *Bull World Health Organ*. 2016; 94: 452–461. <https://doi.org/10.2471/BLT.15.168302> PMID: 27274597
43. Kyei NNA, Chansa C, Gabrysch S. Quality of antenatal care in Zambia: a national assessment. *BMC Pregnancy Childbirth*. 2012; 12: 151. <https://doi.org/10.1186/1471-2393-12-151> PMID: 23237601
44. Fagbamigbe AF, Idemudia ES. Assessment of quality of antenatal care services in Nigeria: evidence from a population-based survey. *Reprod Health. BioMed Central*; 2015; 12: 88.
45. Joshi C, Torvaldsen S, Hodgson R, Hayen A. Factors associated with the use and quality of antenatal care in Nepal: a population-based study using the demographic and health survey data. *BMC Pregnancy Childbirth. BMC Pregnancy and Childbirth*; 2014; 14: 94. <https://doi.org/10.1186/1471-2393-14-94> PMID: 24589139
46. Afulani PA. Rural/urban and socioeconomic differentials in quality of antenatal care in Ghana. *PLoS One. Public Library of Science*; 2015; 10: e0117996.
47. Amoakoh-Coleman M, Klipstein-Grobusch K, Agyepong IA, Kayode GA, Grobbee DE, Ansah EK. Provider adherence to first antenatal care guidelines and risk of pregnancy complications in public sector facilities: a Ghanaian cohort study. *BMC Pregnancy Childbirth*. 2016; 16: 369.
48. Amoakoh-Coleman M, Agyepong IA, Zuihoff NPA, Kayode GA, Grobbee DE, Klipstein-Grobusch K, et al. Client Factors Affect Provider Adherence to Clinical Guidelines during First Antenatal Care. Gutman J, editor. *PLoS One*. 2016; 11: e0157542. <https://doi.org/10.1371/journal.pone.0157542> PMID: 27322643
49. Wang WJ, Do M, Hembling J, Ametepi P. Assessing the quality of care in family planning, antenatal, and sick child services at health facilities in Kenya, Namibia, and Senegal. DHS. 2014. <http://www.dhsprogram.com/pubs/pdf/AS44/AS44.pdf>. Accessed 25 May 2018.
50. Desalegn DM, Abay S, Taye B. The availability and functional status of focused antenatal care laboratory services at public health facilities in Addis Ababa, Ethiopia. *BMC Res Notes*. 2016; 9: 403. <https://doi.org/10.1186/s13104-016-2207-z> PMID: 27514511
51. Choi Y, Ametepi P. Comparison of medicine availability measurements at health facilities: evidence from Service Provision Assessment surveys in five sub-Saharan African countries. *BMC Health Serv Res*. 2013; 13: 266. <https://doi.org/10.1186/1472-6963-13-266> PMID: 23837467
52. Solnes Miltenburg A, van der Eem L, Nyanza EC, van Pelt S, Ndaki P, Basinda N, et al. Antenatal care and opportunities for quality improvement of service provision in resource limited settings: A mixed methods study. Puebla I, editor. *PLoS One*. 2017; 12: e0188279. <https://doi.org/10.1371/journal.pone.0188279> PMID: 29236699
53. Kerber KJ, de Graft-Johnson JE, Bhutta ZA, Okong P, Starrs A, Lawn JE. Continuum of care for maternal, newborn, and child health: from slogan to service delivery. *Lancet*. 2007; 370: 1358–1369. [https://doi.org/10.1016/S0140-6736\(07\)61578-5](https://doi.org/10.1016/S0140-6736(07)61578-5) PMID: 17933651
54. Nyamtema AS, Bartsch-de Jong A, Urassa DP, Hagen JP, van Roosmalen J. The quality of antenatal care in rural Tanzania: what is behind the number of visits? *BMC Pregnancy Childbirth*. 2012; 12: 70. <https://doi.org/10.1186/1471-2393-12-70> PMID: 22823930

55. Nikiema L, Kameli Y, Capon G, Sondo B, Martin-Prével Y. Quality of antenatal care and obstetrical coverage in rural Burkina faso. *J Heal Popul Nutr*. 2010; 28: 67–75.
56. Carolan M, Cassar L. Antenatal care perceptions of pregnant African women attending maternity services in Melbourne, Australia. *Midwifery*. 2010; 26: 189–201. <https://doi.org/10.1016/j.midw.2008.03.005> PMID: 18653262
57. Tetui M, Ekirapa EK, Bua J, Mutebi A, Tweheyo R, Waiswa P. Quality of Antenatal care services in eastern Uganda: implications for interventions. *Pan Afr Med J*. 2012; 13: 27. PMID: 23308332
58. Osungbade K, Oginni S, Olumide A. Content of antenatal care services in secondary health care facilities in Nigeria: implication for quality of maternal health care. *Int J Qual Heal Care*. 2007; 20: 346–351.
59. Munuswamy S, Nakamura K, Seino K, Kizuki M. Inequalities in Use of Antenatal Care and Its Service Components in India. *J Rural Med*. 2014; 9: 10–19. <https://doi.org/10.2185/jrm.2877> PMID: 25649920
60. Bintabara D, Mohamed MA, Mghamba J, Wasswa P, Mpembeni RN. Birth preparedness and complication readiness among recently delivered women in chamwino district, central Tanzania: a cross sectional study. *Reprod Health*. 2015; 12: 44. <https://doi.org/10.1186/s12978-015-0041-8> PMID: 25981513
61. JHPIEGO. Maternal and Neonatal Health Programme Birth Preparedness and Complication Readiness: A Matrix of Shared Responsibilities. Revised. JHPIEGO. 2004. <http://reprolineplus.org/resources/birth-preparedness-and-complication-readiness-matrix-shared-responsibility> Accessed 6 Nov 2018.
62. Pembe AB, Urassa DP, Carlstedt A, Lindmark G, Nyström L, Darj E. Rural Tanzanian women's awareness of danger signs of obstetric complications. *BMC Pregnancy Childbirth*. 2009; 9: 12. <https://doi.org/10.1186/1471-2393-9-12> PMID: 19323836
63. Urassa DP, Pembe AB, Mganga F. Birth preparedness and complication readiness among women in Mpwapwa district, Tanzania. *Tanzan J Health Res*. National Institute for Medical Research; 2012; 14.
64. Bintabara D, Mpembeni RNM, Mohamed AA. Knowledge of obstetric danger signs among recently-delivered women in Chamwino district, Tanzania: a cross-sectional study. *BMC Pregnancy Childbirth*. 2017; 17: 276. <https://doi.org/10.1186/s12884-017-1469-3> PMID: 28851408
65. Pembe AB, Carlstedt A, Urassa DP, Lindmark G, Nyström L, Darj E, et al. Quality of antenatal care in rural Tanzania: counseling on pregnancy danger signs. *BMC Pregnancy Childbirth*. *BioMed Central*; 2010; 10: 35
66. de Jonge V, Nicolaas JS, van Leerdam ME, Kuipers EJ. Overview of the quality assurance movement in health care. *Best Pract Res Clin Gastroenterol*. 2011; 25: 337–347. <https://doi.org/10.1016/j.bpg.2011.05.001> PMID: 21764002
67. Busari J. Comparative analysis of quality assurance in health care delivery and higher medical education. *Adv Med Educ Pract*. 2012; 121.
68. Mosadeghrad AM. Factors Influencing Healthcare Service Quality. *Int J Heal Policy Manag*. 2014; 3: 77–89.
69. White James, O'Hanlon Barbara Chee Grace, Emmanuel Malangalila, Kimambo Adeline, Coarasa Jorge, Callahan Sean, Levey Ilana Ron and M K. Tanzania private health sector assessment. Bethesda, MD: Strengthening Health Outcomes through the Private Sector Project, Abt Associates Inc. 2013.
70. Bhutta ZA, Darmstadt GL, Haws RA, Yakoob M, Lawn JE. Delivering interventions to reduce the global burden of stillbirths: improving service supply and community demand. *BMC Pregnancy Childbirth*. 2009; 9: S7. <https://doi.org/10.1186/1471-2393-9-S1-S7> PMID: 19426470
71. Gross K, Schellenberg JA, Kessy F, Pfeiffer C, Obrist B. Antenatal care in practice: an exploratory study in antenatal care clinics in the Kilombero Valley, south-eastern Tanzania. *BMC Pregnancy Childbirth*. 2011; 11: 36. <https://doi.org/10.1186/1471-2393-11-36> PMID: 21599900
72. Mubyazi GM, Bygbjerg IC, Magnussen P, Olsen Ø, Byskov J, Hansen KS, et al. Prospects, achievements, challenges and opportunities for scaling-up malaria chemoprevention in pregnancy in Tanzania: the perspective of national level officers. *Malar J*. 2008; 7: 135. <https://doi.org/10.1186/1475-2875-7-135> PMID: 18647404
73. Kaaya EE, Macfarlane SB, Mkony CA, Lyamuya EF, Loeser H, Freeman P, et al. Educating Enough Competent Health Professionals: Advancing Educational Innovation at Muhimbili University of Health and Allied Sciences, Tanzania. *PLoS Med*. 2012; 9: e1001284. <https://doi.org/10.1371/journal.pmed.1001284> PMID: 22904688
74. Cancedda C, Farmer PE, Kerry V, Nuthulaganti T, Scott KW, Goosby E, et al. Maximizing the Impact of Training Initiatives for Health Professionals in Low-Income Countries: Frameworks, Challenges, and Best Practices. *PLOS Med*. 2015; 12: e1001840. <https://doi.org/10.1371/journal.pmed.1001840> PMID: 26079377

75. De Jongh T, Gurol-Urganci I, Allen E, Zhu NJ, Atun R. Barriers and enablers to integrating maternal and child health services to antenatal care in low and middle income countries. *BJOG*. 2016; 123: 549–557. <https://doi.org/10.1111/1471-0528.13898> PMID: 26861695
76. Dale DC. Issues in health services. *Soc Sci Med Part C Med Econ*. 1981; 15: 199.
77. Ejigu Tafere T, Afework MF, Yalew AW. Antenatal care service quality increases the odds of utilizing institutional delivery in Bahir Dar city administration, North Western Ethiopia: A prospective follow up study. Ghose B, editor. *PLoS One*. 2018; 13: e0192428. <https://doi.org/10.1371/journal.pone.0192428> PMID: 29420598
78. Villadsen SF, Negussie D, GebreMariam A, Tilahun A, Friis H, Rasch V. Antenatal care strengthening for improved quality of care in Jimma, Ethiopia: an effectiveness study. *BMC Public Health*. 2015; 15: 360. <https://doi.org/10.1186/s12889-015-1708-3> PMID: 25884590
79. Meri n AER, van de Ven J, Mol BW, Houterman S, Oei SG. Multidisciplinary Team Training in a Simulation Setting for Acute Obstetric Emergencies. *Obstet Gynecol*. 2010; 115: 1021–1031.
80. Lassi ZS, Haider BA, Bhutta ZA. Community-based intervention packages for reducing maternal and neonatal morbidity and mortality and improving neonatal outcomes. In: Bhutta ZA, editor. *Cochrane Database of Systematic Reviews*. Chichester, UK: John Wiley & Sons, Ltd; 2010. p. CD007754.
81. Leslie HH, Gage A, Nsona H, Hirschhorn LR, Kruk ME. Training And Supervision Did Not Meaningfully Improve Quality Of Care For Pregnant Women Or Sick Children In Sub-Saharan Africa. *Health Aff*. 2016; 35: 1716–1724.
82. Halm EA. Understanding Physician Adherence With a Pneumonia Practice Guideline: Effects of Patient, System, and Physician Factors. *Arch Intern Med*. 2000; 160: 98–104. PMID: 10632310
83. Papaevangelou V, Hadjichristodoulou C, Cassimos D, Theodoridou M. Adherence to the screening program for HBV infection in pregnant women delivering in Greece. *BMC Infect Dis*. 2006; 6: 84. <https://doi.org/10.1186/1471-2334-6-84> PMID: 16681862
84. Atinga R, Baku A. Determinants of antenatal care quality in Ghana. *Int J Soc Econ*. Emerald Group Publishing Limited; 2013; 40: 852–865.
85. Leonard K, Masatu MC. Outpatient process quality evaluation and the Hawthorne Effect. *Soc Sci Med*. 2006; 63: 2330–2340. <https://doi.org/10.1016/j.socscimed.2006.06.003> PMID: 16887245