Social Science & Medicine 291 (2021) 114492

Contents lists available at ScienceDirect

Social Science & Medicine

journal homepage: www.elsevier.com/locate/socscimed

Patterns, travel to care and factors influencing obstetric referral: Evidence from Nigeria's most urbanised state

Aduragbemi Banke-Thomas [a,b,*], Cephas Avoka [c], Abimbola Olaniran [d], Mobolanle Balogun [e], Ololade Wright [b,f], Olabode Ekerin [g], Lenka Benova [h]

[a] LSE Health, London School of Economics and Political Science, London, United Kingdom
[b] Centre for Reproductive Health Research and Innovation, Lagos State University College of Medicine, Ikeja, Lagos, Nigeria
[c] Faculty of Public Health, Ghana College of Physicians and Surgeons, Accra, Ghana
[d] Infectious Disease and Epidemiology, London School of Hygiene and Tropical Medicine Faculty of Epidemiology and Population Health, London, United Kingdom
[e] Department of Community Health and Primary Care, College of Medicine, University of Lagos, Lagos, Nigeria
[f] Department of Community Health and Primary Health Care, Lagos State University College of Medicine, Ikeja, Lagos, Nigeria
[g] Department of Obstetrics and Gynaecology, Obafemi Awolowo University, Ile-Ife, Osun, Nigeria
[h] Department of Public Health, Institute of Tropical Medicine, Antwerpen, Belgium

ARTICLE INFO

Keywords:
Referral
Public sector
Maternal health
Emergency obstetric care
Pregnant women
Nigeria
Sub-Saharan Africa

ABSTRACT

The criticality of referral makes it imperative to study its patterns and factors influencing it at a health systems level. This study of referral in Lagos, Nigeria is based on health records of 4181 pregnant women who presented with obstetric emergencies at one of the 24 comprehensive emergency obstetric care (EmOC) facilities in the state between November 2018 and October 2019 complemented with distance and time data extracted from Google Maps. Univariate, bivariate, and multivariate analyses were conducted. About a quarter of pregnant women who presented with obstetric emergencies were referred. Most referrals were from primary health centres (41.9 %), private (23.5 %) and public (16.2 %) hospitals. Apart from the expected low-level to high-level referral pattern, there were other patterns observed including non-formal, multiple, and post-delivery referrals. Travel time and distance to facilities that could provide needed care increased two-fold on account of referrals compared to scenarios of going directly to the final facility, mostly travelling to these facilities by private cars/taxis (72.8 %). Prolonged/obstructed labour was the commonest obstetric indication for referral, with majority of referred pregnant women delivered via caesarean section (52.9 %). After adjustment, being married, not being registered for antenatal care at facility of care, presenting at night or with a foetus in distress increased the odds of referral. However, parity, presentation in the months following the commissioning of a new comprehensive EmOC facility or with abortion reduced the likelihood of being referred. Our findings underscore the need for health systems strengthening interventions that support women during referral and the importance of antenatal care and early booking to aid identification of potential pregnancy complications whilst establishing robust birth preparedness plans that can minimise the need for referral in the event of emergencies. Indeed, there are context-specific influences that need to be addressed if effective referral systems are to be designed.

1. Introduction

Globally, 295,000 maternal deaths and two million stillbirths occur annually, with 99 % and 98 % of the global burden occurring in low- and middle-income countries (LMICs), respectively. Of these annual global deaths, 67,000 maternal deaths (23 % of global maternal deaths) and over 171,000 stillbirths (9 % of global burden) occur in Nigeria alone (UNICEF et al., 2020; WHO et al., 2019). In September 2015, reducing maternal mortality ratio (MMR) to less than 70 per 100,000 live births by the year 2030 was established as one of the key targets of Sustainable Development Goal 3, which seeks to ensure healthy lives and promote well-being for all ages (United Nations, 2016). If this is to be achieved, prompt access to emergency obstetric care (EmOC), a care package of evidence-based medical interventions addressing the leading causes of maternal and neonatal mortality, will be critical (Campbell and Graham, 2006; WHO et al., 2018). EmOC has been shown to reduce maternal

* Corresponding author. LSE Health, London School of Economics and Political Science, London, WC2A 2AE, UK.
E-mail address: a.banke-thomas@lse.ac.uk (A. Banke-Thomas).

https://doi.org/10.1016/j.socscimed.2021.114492
Received 22 March 2021; Received in revised form 1 October 2021; Accepted 14 October 2021
Available online 15 October 2021

deaths by 50 % and stillbirths by up to 75 % (Paxton et al., 2005).

Health facilities that provide seven EmOC interventions, including parenteral administration of antibiotics, uterotonic drugs, anticonvulsants, manual removal of placenta, removal of retained products of conception, assisted vaginal delivery, and neonatal resuscitation, are classified as basic EmOC facilities. In addition to these seven interventions, facilities that provide blood transfusion and surgery (i.e., caesarean section and exploratory laparotomy) are comprehensive EmOC facilities (WHO et al., 2009).

Multiple factors contribute to delay in receiving health care. These include some delays that women may experience when deciding to seek care and others while travelling to a health facility, including traffic and road conditions. However, even after reaching a health facility, such a facility may not have the capacity to provide the requisite care needed by the woman in an emergency (Thaddeus and Maine, 1994). In such instances of inadequate capacity, a referral, defined as "a process in which a health worker at a level of the health system (initiating facility), having insufficient resources (drugs, equipment, skills) to manage a clinical condition, seeks the assistance of a better or differently resourced facility at the same or higher level (receiving facility) to assist in, or take over the management of, the client's case" (WHO, 2005), is needed. In some instances, a woman might require multiple referrals before she reaches a health facility that is adequately resourced to provide the much-needed care (Elmusharaf et al., 2017). As per global guidelines, the more complex emergencies should be referred from lower-level basic EmOC facilities (such as primary health centres (PHCs)) to higher-level comprehensive EmOC facilities (e.g., hospitals), which are expected to have the capacity to provide the complete care needed by pregnant women with obstetric emergencies (WHO et al., 2009).

Despite over a decade-long recognition of critical research needs to optimise obstetric referral systems in LMICs, including the need for theoretically informed research (Murray and Pearson, 2006), the empirical evidence on the topic has remained limited. Where quantitative studies exist, particularly in sub-Saharan Africa, these studies have mostly been descriptive, and many have been based on data collected from only one or two health facilities (Assefa and Berhane, 2020; Awoyesuku and MacPepple, 2019; Nkyekyer, 2000; Okafor et al., 2015). However, policies to strengthen EmOC should also be informed by studies of referral across multiple health facilities in a health system. When studies have been conducted across multiple health facilities in sub-Saharan Africa, for example, in Ethiopia (12 public health centres) and Ghana (977 health facilities) (Bailey et al., 2019; Mirkuzie et al., 2016), these studies have primarily focused on describing patterns, without paying attention to factors influencing referral. In addition, there has been limited attention paid to the distance and time that pregnant women have needed to undertake while being referred. Understanding these factors will be critical for improving referral systems, especially as more than half of maternal near-misses arriving at Nigerian public hospitals are referrals from lower-level facilities and private hospitals (Oladapo et al., 2016), and delays in referrals have been associated with stillbirths (Banke-Thomas et al., 2021a). Our objective in this study was to describe patterns, travel time and distance and assess factors that influence referral for EmOC within the public health system of Lagos State, south-west Nigeria.

2. Methods

2.1. Setting

According to recent estimates, the MMR estimate In Nigeria is 917 maternal deaths per 100,000 live births (WHO et al., 2019). While there is no recent state-wide estimate of MMR in Lagos State, a 2017 study reported MMR as high as 1050 per 100,000 live births in some slum areas of Lagos (Anastasi et al., 2017). Within comprehensive EmOC facilities in the state, institutional MMR has been estimated to range from 987 to 2111 per 100,000 live births (Okonofua et al., 2017).

As of the year 2019, the population of Lagos State was put at 26 million (LASG, 2019). Like the rest of the country, public sector healthcare provision in Lagos is three-tiered (primary, secondary, and tertiary). Within the public sector, there are 256 primary healthcare centres (PHCs) at the primary level, 17 general hospitals (including 12 specifically designated as specialist maternal and childcare centres [MCCs]) and three secondary health centres at the secondary level (non-apex public referral hospital), and four teaching/residency training hospitals at the tertiary level (apex public referral hospital), bringing to a total of 24 public hospitals in Lagos (FMOH, 2019) (Table S1). While PHCs are classed as basic EmOC facilities, general hospitals/MCCs and teaching hospitals are comprehensive EmOC facilities and are expected to function 24 h a day. As per the State's Health Facility Monitoring and Accreditation Agency (HEFAMAA), there are also 1329 accredited private hospitals, 399 clinics and 295 maternity homes. All clinics and most private hospitals are basic EmOC facilities, while some private hospitals are classed as comprehensive EmOC facilities. On the other hand, maternity homes are expected to provide antenatal care (ANC) and uncomplicated childbirth services, with basic or comprehensive EmOC is beyond their scope of practice. Across the board, twice as many Nigerian women give birth in public facilities (26 %) compared to private facilities (13 %) (National Population Commission and ICF International, 2019).

The referral practice in Lagos is similar to what is obtainable in many other LMIC settings. Pregnant women with emergencies can leave their homes or other locations in the community and are expected to travel towards formally recognised facilities, including hospitals (public or private), PHCs, clinics, or nursing/maternity homes. Some women in Lagos choose to go to non-formal settings like religious organisations, chemists, or traditional birth attendants (TBAs), despite living close to formal health facilities (Olusanya et al., 2010). Regarding TBAs in the state, they can be registered or unregistered. The registered TBAs complete training on recognising danger signs are assessed for fitness to practice by the Medical Officer of Health at the local government level, accredited by HEFAMAA at the state level and registered with the State Traditional Medicine Board. The registered TBAs are also supervised by Apex Community Health Officers and linked to specific PHCs or non-apex hospitals for referrals (Lagos State Government, 2006). Essentially, the registered ones are integrated within the referral system, as is done in a few other LMIC settings (Miller and Smith, 2017). However, unregistered TBAs are not incorporated in formal referral pathways but still refer some women in need of care. Irrespective of the first level of care visited (formal or non-formal), pregnant women identified as requiring EmOC at lower-level facilities would need to travel to another facility, typically a higher-level one, to receive the requisite care (Fig. 1).

For transport in an emergency, the Lagos State Ambulance system functions to transfer patients between facilities. Though the service is not always available for pregnant women, when it is, it mainly transfers women from hospitals to other hospitals and not from PHCs (Banke-Thomas et al., 2020). Poor road infrastructure, traffic congestion, other commuters not giving way and community disturbance are some reasons that minimise the service effectiveness for patient transfer during referrals (Adewole et al., 2012; Venkatraman et al., 2020).

2.2. Data collection

A list of all pregnant women who presented at obstetric emergency rooms in any of the 24 public comprehensive EmOC facilities in Lagos between November 1, 2018 and October 31, 2019 with any major pregnancy and childbirth complication, as defined by the World Health Organization (WHO et al., 2009), was retrospectively extracted from facility registers. However, one facility (Eti-Osa MCC) was being built, and another, the Institute of Maternal and Child Health (IMCH, commonly known as Àyìnkę House), was closed for repairs for some part

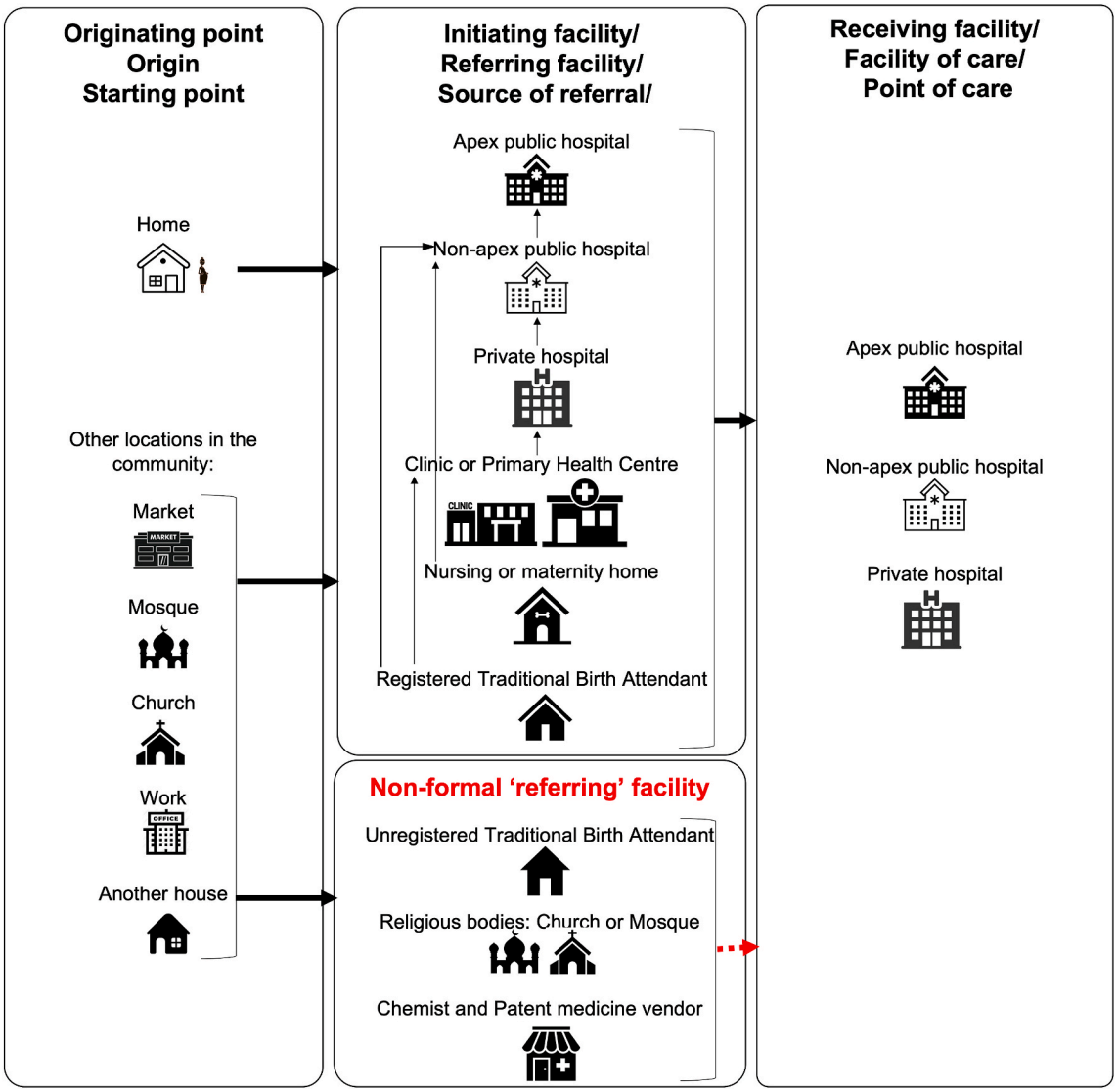

Fig. 1. Schematic representation of pathways to care for pregnant women in Lagos.

of our data collection period (Tribune Online, 2019; Ugvodaga, 2019). As such, data was only collected for September 1, 2019 to December 31, 2019 for Eti-Osa MCC and July 1, 2019 to September 30, 2019 for IMCH. The major complications included in the study were obstructed labour, haemorrhage, hypertension, sepsis, abortion and others to the expectant mother and foetal distress or intrauterine foetal death for the foetus.

Based on the patient identification data extracted from the facility registers, health records of such women, which are kept in the hospital in paper format, were pulled out for detailed data extraction. Using a pre-tested data extraction tool, data on socio-demographic characteristics, obstetric history, travel points to reach the receiving facility (including originating and referral points, if applicable), obstetric complication(s) managed (WHO et al., 2009), and EmOC intervention received were extracted from the health records (Definition and description of variables presented in Table S2). The data extraction process was conducted at the same time for all comprehensive EmOC facilities in the state. The data were collected by members of the research team supported by trained research assistants, all of whom were medical doctors with more than two years of experience working in a Lagos State comprehensive EmOC facility.

For referred pregnant women whose journeys could be traced from information available in their health records (96 % of the sample), their originating point, initiating facility and receiving facility, as extracted from their records, were geocoded. Driving distance (in kilometres (km)) and travel time (in minutes (mins)) to the receiving facility for the period-of-day that the woman travelled was estimated using the 'typical time of travel' feature of Google Maps (Alphabet Inc., Mountain View, California, United States). In cases in which we could not tell the period-of-day that women travelled to the hospital (33 % of cases), travel time was extracted for the afternoon (3.00 p.m.), as it was a mid-point estimate between the two known travel peak periods in Lagos (6.30 a.m. and 11.30 a.m. (morning peak period) and 3.00 p.m. and 7.30 p.m. (evening peak period)) (Asiyanbola et al., 2012). Furthermore, an assumption was made that the women travelled to the facility with a public or privately-owned motor vehicle, as this is almost always the transport mode of choice used by pregnant women in emergencies, especially as tricycles and motorcycles have been banned in the state (Banke-Thomas et al., 2020). In addition to the travel time and distance estimated for referred women from the originating point through initiating to receiving (referral pathway), time and distance were also calculated for a scenario in which the women went directly to the final 'receiving' facility (direct pathway).

2.3. Data analysis

All statistical analyses were done using STATA SE 15.0® (StataCorp,

College Station, Texas, United States). Descriptive statistics were used to summarise the socio-demographic and obstetric characteristics of pregnant women who presented with an obstetric emergency in Lagos public comprehensive EmOC facilities. Specifically, frequencies and percentages were used for categorical variables. For continuous variables, median with interquartile range (IQR) was used. A comparative analysis of median driving distances and travel times following the referral pathway taken by women who were referred with the same metrics for a scenario if they had travelled directly to the receiving facility (direct pathway) was conducted. Outliers were not excluded from the analysis. However, missing data were excluded from the analysis.

Apart from the referral to a comprehensive EmOC variable, which was the outcome being tested in this study, and as such, the dependent variable, all other variables were treated as independent variables for our analysis (Table S2). To examine associations between the dependent and the various independent variables, odds and odds ratios were calculated. Bivariate analysis explored the odds of being referred for socio-demographic, obstetric and travel-related characteristics of respondents. A stepwise multivariable logistic regression model incorporated factors showing strong association with referral from the bivariate analysis. Building on theoretical and empirical evidence (Hussein et al., 2012; Murray and Pearson, 2006), all other relevant variables were included, ensuring that all variables were adjusted for each other in the model. As variables were added to the model, a likelihood ratio test was conducted for each run to test that the model still fit the data significantly better than the one with fewer variables. *P*-values with a significance threshold of 0.05 and 95 % confidence intervals of the adjusted odds ratio were used to show the strength of evidence.

2.4. Ethical approval

Ethical approval was obtained from the Research and Ethics Committees of the Lagos University Teaching Hospital (ADM/DCST/HREC/APP/2880) and Lagos State University Teaching Hospital (LREC/06/10/1226). To ensure privacy, only medical doctors who were part of the research team were allowed to input data, and no patient identifying data was extracted.

3. Results

In the one-year period of the study, 4181 pregnant women presented with an obstetric emergency. Of the total sample, 1015 (24.3 %) were received as a referral. Fifty-two women (1.2 %) had two or more referrals before reaching a hospital that could provide the care needed, and 22 (0.5 %) were referred from non-formal settings like churches and mosques. Of those referred (1,015), 51 (4.9 %) had babies delivered after 28 weeks' gestation who had to be referred again for specialist newborn care after delivery in the receiving hospital.

More women who were referred were aged 20–34 years (72.4 %), married (94.8 %), self-employed petty traders (50.3 %) and had attained secondary education (57.5 %). In terms of obstetric features, referrals were commoner amongst women who had no history of obstetric complication in previous pregnancies (86.3 %) and those who had given birth to one to four children previously - multiparous (63.4 %), with singletons (95.1 %). Those who had no record of ANC visits at the hospital of care (un-booked) (91.7 %). Preeclampsia/eclampsia (30.3 %), haemorrhage (22.4 %), obstructed labour, and reduced foetal movement (15.3 %) were the commonest indication for referral. March (12.7 %) followed by April (11.5 %) recorded the highest number of referrals, while Tuesday (17.5 %) had the highest for the day of the week. Most referrals were women who travelled to the health facility in the morning (33.5 %), whilst personal car (50.0 %) and taxi (22.8 %) were the commonest means of travel for referrals. Many referrals were eventually delivered via caesarean section (52.9 %) (Table 1).

In terms of type of facility initiating the referral, 425 (41.9 %), 238 (23.5 %) and 164 (16.2 %) were referred from a PHC, private and public

Table 1
Socio-demographics, obstetric history, and characteristics of index pregnancy.

Characteristics	Total N = 4181 (n (%))	Referral (n = 1015) (n (%))	Non-referral (n = 3166) (n (%))	*p*-value
Age group				
12-19	123 (2.9)	22 (2.2)	101 (3.2)	0.040
20-34	3094 (74.0)	735 (72.4)	2359 (74.5)	
35-60	964 (23.1)	258 (25.4)	706 (22.3)	
Marital status				
Single	304 (7.3)	53 (5.2)	251 (7.9)	0.004
Married	3877 (92.7)	962 (94.8)	2915 (92.1)	
Educational level attained (n = 869)				
Primary	58 (6.7)	18 (6.4)	40 (6.8)	0.973
Secondary	496 (57.1)	161 (57.5)	335 (56.9)	
Tertiary	315 (36.2)	101 (36.1)	214 (36.3)	
Employment status				
Unemployed/ Housewife	721 (17.2)	202 (19.9)	519 (16.4)	<0.001
Student	274 (6.6)	45 (4.4)	229 (7.2)	
Self-employed (Petty-trader)	1877 (44.9)	511 (50.3)	1366 (43.2)	
Self-employed (Mid-high business)	442 (10.6)	90 (8.8)	352 (11.1)	
Employed	867 (20.7)	167 (16.5)	700 (22.1)	
Obstetric complications in previous pregnancy				
Yes	733 (17.5)	139 (13.7)	594 (18.8)	<0.001
No	3448 (82.5)	876 (86.3)	2572 (81.2)	
Parity				
Nulliparous (0)	1495 (35.8)	348 (34.3)	1147 (36.2)	0.046
Primiparous (1)	1066 (25.5)	238 (23.4)	828 (26.2)	
Multiparous (2–4)	1515 (36.2)	405 (39.9)	1110 (35.1)	
Grand-multiparous (5 or more)	105 (2.5)	24 (2.4)	81 (2.6)	
Number of gestations				
Singleton	4000 (95.7)	965 (95.1)	3035 (95.9)	0.283
Multiple	181 (4.3)	50 (4.9)	131 (4.1)	
Booking status				
Booked	1502 (35.9)	84 (8.3)	1418 (44.8)	<0.001
Un-booked	2679 (64.1)	931 (91.7)	1748 (55.2)	
Foetal complications				
No foetal complication	2748 (65.7)	680 (67.0)	2068 (65.3)	<0.001
Reduced/absent foetal movement	428 (10.2)	155 (15.3)	273 (8.6)	
Intra-uterine foetal death	159 (3.8)	55 (5.4)	104 (3.3)	
Aborted	846 (20.2)	125 (12.3)	721 (22.8)	
Maternal complications				
No maternal complication	145 (3.7)	36 (3.6)	109 (3.4)	<0.001
Obstructed labour	996 (23.8)	201 (19.8)	795 (25.1)	
Haemorrhage	737 (17.6)	227 (22.4)	510 (16.1)	
Preeclampsia/ eclampsia	942 (22.5)	308 (30.3)	634 (20.0)	
Sepsis	173 (4.1)	37 (3.6)	136 (4.3)	
Abortion	846 (20.2)	125 (12.3)	721 (22.8)	
Others	342 (8.2)	81 (8.0)	261 (8.3)	
Month of presentation				
January	323 (7.7)	100 (9.9)	223 (7.0)	<0.001
February	287 (6.9)	62 (6.1)	225 (7.1)	
March	383 (9.2)	129 (12.7)	254 (8.0)	
April	411 (9.8)	117 (11.5)	294 (9.3)	
May	408 (9.8)	116 (11.4)	292 (9.2)	
June	346 (8.3)	84 (8.3)	262 (8.3)	
July	283 (6.8)	79 (7.8)	204 (6.4)	
August	405 (9.7)	65 (6.4)	340 (10.7)	
September	316 (7.6)	56 (5.5)	260 (8.2)	

(*continued on next page*)

Table 1 (*continued*)

Characteristics	Total N = 4181 (n (%))	Referral (n = 1015) (n (%))	Non-referral (n = 3166) (n (%))	*p*-value
October	383 (9.2)	77 (7.6)	306 (9.7)	
November	350 (8.4)	67 (6.6)	283 (8.9)	
December	286 (6.8)	63 (6.2)	223 (7.0)	
Weekend travel to facility				
Yes	948 (22.7)	245 (24.1)	703 (22.2)	0.201
No	3233 (77.3)	770 (75.9)	2463 (77.8)	
Day of travel to facility				
Monday	665 (15.9)	140 (13.8)	525 (16.6)	0.028
Tuesday	613 (14.7)	178 (17.5)	435 (13.7)	
Wednesday	739 (17.7)	168 (16.6)	571 (18.0)	
Thursday	638 (15.3)	154 (15.2)	484 (15.3)	
Friday	568 (13.6)	129 (12.7)	439 (13.9)	
Saturday	504 (12.1)	127 (12.5)	377 (11.9)	
Sunday	454 (10.9)	119 (11.7)	335 (10.6)	
Period of day of travel to the facility (n = 2813)				
Morning	1021 (36.3)	199 (33.5)	822 (37.0)	0.010
Afternoon	751 (26.7)	148 (25.0)	603 (27.2)	
Evening	644 (22.9)	138 (23.3)	506 (22.8)	
Night	397 (14.1)	108 (18.2)	289 (13.0)	
Means of travel (n = 70)				
Personal car	27 (38.6)	11 (50.0)	16 (33.3)	0.004
Taxi	13 (18.6)	5 (22.8)	8 (16.7)	
Bus	11 (15.7)	0 (0)	11 (22.9)	
Ambulance	3 (4,3)	3 (13.6)	0 (0.0)	
Tricycle	13 (18.6)	3 (13.6)	10 (20.8)	
Motorcycle	3 (4.3)	0 (0.0)	3 (6.3)	
Mode of delivery				
Spontaneous vaginal delivery	1240 (29.7)	325 (32.0)	915 (28.9)	P < 0.001
Assisted vaginal delivery	151 (3.6)	29 (2.9)	122 (3.9)	
Caesarean delivery	1944 (46.5)	537 (52.9)	1407 (44.5)	
Uterine evacuation	846 (20.2)	125 (12.3)	721 (22.8)	

hospitals, respectively. Most referrals from nursing/maternity homes (100.0 %), TBAs (86.4 %), PHCs (82.6 %), clinics (57.0 %) and private hospitals (65.1 %) were referred to non-apex public hospitals (general hospitals and MCCs). Obstetric emergencies from general hospitals/MCCs (71.2 %) and teaching hospitals (87.5 %) were referred to apex referral public hospitals. In one case, a teaching hospital referred to a non-apex referral hospital (Fig. 2).

Across the entire sample, the median total distance travelled in an emergency from originating point to the receiving facility was 7.2 km (IQR 3.1–17), while the median total time travelled was 24 min (IQR 12–50). Pregnant women referred from institutions travelled a median distance of 6.0 km (IQR 2.4–13.3) and a median time of 22 min (IQR 1–45) to reach an initiating facility. The total actual distance covered from originating point to the receiving facility was 15.6 km (IQR 7.6–29.4). The median modelled travel distance if referred women went directly to the receiving (final) facility without referral was 8.3 km (IQR 3.8–17.0). Total travel time from the originating point to receiving facility was 54 min (IQR 28–91). Median modelled travel time if referred women went directly to the final facility was 28 min (IQR 14–55) (Table 2). For women who initially reported to a primary health centre or clinic, 81.0 % travelled 15 km or less, and 89.0 % of them arrived within 60 min. Women who reported to one of the apex referral hospitals first travelled relatively longer distances (57.1 % travelled 15 km or less) and took more time to get these facilities (71.4 % arrived within 60 min), before being referred to another apex referral hospitals.

There was a relatively higher proportion of referrals from private hospitals for complications due to abortion (44.0 %) and sepsis (37.8 %) compared to other facility types. For referrals from non-apex referral hospitals, there were high proportions for complications due to hypertension (22.4 %), foetal distress (17.4 %) and abortion (15.2 %). For referrals from the apex referral hospitals, there were between one and three referrals for abortion, prolonged/obstructed labour, and high blood pressure. Referrals from PHC or clinic had the highest rate of Caesarean section (47.5 %) and assisted vaginal delivery (51.7 %) (Table S3).

In the adjusted model, the odds of having been referred were significantly higher for pregnant women who were married (1.48, 95 % CI 1.03:2.12, $p < 0.050$) and un-booked (11.48, 95 %CI 8.94:14.74, $p < 0.001$). There was an increased odds of referral for pregnant women with foetuses in distress (1.40, 95 % CI 1.10:1.93, $p < 0.010$) and hypertension (1.63, 95 % CI 1.03:2.59, $p < 0.050$) but a reduced odds for abortion (0.44, 95 % CI 0.27:0.71, $p < 0.010$). Odds were also lower for primiparous (0.76, 95 % CI 0.61:0.94, $p < 0.050$) and grand-multiparous women (0.55, 95 % CI 0.33:0.93, $p < 0.050$). The odds of referral were lower in August (0.34, 95 % CI 0.23:0.50, $p < 0.001$), September (0.44, 95 % CI 0.29:0.66, $p < 0.001$), October (0.50, 95 % CI 0.34:0.73, $p < 0.001$), November (0.53, 95 % CI 0.36:0.79, $p < 0.010$) and December (0.58, 95 % CI 0.39:0.87, $p < 0.001$) compared to those who presented in January. Pregnant women who travelled to a facility with a complication on a Tuesday were 49 % (95 %CI 1.12:1.99, $p < 0.010$) more likely to be referred compared to those who travelled on Monday. Similarly, those who travelled at night were 44 % (95 % CI 1.17:1.79, $p < 0.010$) more likely to be referred compared to those who travelled in the morning (Table 3).

4. Discussion

This study set out to describe patterns and assess factors that influence obstetric referral within a public health system, using data collected from public comprehensive EmOC facilities combined with driving distance and travel time data extracted from Google Maps. The study makes an important contribution to the literature as it takes a unique health systems approach to understand obstetric referrals within a sub-Saharan Africa context.

4.1. Patterns of obstetric referral

Regarding patterns, about a quarter of pregnant women who presented in an emergency were referred across the entire sample. Unsurprisingly, most referrals were from PHCs (41.8 %), as these facilities do not have the capacity and are not expected to provide the entire EmOC repertoire. In India, 14.0 %–36.0 % of referrals at comprehensive EmOC facilities were from nurse-led delivery or basic EmOC facilities (Singh et al., 2016). In our study, there were also significant proportions of referrals from private (23.5 %) and public (16.2 %) hospitals. When referral numbers were disaggregated by facility type, private hospitals contributed the highest proportion of abortion (44.0 %) and sepsis (37.8 %) related referrals. These complications require basic EmOC interventions, so this high proportion is puzzling. In a survey across multiple states in Nigeria, 57 % of medical practitioners working in the private sector reported that they lacked expertise in managing second-trimester abortions. In contrast, those admitting that they manage second-trimester abortions reported nonstandard methods and procedures (Okonofua et al., 2005). It might also be a case of low caseload, meaning that health workers do not feel particularly confident performing a manual vacuum aspiration to remove retained products of conception (Odland et al., 2019), therefore resulting in referrals. In any case, it is well established that in LMICs, capacity varies widely within the private sector (Benova et al., 2015). Indeed, based on available skill, equipment, and medicines, some private hospitals are better classed as basic EmOC facilities with no expectation that they can provide the full spectrum of care, thereby needing to refer cases. However, even for those who can, private providers are known to refer women quickly to the public sector to avoid blame for any unfavourable outcome that may result from an obstetric complication. Women also perceive that skilled health personnel in the public sector are more skilled than those in the

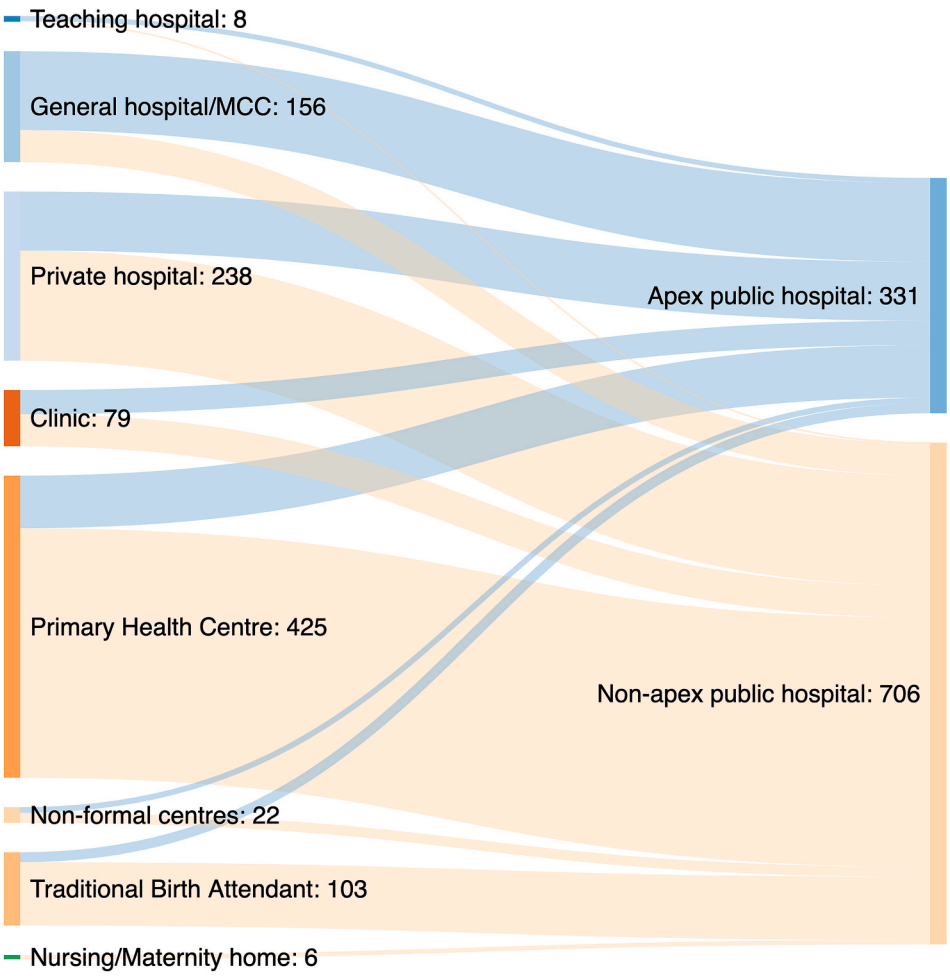

Fig. 2. Flow of referrals for pregnant women who presented at health facilities in emergencies.

Table 2
Travel time and distance covered if referred to a public comprehensive EmOC facility (N = 611).

Factor	Median distance travelled (km)	Inter-quartile range of distance (km)	Median time travelled (min)	Inter-quartile range of time (min)
Travel from home/ other location to initial facility	6.0	2.4–13.3	22	11–45
Referral from initial facility to final facility	7.7	2.9–16.5	26	14–50
Total actual travel from home/other location to final facility	15.6	7.6–29.4	54	28–91
Modelled travel from home/other location to final facility of delivery	8.3	3.8–17.0	28	14–55
Additional travel (actual travel – replicated travel)	7.3		26	

private sector (Wright et al., 2017). However, there is almost always a cross-over of skilled health personnel between the sectors.

On another note, the high proportion of referrals being received from public non-apex referral hospitals is a bit more concerning, as these hospitals are expected to provide the entire comprehensive EmOC package. The estimate in our study is almost double the estimate for 'non-apex referrals' in Ghana (Bailey et al., 2019). For non-apex referrals in our study, hypertension (22.4 %) and foetal distress (17.4 %) had the highest relative proportions of referrals. Despite further exploration, the reason for this high proportion of hypertension-related referrals coming from non-apex referral hospitals could not be established. For foetal distress, this might be explained by the fact that over 85 % of health facilities in sub-Saharan Africa have been shown to either lack skill or supplies needed for resuscitation of a newborn in distress (Okonkwo et al., 2019).

Our study showed that just a little over 1 % of women were multiple referrals. This pattern of referral is recognised in the literature (Elmusharaf et al., 2017). A deeper dive into our data showed that all multiple referrals first went to TBAs, PHCs or clinics or private hospitals before being referred to either other private hospitals or a non-apex referral hospital. This observation is probably due to a lack of communication between facilities, with the initiating facility not being aware of the 'live' capacity of the proposed receiving facility to be able to provide the care that the pregnant woman needs. Another pattern observed related to pregnant women who had received care themselves, and their babies needed to be referred for specialist newborn care after delivery, which was not available at the facility that provided care to the woman. This pattern has also been observed in India (Singh et al., 2016). In our study, of the women referred for specialist care, 91 % of them were referred to one of three apex referral hospitals and one non-apex referral hospital in the suburbs. This 'post-delivery referral pattern suggests

Table 3
Logistic regression showing association between referral and relevant independent variables.

Factor	Adjusted odds ratio (95 % CI)‡
Marital status	
Single	Reference
Married	1.48 (1.03:2.12) *
Employment status	
Unemployed/Housewife	1.19 (0.92:1.55)
Student	0.99 (0.65:1.51)
Self-employed (Petty-trader)	1.22 (0.97:1.65)
Self-employed (Mid-high business)	0.90 (0.66:1.24)
Employed	Reference
Obstetric complications in previous pregnancy	
No	Reference
Yes	1.04 (0.82:1.32)
Parity	
Nulliparous (0)	Reference
Primiparous (1)	0.76 (0.61:0.94) *
Multiparous (2–4)	0.85 (0.69–1.03)
Grand-multiparous (5 or more)	0.55 (0.33–0.93) *
Number of gestations	
Singleton	Reference
Multiple	1.25 (0.85–1.84)
Booking status	
Booked	Reference
Un-booked	11.48 (8.94:14.74) ***
Foetal complications	
No foetal complication	Reference
Foetal distress	1.42 (1.11:1.81) **
Intra-Uterine Foetal Death	1.28 (0.87:1.89)
Abortion	0.44 (0.27:0.72) **
Maternal complications	
No maternal complication	Reference
Obstructed labour	1.29 (0.80:2.06)
Haemorrhage	1.40 (0.88:2.22)
Hypertension	1.63 (1.03:2.60) *
Sepsis	1.02 (0.57:1.84)
Abortion	1.00 (omitted)
Others	1.39 (0.83:2.32)
Month of presentation	
January	Reference
February	0.62 (0.41:1.02)
March	0.97 (0.68:1.39)
April	0.97 (0.67:1.39)
May	0.91 (0.63:1.30)
June	0.63 (0.43:0.92)
July	0.78 (0.52:1.15)
August	0.34 (0.23:0.50) ***
September	0.44 (0.29:0.66) ***
October	0.50 (0.34:0.73) ***
November	0.53 (0.36:0.80) **
December	0.58 (0.39:0.87) **
Day of travel to facility	
Monday	Reference
Tuesday	1.49 (1.12:1.99) **
Wednesday	1.09 (0.82:1.44)
Thursday	1.11 (0.83:1.49)
Friday	0.98 (0.73:1.33)
Saturday	1.15 (0.84:1.56)
Sunday	1.23 (0.90:1.68)
Period of day travel to facility commenced	
Morning	Reference
Afternoon	0.92 (0.72:1.21)
Evening	1.00 (0.76:1.30)
Night	1.44 (1.17:1.79) *

Note: ***$p < 0.001$; **$p < 0.010$; *$p < 0.050$; OR Odds Ratio, CI Confidence Interval.
‡All variables were adjusted for each other in the model. The p-value for the likelihood ratio test was $p < 0.001$.

some inadequacy of the non-apex referral hospital in providing comprehensive newborn care that sometimes requires admission into an intensive neonatal care unit. Indeed, in Lagos, only a few public hospitals can fully support critically ill newborns (Okonkwo et al., 2016).

In addition to the formal referral pattern, 0.5 % of women in our study were reported to have been non-formal referrals. Some referrals emanating from nursing/maternity homes and TBAs would have been unregistered personnel who had not been trained to recognise danger signs and were not formally integrated into the referral system. If an assumption were made that all these were 'non-formal referrals (which is highly unlikely), they would constitute 10.7 % of all referrals. This is probably an underestimate, as alternative birthing centres remain very popular within several Lagos communities. A community-based survey in an inner-city area of Lagos previously reported a TBA delivery rate of 42.5 % (Olusanya et al., 2011). A study of un-booked cases in southeast Nigeria estimated that TBA referrals were 16.1 %, while 2.3 % came from places of worship (Obi et al., 2001). As per evidence from eight public hospitals spread across Nigeria, referral from non-formal settings is associated with an increased risk of maternal and foetal jeopardy (Ntoimo et al., 2018). Beyond the lack of skill in these settings, a significant contributor to the higher risk of poor outcomes is the delay women are subjected to in these settings, without the carers knowing how to proceed with management. In such facilities, women have been reported to spend more than 12 h being managed before being referred to a hospital (Okafor et al., 2015).

4.2. Travel time and distance required for referral

As per our findings, referral doubled travel time and distance to reach facilities that could actually provide the care needed by pregnant women compared to a scenario if they went direct to the receiving (final) facility. This confirms qualitative findings from an earlier study with pregnant women in Lagos, which reported that referral prolongs travel time (Banke-Thomas et al., 2020) and is particularly important in a state in which a fifth of pregnant women with obstetric complications require more than an hour to access a hospital of care in an emergency (Banke-Thomas et al., 2021). However, the interpretation of this finding needs to be nuanced, as pregnant women may not recognise the severity of an emergency or which level of care that require when in an emergency. In our study, the highest proportion of referrals because of abortion, sepsis and hypertensive disorders came from private hospitals and PHCs, which for the most part, are expected to be able to manage these conditions, except if surgery or blood transfusion is required. These could be classed as 'avoidable referrals', which could have a huge consequence on maternal survival, with more than 25 % of maternal deaths following an abortion occurring on the same day of hospital admission (Adanikin et al., 2019).

Of course, there are other pregnant women who have to be referred ('unavoidable referral') because the skilled health personnel recognised appropriately that care would be better elsewhere. For these, it is important to bear in mind that we have only estimated the actual travel time and compared it to a modelled scenario if the woman travelled directly to the destination facility. However, there could be further delays within the referring facility that women may face, including delay in being referred by the health workers and delay in sourcing transportation to transfer them to the destination facility, as pregnant women and their families in LMICs are often left on their own to navigate the referral process (Banke-Thomas et al., 2020; Elmusharaf et al., 2017; Hofman et al., 2008). Indeed, our study showed only about 14 % of referrals were transferred in an ambulance. Private cars and taxis (72.8 %) were the most popular means of travel for referrals. Even after arriving at a large referral facility, women still face long waiting times when referred (Goodman et al., 2017).

4.3. Indications for obstetric referral

As in a Ghanaian study (Nkyekyer, 2000) and hospital-based studies conducted in southern Nigeria (Awoyesuku and MacPepple, 2019; Bailey et al., 2019), prolonged/obstructed labour was the leading indication for referral in Lagos. In another study conducted in a Nigerian tertiary hospital in the central part of the country, pregnancy-induced

hypertension (26.8 %) was the commonest obstetric indication for referral (Akaba and Ekele, 2018). There might be some regional variations in indications warranting referral, but this needs to be explored in greater depth. For mode of delivery, many of the referred pregnant women in our study were delivered via caesarean section (52.9 %), with those from PHCs or clinics having the highest Caesarean section rate. Caesarean section was also the commonest mode of delivery for women referred in an emergency (54.6 %) as per a study conducted in the southern part of Nigeria (Awoyesuku and MacPepple, 2019). Our study found that those referred have a 44 % higher likelihood of requiring a Caesarean section for delivery. As expected, most referrals that needed to be delivered via Caesarean were from lower-level facilities (PHCs and clinics).

4.4. Factors influencing obstetric referral

In our study, parous pregnant women with an obstetric emergency had reduced odds of referral compared to nulliparous women. We believe a plausible reason for this might be the higher risk of nulliparous women for adverse pregnancy outcomes such as ectopic pregnancy (Chauhan et al., 2020; Wang et al., 2020), necessitating referrals. Our finding that married women had higher likelihood for referral probably relates more with that such women would more likely have companionship when they visit the hospital compared to single women (Essex and Pickett, 2008). We also found that un-booked patients were over 11 times more likely to have been referred. This could simply relate to the fact that many comprehensive EmOC facilities would only describe a woman as booked if she is registered in their facility. Expectedly, our results showed that most referrals came from PHCs. Some women would have been booked at a PHC or a private hospital. However, because of the fragmented nature of the health management information system, their records were not transferred. As such, the information on their booking status was not reflected in their notes in the hospital where they presented with an obstetric emergency. It could also be that there were some women with high-risk pregnancies in the early first trimester who were yet to present for an antenatal clinic. As such, the first time they presented at a formal facility was in a critical situation necessitating referral.

We also found significantly higher odds for being received as a referral when pregnant women with emergencies travelled at night compared to the morning. Though most PHCs in Lagos are open for 8 h a day, some are open 24 h (HEFAMAA, 2021). However, the complement of the health workforce available at night is almost always limited. PHCs had the highest number of referrals in the sample and a further analysis disaggregated by travel period of the day revealed that 39 % emanate from PHCs at night. While it might be the case that pregnant women in emergency are presenting first at PHCs because they do not have a clear sense of urgency as it relates to their situation (Banke-Thomas et al., 2020), there is also the possibility that they are not familiar with the functionality of the PHC to provide the care that they need. The next highest number of cases was private hospital (22.2 %), followed by public hospital (16.7 %). This finding suggests that there might be fewer skilled health personnel on duty during the night shift, necessitating the need for referrals. Indeed, many health facilities work at low capacity at night, and even in large hospitals, women have longer wait times when they present during the night shift (Goodman et al., 2017). For the month of presentation, our finding that the odds of being referred were significantly lower for the so-called '-ember' months is probably less about the months themselves and more about what happened during those months, which coincide with the opening date of the newly commissioned Eti-Osa MCC in August 2019 (Tribune Online, 2019).

4.5. Practice and policy implications

Some practice and policy implications can be drawn from our study. Specifically, our findings underscore the need for health system strengthening and the importance of ANC and early booking to aid identification of risk for pregnancy complications and establish robust birth preparedness plans that can minimise the need for referral when emergencies arise. Women need to be able to recognise danger signs and be advised on where to go if they occur. For the existing comprehensive EmOC facilities, there is a need for regular auditing on their readiness to manage obstetric emergencies. There is also a question of the sufficiency of the non-apex referrals to manage the obstetric emergency caseload in Lagos. Indeed, the state government has made many investments to build and equip public hospitals for comprehensive EmOC services (Fabamwo and Okonofua, 2010). However, with a population of 26 million and 24 public comprehensive EmOC facilities (LASG, 2019), the ratio of facility to population in Lagos is 1:1,083,333. This ratio is less than the WHO recommended one comprehensive EmOC per 500,000 population (WHO et al., 2009), suggesting that the state needs to double its current number. In recent years, there have been calls for a redesign of service delivery to maximise health outcomes by ensuring that conditions at risk of unexpected complications such as births are managed in hospitals from the onset rather than lower-level facilities such as PHCs (Gage et al., 2019). With a significant cost implication for setting up comprehensive EmOC facilities (Fabamwo and Okonofua, 2010), concerns about the sustainability of building new hospitals (Chabrol et al., 2018), and the consensus on the need to maximise value-for-money for maternal health interventions (Banke-Thomas et al., 2017), official public-private partnerships established with trusted private sector providers might help to improve referral systems. Our study showed that almost 90 % of women could reach PHCs in 1 h, indicating that these facilities are more accessible, as it should be. As such, it might not be time to abandon PHCs just yet. Instead, emphasis needs to be placed on upscaling skills at lower-level facilities in public and private sectors to be able to manage all emergencies requiring basic EmOC services, establishing a clear protocol for referral, and strengthening communication and transportation linkages between PHCs and hospitals. This is extremely important, as for some women, even when the facility is not too far off, they are too poor to pay for themselves to reach those facilities (Banke-Thomas et al., 2021; Wong et al., 2020).

With referral doubling travel time to a facility that can provide needed care, there is a need to equip PHCs with functional ambulances while improving road infrastructure, which is known to be deplorable in many parts of the state (Asiyanbola et al., 2012; Atubi, 2013). This is particularly important for women who have made it to one facility. It is also imperative that some global understanding of the capacity of health facilities are published to allow women to have the information to make an informed decision on where to travel in emergency situations. Such information on facility functionality and the pathway to care and clinical assessment of pregnant women will be invaluable for service planning and auditing, especially for identifying avoidable vs unavoidable referrals and optimising the referral system. In addition, a pre-travel triage system should be established so that women can be advised on where to go in an emergency, and the receiving facility can be better prepared to receive and manage them.

Irrespective of number of infrastructure and equipment provided, these need to be adequately staffed to ensure that an optimum mix of skilled health personnel are available all hours every day of the week, as this may be the reason for referrals at night. Presently, there is a massive shortage of doctors in the public sector (Obinna, 2020). Two in five referrals were due to an inadequate complement of skilled health workers in a Nigerian facility-based study (Akaba and Ekele, 2018). The available personnel need to be able to provide the care required. In non-apex referral hospitals, there is a case for capacity building of personnel on management of pregnancy-induced hypertension and foetal distress. For personnel at PHC, building their capacity to provide basic EmOC, including abortion care and management of sepsis supporting them with guidelines may help decongest the hospitals. Ultimately, there is a fine line between discretion and judgement, which skilled health personnel must be able to identify before initiating a

referral (Kane et al., 2020).

4.6. Study limitations

First, we were not able to assess the appropriateness or otherwise of each referral. However, the obstetric complication provided some valuable insights for interpretation. Second, there was a lot of missing information relating to mode of transport and education level attained. These data are not routinely collected inpatient health records in Lagos (Radovich et al., 2021). In any case, estimates of proportions of travel by motor vehicle might be higher today, as bicycles and tricycles have been banned in the state (Ezeamalu, 2020). Third, our characterisation of the pathways to care that the women took is only as good as details provided in the health records. We also cannot if all women went to the nearest facility (public or private), 'bypassed' services closer to them (Stein et al., 2020) or if they went to more health facilities other than those reported in their health records. In addition, we have assumed that women knew they needed to travel to a hospital in an emergency. Still, they could have simply gone directly to them because they were booked in the hospital a priori. Furthermore, travel time and distance estimated may not have also followed the actual path of travel that the women took to reach the facility of care. However, the application used, though not perfect, has been shown to offer closest-to-reality estimate of actual travel time and distance, compared to other approaches used in the literature, as it uses real-time traffic data (Banke-Thomas et al., 2019, 2021a).

5. Conclusion

Referral systems remain "under-documented, under-researched, and under-theorised" (Murray and Pearson, 2006) and it is well known that referral practices are sub-optimal in many LMIC settings (Geleto et al., 2018). Our study provides a template that can inform the development of referral theory in LMICs and for principally urban LMIC settings like Lagos. Indeed, understanding the pattern of referrals across multiple levels of care, as done in most of the literature, is only a first step for optimising existing referral systems. Understanding travel to reach health facilities and recognising the factors that influence referrals and specific levels of care for which action is required is the next step towards developing an effective referral system. Our study demonstrates that the realisation of an effective referral system is more about addressing health systems issues and not those related to the pregnant women themselves. Indeed, there are a few generalisable lessons that can be gleaned for designing referral systems for LMICs, including the positive effect of investments in fully equipped and functional comprehensive EmOC facilities. However, some context-specific influences need to be exposed and addressed if effective referral systems are designed. For example, in the context of our study, given the significant demand for life-saving obstetric services at apex referral hospitals, gaps in facility readiness of non-apex referral facilities in the public sector must be promptly identified and addressed. Every health system should deem the understanding of such contextual factors as critical for planning services.

Credit author statement

Aduragbemi Banke-Thomas: Conceptualization, Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing. Cephas Avoka: Formal analysis; Investigation; Methodology; Resources; Software; Validation; Visualization; Roles/Writing - original draft; Writing – review & editing. Abimbola Olaniran: Formal analysis; Investigation; Methodology; Resources; Software; Validation; Visualization; Writing – original draft; Writing – review & editing. Mobolanle Balogun: Conceptualization, Data curation; Methodology; Supervision; Validation; Roles/Writing - original draft; Writing – review & editing. Ololade Wright: Conceptualization, Data curation; Investigation; Methodology; Project administration; Resources; Visualization; Writing – review & editing. Olabode Ekerin: Data curation; Formal analysis; Investigation; Methodology; Resources; Writing – original draft; Writing – review & editing. Lenka Benova: Formal analysis; Investigation; Methodology; Supervision; Validation; Writing – review & editing.

Ethical approval

Ethical approval was obtained from the Research and Ethics Committees of the Lagos University Teaching Hospital (ADM/DCST/HREC/APP/2880) and Lagos State University Teaching Hospital (LREC/October 06, 1226). To ensure privacy, only medical doctors who were part of the research team were allowed to input data, and no patient identifying data was extracted.

Declaration of competing interest

None declared.

Acknowledgements

We are grateful to several individuals and organisations that have made this study possible. Sincere appreciation to all the research assistants who supported the research team in collecting the data for this study. We would like to express our sincere appreciation to the Lagos State Government, and in particular, the Ministry of Health and Health Service Commission, for their support in gaining access to all state-owned facilities. We also thank the leadership of federal government-owned facilities included in our study for their support. In addition, we are immensely grateful to the three anonymous reviewers who painstakingly reviewed this paper and provided invaluable feedback and comments.

This study was funded by AXA Research Fund. The funder had no role in the study design, data collection, analysis, and interpretation of data, writing of the manuscript or decision to publish the findings.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2021.114492.

References

Adanikin, A., Umeora, O., Nzeribe, E., Agbata, A., Ezeama, C., Ezugwu, F., Ugwu, G., Ikechebelu, J., Oladapo, O., 2019. Maternal near-miss and death associated with abortive pregnancy outcome: a secondary analysis of the Nigeria Near-miss and Maternal Death Survey. BJOG 126, 33–40.

Adewole, O.A., Fadeyibi, I.O., Kayode, M.O., Giwa, S.O., Shoga, M.O., Adejumo, A.O., Ademiluyi, S.A., 2012. Ambulance services of lagos state, Nigeria: a six-year (2001-2006) audit. W. Afr. J. Med. 31, 3–7.

Akaba, G.O., Ekele, B.A., 2018. Maternal and fetal outcomes of emergency obstetric referrals to a Nigerian teaching hospital. Trop. Doct. 48, 132–135.

Anastasi, E., Ekanem, E., Hill, O., Adebayo Oluwakemi, A., Abayomi, O., Bernasconi, A., 2017. Unmasking inequalities: sub-national maternal and child mortality data from two urban slums in Lagos, Nigeria tells the story. PLoS One 12, e0177190.

Asiyanbola, R.A., Osoba, S.B., Adewale, S.S., 2012. Road traffic administration and management in the third world mega-city: lagos, Nigeria. Int. J. Dev. Sustain. 1 (2), 490–509.

Assefa, E.M., Berhane, Y., 2020. Delays in emergency obstetric referrals in Addis Ababa hospitals in Ethiopia: a facility-based, cross-sectional study. BMJ Open 10, e033771.

Atubi, A.O., 2013. An evaluation of transport infrastructure in lagos state, Nigeria. J. Geogr. Earth Sci. 1, 9–18.

Awoyesuku, P.A., MacPepple, D.A., 2019. Pattern of referral cases to the obstetrics unit of the rivers state university teaching hospital for maternal delivery. J. Adv. Med. Med. Res. 30, 1–7. https://doi.org/10.9734/jammr/2019/v30i830219.

Bailey, P.E., Awoonor-Williams, J.K., Lebrun, V., Keyes, E., Chen, M., Aboagye, P., Singh, K., 2019. Referral patterns through the lens of health facility readiness to manage obstetric complications: national facility-based results from Ghana. Reprod. Health 16, 19.

Banke-Thomas, A., Avoka, C.K., Gwacham-Anisiobi, U., Benova, L., 2021a. Influence of travel time and distance to the hospital of care on stillbirths: a retrospective facility-based cross-sectional study in Lagos, Nigeria. BMJ Global Health 6, e007052. https://doi.org/10.1136/BMJGH-2021-007052.

Banke-Thomas, A., Ayomoh, F.I., Abejirinde, I.-O.O., Banke-Thomas, O., Eboreime, E.A., Ameh, C.A., 2021. Cost of utilising maternal health services in low- and middle-income countries: A systematic review. Int. J. Health Policy Manag. 10, 564–577. https://doi.org/10.34172/ijhpm.2020.104.

Banke-Thomas, Aduragbemi, Balogun, Mobolanle, Wright, Ololade, Ajayi, Babatunde, Abejirinde, Ibukun-Oluwa, Olaniran, Abimbola, Giwa-Ayedun, Rokibat, Odusanya, Bilikisu, Afolabi, Bosede, 2020. Reaching health facilities in situations of emergency: qualitative study capturing experiences of pregnant women in Africa's largest megacity. Reprod. Health 17, 145. https://doi.org/10.1186/s12978-020-00996-7.

Banke-Thomas, A., Madaj, B., Kumar, S., Ameh, C., van den Broek, N., 2017. Assessing value-for-money in maternal and newborn health. BMJ Global Health 2, e000310. https://doi.org/10.1136/bmjgh-2017-000310.

Banke-Thomas, A., Wong, K.L.M., Ayomoh, F.I., Giwa-Ayedun, R.O., Benova, L., 2021a. In cities, it's not far, but it takes long": comparing estimated and replicated travel times to reach life-saving obstetric care in Lagos, Nigeria. BMJ Global Health 6, e004318. https://doi.org/10.1136/bmjgh-2020-004318.

Banke-Thomas, A., Wong, K.L.M., Collins, L., Olaniran, A., Balogun, M., Wright, O., Babajide, O., Ajayi, B., Afolabi, B.B., Abayomi, A., Benova, L., 2021. An assessment of geographical access and factors influencing travel time to emergency obstetric care in the urban state of Lagos, Nigeria. Health Policy Plann. 36, 1384–1396. https://doi.org/10.1093/heapol/czab099.

Banke-Thomas, A., Wright, K., Collins, L., 2019. Assessing geographical distribution and accessibility of emergency obstetric care in sub-Saharan Africa: a systematic review. J. Global Health 9, 010414. https://doi.org/10.7189/jogh.09.010414.

Benova, L., Macleod, D., Footman, K., Cavallaro, F., Lynch, C.A., Campbell, O.M.R., 2015. Role of the private sector in childbirth care: cross-sectional survey evidence from 57 low- and middle-income countries using Demographic and Health Surveys. Trop. Med. Int. Health 20, 1657–1673.

Campbell, O.M., Graham, W.J., 2006. Strategies for reducing maternal mortality: getting on with what works. Lancet 368, 1284–1299.

Chauhan, S.P., Rice, M.M., Grobman, W.A., et al., 2020. Neonatal and maternal composite adverse outcomes among low-risk nulliparous women compared with multiparous women at 39-41 Weeks of gestation. Obstet. Gynecol. 136, 450–457.

Chauhan, F., Albert, L., Ridde, V., 2018. 40 years after Alma-Ata, is building new hospitals in low-income and lower-middle-income countries beneficial? BMJ Global Health 3, e001293. https://doi.org/10.1136/BMJGH-2018-001293.

Elmusharaf, K., Byrne, E., AbuAgla, A., AbdelRahim, A., Manandhar, M., Sondorp, E., O'Donovan, D., 2017. Patterns and determinants of pathways to reach comprehensive emergency obstetric and neonatal care (CEmONC) in South Sudan: qualitative diagrammatic pathway analysis. BMC Pregnancy Childbirth 17, 278. https://doi.org/10.1186/s12884-017-1463-9.

Essex, H.N., Pickett, K.E., 2008. Mothers without companionship during childbirth: an analysis within the Millennium cohort study. Birth 35, 266–276.

Ezeamalu, B., 2020. Lagos Bans Tricycles, Motorcycles in 15 Local Govts. Premium Times. https://www.premiumtimesng.com/regional/ssouth-west/374565-lagos-bans-tricycles-motorcycles-in-15-local-govts.html. (Accessed 12 October 2021).

Fabamwo, A.O., Okonofua, F.E., 2010. An assessment of policies and programs for reducing maternal mortality in lagos state, Nigeria. Afr. J. Reprod. Health 14, 55–59.

FMOH, 2019. Nigeria Health Facility Registry (HFR). Federal Ministry of Health, Abuja, Nigeria. https://hfr.health.gov.ng/. (Accessed 12 October 2021), 6.26.21.

Gage, A.D., Carnes, F., Blossom, J., et al., 2019. In low- and middle-income countries, is delivery in high-quality obstetric facilities geographically feasible? Health Aff. 38, 1576–1584.

Geleto, A., Chojenta, C., Musa, A., Loxton, D., 2018. Barriers to access and utilization of emergency obstetric care at health facilities in sub-Saharan Africa: a systematic review of literature. Syst. Rev. 7, 183.

Goodman, D.M., Srofenyoh, E.K., Olufolabi, A.J., Kim, S.M., Owen, M.D., 2017. The third delay: understanding waiting time for obstetric referrals at a large regional hospital in Ghana. BMC Pregnancy Childbirth 17, 216.

HEFAMAA, 2021. Public Primary Health Centers. Health Facility Monitoring and Accreditation Agency, Lagos, Nigeria. https://hefamaa.lagosstate.gov.ng/registration/public-primary-health-centers/. (Accessed 14 October 2021).

Hofman, J.J., Dzimadzi, C., Lungu, K., Ratsma, E.Y., Hussein, J., 2008. Motorcycle ambulances for referral of obstetric emergencies in rural Malawi: do they reduce delay and what do they cost? Int. J. Gynecol. Obstet. 102, 191–197.

Hussein, J., Kanguru, L., Astin, M., Munjanja, S., 2012. The effectiveness of emergency obstetric referral interventions in developing country settings: a systematic review. PLoS Med. 9, e1001264.

Kane, S., Jiang, H., Tian, Y., Mukhopadhyay, M., Qian, X., 2020. Making effective referrals happen: a theory-informed policy analysis. Health Pol. Plann. 35, 1309–1317.

Lagos State Government, 2006. Lagos State Health Sector Reforms Law. Lagos, Nigeria. https://laws.lawnigeria.com/2019/04/04/health-sector-reform-law/. (Accessed 14 October 2021).

LASG, 2019. Abstract of Local Government Statistics. Lagos State Government, Lagos, Nigeria. https://mepb.lagosstate.gov.ng/wp-content/uploads/sites/29/2018/06/Abstract-of-LG-Statistics-2017editted.pdf. (Accessed 14 October 2021).

Miller, T., Smith, H., 2017. Establishing partnership with traditional birth attendants for improved maternal and newborn health: a review of factors influencing implementation. BMC Pregnancy Childbirth 17, 365. https://doi.org/10.1186/s12884-017-1534-y.

Mirkuzie, A.H., Sisay, M.M., Bedane, M.M., 2016. High proportions of obstetric referrals in Addis Ababa: the case of term premature rupture of membranes. BMC Res. Notes 9, 40.

Murray, S.F., Pearson, S.C., 2006. Maternity referral systems in developing countries: current knowledge and future research needs. Soc. Sci. Med. 62, 2205–2215.

National Population Commission, ICF International, 2019. Nigeria Demographic and Health Survey 2018. Abuja, Nigeria and Rockville, Maryland, USA.

Nkyekyer, K., 2000. Peripartum referrals to korle bu teaching hospital, Ghana - a descriptive study. Trop. Med. Int. Health 5, 811–817.

Ntoimo, L.F.C., Okonofua, F.E., Ogu, R., Galadanci, H.S., Mohammed, G., Adetoye, D., Abe, E., Okike, O., Agholor, K., Abdus-salam, R., 2018. Prevalence and determinants of maternal mortality in referral hospitals in Nigeria: a multi-centre study. Reproductive System & Sexual Disorders. Curr. Res. 7, 1.

Obi, S.N., Ozumba, B.C., Okaro, J.M., 2001. Emergency obstetric referrals at a university teaching hospital, Nigeria. East Afr. Med. J. 78, 262–264.

Obinna, C., 2020. Shortage: medical Guild warns of imminent crisis in health services. Vanguard Newspaper. https://www.vanguardngr.com/2020/01/shortage-medical-guild-warns-of-imminent-crisis-in-health-services/. (Accessed 14 October 2021).

Odland, M.L., Membe-Gadama, G., Kafulafula, U., Odland, J.O., Darj, E., 2019. Confidence comes with frequent practice: health professionals' perceptions of using manual vacuum aspiration after a training program. Reprod. Health 16, 20.

Okafor, I., Arinze-Onyia, S., Ohayi, S., Onyekpa, J., Ugwu, E., 2015. Audit of childbirth emergency referrals by trained traditional birth attendants in Enugu, Southeast, Nigeria. Ann. Med. Health Sci. Res. 5, 305.

Okonkwo, I., Abhulimhen-Iyoha, B., Okolo, A., 2016. Scope of neonatal care services in major Nigerian hospitals. Niger. J. Paediatr. 43, 13.

Okonkwo, I.R., Ezeaka, V.C., Mustapha, B., Ezeanosike, O., Tongo, O., Okolo, A.A., Olateju, E.K., Oruamabo, R., Ibe, B., 2019. Newborn resuscitation practices and paucity of resuscitative devices in Nigeria; a call to action. Afr. Health Sci. 19, 1563–1565.

Okonofua, F.E., Shittu, S.O., Oronsaye, F., Ogunsakin, D., Ogbomwan, S., Zayyan, M., 2005. Attitudes and practices of private medical providers towards family planning and abortion services in Nigeria. Acta Obstet. Gynecol. Scand. 84, 270–280.

Okonofua, F., Imosemi, D., Igboin, B., Adeyemi, A., Chibuko, C., Idowu, A., Imongan, W., 2017. Maternal death review and outcomes: an assessment in Lagos State, Nigeria. PLoS One 12, e0188392.

Oladapo, O., Adetoro, O., Ekele, B., et al., 2016. When getting there is not enough: a nationwide cross-sectional study of 998 maternal deaths and 1451 near-misses in public tertiary hospitals in a low-income country. BJOG An Int. J. Obstet. Gynaecol. 123, 928–938.

Olusanya, B.O., Alakija, O.P., Inem, V.A., 2010. Non-uptake of facility-based maternity services in an inner-city community in Lagos, Nigeria: an observational study. J. Biosoc. Sci. 42, 341–358.

Olusanya, B.O., Inem, V.A., Abosede, O.A., 2011. Infants delivered in maternity homes run by traditional birth attendants in urban Nigeria: a community-based study. Health Care Women Int. 32, 474–491.

Paxton, A., Maine, D., Freedman, L., 2005. The evidence for emergency obstetric care. Int. J. Gynaecol. Obstet. 88, 181–193.

Radovich, E., Banke-Thomas, A., Campbell, O.M.R., Ezeanochie, M., Gwacham-Anisiobi, U., Ande, A.B.A., Benova, L., 2021. Critical comparative analysis of data sources toward understanding referral during pregnancy and childbirth: three perspectives from Nigeria. BMC Health Serv. Res. 21, 927.

Singh, S., Doyle, P., Campbell, O.M., Mathew, M., Murthy, G.V.S., 2016. Referrals between public sector health institutions for women with obstetric high risk, complications, or emergencies in India - a systematic review. PLoS One 11, e0159793.

Stein, D.T., Golub, G., Rothschild, C.W., Nyakora, G., Cohen, J., Mcconnell, M., 2020. Bypassing high-quality maternity facilities: evidence from pregnant women in peri-urban Nairobi. Health Pol. Plann. 36 (1), 84–92. https://doi.org/10.1093/heapol/czaa092.

Thaddeus, S., Maine, D., 1994. Too far to walk: maternal mortality in context. Soc. Sci. Med. 38, 1091–1110.

Tribune Online, 2019. LASG Targets 1m People For Maternal, Childcare In Eti-Osa. Tribune, Lagos, Nigeria. https://tribuneonlineng.com/lasg-targets-1m-people-for-maternal-childcare-in-eti-osa/. (Accessed 14 October 2021).

Ugvodaga, K., 2019. Buhari Unveils Reconstructed Ayinke House, Nigeria's Biggest Maternity Hospital. PM News, Lagos, Nigeria. https://pmnewsnigeria.com/2019/04/24/buhari-unveils-reconstructed-ayinke-house-nigerias-biggest-maternity-hospital/. (Accessed 14 October 2021).

UNICEF, WHO, World Bank, UNPD, 2020. A Neglected Tragedy: the Global Burden of Stillbirths. United Nations Children's Fund, New York.

United Nations, 2016. Sustainable Development Goals: 17 Goals to Transform Our World. United Nations, New York, US. http://www.un.org/sustainabledevelopment/sustainable-development-goals/. (Accessed 14 October 2021).

Venkatraman, C., Odusola, A.O., Malolan, C., Kola-Korolo, O., Olaomi, O., Idris, J., Nwariaku, F.E., 2020. Lagos state ambulance service: a performance evaluation. Eur. J. Trauma Emerg. Surg. 47, 1591–1598. https://doi.org/10.1007/s00068-020-01319-y.

Wang, X., Huang, L., Yu, Y., Xu, S., Lai, Y., Zeng, W., 2020. Risk factors and clinical characteristics of recurrent ectopic pregnancy: a case–control study. J. Obstet. Gynaecol. Res. 46, 1098.

WHO, 2005. Referral Systems - a summary of key processes to guide health services managers. World Health Organization, Geneva, Switzerland. https://www.who.int/management/Referralnotes.doc. (Accessed 15 October 2021).

WHO, UNFPA, UNICEF, Averting Maternal Deaths and Disabilities, 2009. Monitoring Emergency Obstetric Care: a Handbook. WHO Press, Geneva, Switzerland.

WHO, UNFPA, UNICEF, International Confederation of Midwives, International Confederation of Nurses, International Federation of Gynecology and Obstetrics, International Pediatric Association, 2018. Definition of Skilled Health Personnel Providing Care during Childbirth. World Health Organization, Geneva.
WHO, UNICEF, UNFPA, World Bank Group, UNDP, 2019. Trends in Maternal Mortality 2000 to 2017: Estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. World Health Organization, Geneva.
Wong, K.L.M., Brady, O.J., Campbell, O.M.R., Banke-Thomas, A., Benova, L., 2020. Too poor or too far? Partitioning the variability of hospital-based childbirth by poverty and travel time in Kenya, Malawi, Nigeria and Tanzania. Int. J. Equity Health 19, 15.
Wright, K., Banke-Thomas, A., Sonoiki, O., Ajayi, B., Ilozumba, O., Akinola, O., 2017. Opinion of women on emergency obstetric care provided in public facilities in Lagos, Nigeria: a qualitative study. Health Care Women Int. 38, 527–543.