

ORIGINAL RESEARCH

EVIDENCE-BASED HEALTH PROGRAMME PLANNING IN NORTHERN NIGERIA: RESULTS FROM THE NAHUCHE HEALTH AND DEMOGRAPHIC SURVEILLANCE SYSTEM PILOT CENSUS

HENRY V. DOCTOR,^{1,2} SALLY E. FINDLEY¹ and ABDULAZEEZ JUMARE³

¹Columbia University, Mailman School of Public Health, Department of Population and Family Health, New York, USA; ²Northern Nigeria Maternal, Newborn and Child Health Programme, Nassarawa GRA, Kano, Nigeria; and ³PRRINN-MNCH Programme, Zamfara State, Nigeria and Ahmadu Bello University, Department of Community Medicine (Zaria Campus), Zaria, Nigeria.

Corresponding author: Dr. Henry Victor Doctor (hvd2105@columbia.edu)

ABSTRACT

Introduction: In 2009, the Partnership for Reviving Routine Immunisation in Northern Nigeria (PRRINN) Maternal, Newborn and Child Health (MNCH) Programme, in collaboration with the Zamfara State Ministry of Health, launched the Nahuche Health and Demographic Surveillance System (HDSS) in a rural north Nigerian setting. Located in Bungudu Local Government Area in Zamfara State, the Nahuche HDSS will support studies aimed at assessing the impact of health systems interventions by monitoring health as well as demographic events and populations at risk over time. This paper reviews the Nahuche model of surveillance as well as selected demographic, maternal and health indicators and their potential in guiding programme planning particularly in resource-constrained northern Nigeria. Potential interventions to address these challenges are also discussed. **Methods:** In May 2010, a pilot census (194 households interviewed out of targeted 205 households) was conducted in Nahuche Keku District followed by a full baseline census in September 2010 and periodic event updates of 120-day work cycles which began in January 2011. **Results:** Poor maternal and child health indicators were observed. For example, 19.8% of all women (n=131) with live births in the five years preceding the pilot census had received antenatal care from a health professional for their last birth. Only 9.2% reported that their births were delivered by a health professional. An even lower proportion (6.6%) delivered in a health facility with 93.4% of all births occurring at home. **Conclusion:** Despite the fundamental problems associated with strengthening health systems in northern Nigeria, the Nahuche HDSS will generate opportunities for testing feasible interventions and set the stage for reducing the high maternal and child mortality rates. The Nahuche HDSS is a system to watch based on its location and the enthusiasm of Nigerians to accelerate progress in meeting the Millennium Development Goals of maternal and child mortality.

KEY WORDS: Child health; Health promotion; Demographic surveillance; Maternal health; Nigeria.**SUBMITTED:** 8 November 2010; **ACCEPTED:** 28 February 2011

INTRODUCTION

Maternal and child health outcomes in Nigeria are among the worst in the world, and Nigeria contributes approximately 10% of the global burden of maternal and child deaths (UNICEF, 2008). According to a recent multi-country study (Hogan et al., 2010), Nigeria is one of few countries where the maternal mortality ratio (MMR) has actually increased from 473 (ranging from 306 to 703) deaths per 100,000 live births in 1990 to 608 (ranging from 372 to 946) in 2008. The situation is a particular cause of concern in northern Nigeria, where maternal mortality is estimated to be higher than the national average. According to the Maternal and Newborn Road Map based on the 2003 Nigeria Demographic and Health Survey, the MMR in 2003 for northern Nigeria was estimated at 1,287 per 100,000 live births; MMR in the North West and North East Zones of Nigeria was estimated at 1,025 and 1,549 deaths per 100,000 live births respectively.

In the context of the Partnership for Reviving Routine Immunisation in Northern Nigeria (PRRINN) Maternal, Newborn and Child Health (MNCH) Programme targeting four states in northern Nigeria (Jigawa, Katsina, Yobe and Zamfara) and co-funded by the Department for International Development of the United Kingdom and the State Department of the Norwegian

Government, baseline household surveys were conducted to develop an evidence base to support the selection of appropriate programme strategies to reduce the unacceptably high rates of maternal, newborn and child mortality in the region. In order to accurately prioritise and plan for programmes to address barriers to maternal and newborn care services, it is critical to have detailed, accurate and timely information about existing service use and barriers to that use. The PRRINN-MNCH Programme is conducting a number of mini-studies which will use results from the baseline surveys to guide programme planning. In addition, in 2009 the PRRINN-MNCH Programme through funding from the Norwegian Government, set up the Nahuche Health and Demographic Surveillance System (Nahuche HDSS), a longitudinal health and population registration system established to monitor health and demographic dynamics in Nahuche emirate in Bungudu Local Government Area (LGA) of Zamfara State in northern Nigeria. The Nahuche HDSS has been implemented by the PRRINN-MNCH Programme in collaboration with the Zamfara State Ministry of Health (SMOH) to support studies aimed at assessing the wider progress and impact of strengthening health systems by monitoring health and demographic events and populations at risk over time.

The Nahucho Health Research Centre (HRC) which oversees the operations of the HDSS was established to provide the core research resource for factorial trials of the best practices to improve maternal and child health outcomes. A pilot census was conducted in May–June 2010 to test the complex systems which are critical to running an HDSS. In September 2010, a full baseline census was conducted to be followed by monitoring of health and demographic events that started in January 2011 by trained interviewers who are visiting rural areas in 120-day work cycles, recording events in registers, and reporting data to the Nahucho HRC for computerization and processing.

The Nahucho system has replicated a model of surveillance which was pioneered by the Navrongo HDSS site in northern Ghana in 1993. Since then a number of projects in Asia and Africa have used the Navrongo system (or a modified version) as a model for replication. The Navrongo model has been described in detail elsewhere (Binka et al., 1999). In brief, the Navrongo HDSS is a longitudinal population and health registration system that monitors health and demographic dynamics in Kassena and Nankana Districts of the Upper East Region of Ghana. The Navrongo HDSS was implemented by the Navrongo Health Research Centre (NHRC) in 1993 to support studies of the determinants of morbidity and mortality and associated problems of high fertility. The NHRC was established in 1992 by the Ghanaian Ministry of Health to investigate health problems in northern Ghana and test suitable and practical interventions. Since July 1993, fieldworkers have been visiting rural areas in 90-day work cycles (with the cycle over the years shifting between 90-day to 120-day or 180-day work cycles due to variations in financial resources), recording events in registers, and reporting data to the NHRC for processing. The NHRC has convened workshops and offered technical support leading to replications of the system for the Rakai Project in Uganda, the Ifakara Project in Tanzania, the Gada Madja University Child Survival Project in Indonesia as well as other initiatives in South Africa, Mali, Burkina Faso, and northern Nigeria, just to mention a few (see Binka et al., 1999 for more details). As a result, this paper briefly introduces the features of the Nahucho HDSS and focuses on the pilot census activities, results and their potential in guiding health programme planning, particularly in resource-constrained northern Nigeria. Potential interventions to address these challenges are also discussed.

The Nahucho HDSS places a locality under observation so that risks of health and demographic events or morbidity are precisely defined for a population over time, providing essential information for the epidemiological evaluation of health technologies or interventions. Earlier studies (e.g., D'Souza, 1984; Mosley, 1989; Garenne et al., 1997) have employed surveillance technologies to conduct research on demographic determinants, demographic inter-relationships and other studies that employ population-based causal inference. Contemporary HDSS sites have greatly benefited from new computing technology that has facilitated development and replication of methodological and analytical systems to study the impact of health technologies in improving people's lives. To this end, the Nahucho HDSS is envisaged to evolve into a robust research infrastructure supporting community-based research whose studies will range from biomedical to ethnographic.

The objective of this paper is to introduce the Nahucho model of surveillance, and to discuss the results from the pilot census and

the opportunities to address health problems in rural northern Nigeria. In the next sections, we describe the Nahucho HDSS with respect to the study area, its core methodological approaches, limitations and efforts to address these, and ethical concerns. We further discuss selected results and implications of the Nahucho approach to surveillance for further epidemiological research in resource-constrained northern Nigeria. We conclude by providing some potential interventions that will be tested on the HDSS platform to provide evidence-based strategies aimed at addressing some of the observed maternal and child health challenges.

METHODS

The study area

The Nahucho study site is located in Zamfara State of northwestern Nigeria. Situated in Bungudu LGA, the site is 32 kilometres from the state capital, Gusau, and is constituted of six districts: Bella, Gada, Karakai, Nahucho Keku, Nahucho Ubandawaki and Rawayya. Gusau is a key commercial centre with a heterogeneous population from many parts of Nigeria. Virtually all members in the study area are Hausa by ethnicity.

The study site contains 306 villages under the leadership of six district heads. The overall hierarchy of Bungudu LGA consists of the LGA chairperson followed by the Emir, the senior district and the district head. The area has a population of about 95,000 people based on the 2010 estimates from the National Population Commission (NPC). Infrastructure remains substandard with limited power supply in the area. The sanitation system is not well developed and the water supply through boreholes or wells is erratic. The road network is bad with local taxis being the predominant means of transport. All villages have at least a primary and junior secondary school. The climate is warm and tropical with temperatures rising to 38°C from March to May. The rainy season starts in May and runs to late September while the cold season known as the Harmattan lasts from December to February. Farming is the most common economic and subsistence activity of the people, hence the slogan of the state "farming is our pride." High unemployment contributes to temporary labour migration of men.

One primary health centre is located adjacent to the HDSS site offices with the general hospital located near Gusau. Most people access healthcare from public health facilities or traditional and faith healers. After neonatal causes (accounting for 26% of total under-5 deaths), the most common direct causes of child mortality as stated in Nigeria's Integrated Maternal Newborn and Child Health Strategy are malaria (24%), pneumonia (20%), diarrhoea (16%), measles (6%) and HIV/AIDS (5%).

Overall study design and population for the HDSS

The operations of the Nahucho HDSS will involve continuously monitoring the health and demographic events of the entire population of the Demographic Surveillance Area (DSA). This will involve a multi-round, prospective community study, with systematic recording of all birth, death, migration and other health events, covering the whole population of the Nahucho emirate.

During the pilot census, accurate and detailed community maps were hand-drawn by the NPC staff. Each existing dwelling unit (DU) was assigned an identification number, allowing repeated visits to each household. Maps will be digitized and updated

regularly to incorporate new dwellings and other infrastructural changes. The maps, global positioning system data and HDSS household identifiers will aid in spatial analyses of health and demographic events and uptake of interventions.

The baseline pilot census

The baseline pilot census was conducted from May 25 to June 2, 2010. The target population of the pilot census consisted of members living in 205 households in Nahuche Keku District. The pilot area was demarcated into 20 clusters with the assistance of staff from the NPC. Four clusters located close to the Nahuche HDSS offices were purposely selected and used for the pilot census. The pilot clusters were selected to allow fieldworkers to walk easily between the offices and the clusters in order to expedite pilot census activities. In addition, since the population is largely homogeneous with all 20 of the demarcated clusters which will eventually be part of the full census, no attempt was made to randomly select the pilot clusters. As a result, the homogeneity of the population does not defeat the representativeness of the pilot population. Based on the NPC statistics, we expected that the four clusters would yield a population of 1,500 people living in approximately 250 households. This estimate was based on the 2006 population census (an average of 7.1 individuals per household). During the pilot, the population size of each enumeration (district) area based on the 2006 census was not available.

Within the HDSS structure, a cluster was defined based on a collection of compounds or DUs in which households are located. The population was divided into smaller, manageable chunks or clusters to enable fieldworkers to complete the enumeration rapidly and submit the completed forms to the computer center for processing. Worldwide, the number of DUs per cluster in HDSS sites varies. It is based on what is subjectively considered manageable. The 20 demarcated clusters were different in terms of size and number of compounds or DUs. The target was to visit all of the identified households in all of the clusters. As part of the pilot census activities, all of the compounds or DUs in the four clusters were listed in order to identify the number of households. After visiting all four clusters, the expected number (250) differed from the observed number (205) of households. All 205 of the identified households were visited and information on every resident was successfully recorded for 194 households, a 94.6% response rate. Non-response was a result of absent household members after three repeated visits. The baseline pilot census questionnaire collected information on names of household members, relationship to head of household, residence status, sex, date of birth, ethnicity, marital status, education, survival status of parents and household characteristics. In addition, the pilot census collected information related to birth history, antenatal care (ANC) and vaccination of children. This information was collected among women of reproductive age ($n=131$) who had given a birth any time during the five years preceding the pilot census. Although it is not recommended to overload questions in the pilot census (or first round) questionnaires, the additional information was needed to provide indicators that would assess progress towards achieving the programme's goal of improving maternal, newborn and child health in northern Nigeria. The fieldworkers interviewed the head of the household or a

responsible adult (using the census form) and women of reproductive age using the maternal and child health module of the pilot census questionnaire. A maximum of three revisits were carried out, following which a non-response was recorded.

Data management and quality control

The Nahuche HDSS used the household registration software (HRS2) for data entry and processing. This software is also used by other HDSS sites (see Binka et al., 1999 for a detailed description based on the Navrongo approach). A filing clerk was used to track questionnaires from the field to the computer centre and vice versa. Any problems encountered during the processing were communicated to the appropriate teams so that corrective action could be taken.

Ethical clearance

Ethical clearance was granted by the Zamfara SMOH Operations Research Advisory Group. Verbal informed consent was obtained from respondents whereas community consent was obtained from both district heads during the beginning of the HDSS activities. The Nahuche HDSS team also aims at ensuring continued cooperation among respondents by maintaining regular updates of activities of the HDSS through social mobilization committees. Data collected from the HDSS will be captured in a secure computer room with restricted access.

Limitations and challenges

One of the key challenges encountered during data collection was that male interviewers were not allowed to interview female respondents. This posed a challenge particularly for the maternal and child health sections of the questionnaire. Efforts were made to ensure that men fully understand the need to interview women for certain modules of the HDSS questionnaires particularly in a situation where the ratio of male to female interviewers was about 5 to 1, an artefact of low literacy levels among females in the catchment area of the HDSS site and northern Nigeria in general. A key approach to address this problem was to use village heads who explained to their community members the role of the HDSS in their area and the need to ensure that community members cooperate with the research activities of Nahuche HDSS. Nevertheless, community members were given the right to refuse to answer any or all of the questions.

RESULTS

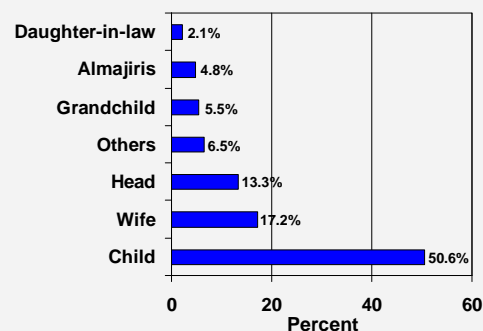
Household population and housing characteristics

Age and sex are important demographic characteristics. They form the basis of demographic classification and are also key variables in the study of mortality, fertility, migration and nuptiality. The distribution of the de jure (usual residents) population in the 2010 pilot census is presented in Table 1. About 47% of the population was female, representing a sex ratio (males/100 females) of 113. The results show that the household population had a greater number of younger people than older people. About half of the total population was under 15 years of age while 3.1% was 65 years or older. The proportion of children under 18 years who had lost their mother was 3.4% whereas those who had lost their father was 3.9%. Less than 1% of all children under 18 years had lost both parents.

Table 1: Selected socio-demographic characteristics of 1,440 individuals (194 households), Nahuche HDSS pilot census, 2010

Characteristics	Number
De jure population size ^a	1,440
Male	764 (53.1%)
Ratio male to female	1.13 to 1
Mean age (years) ^b	20.0 (SD 18.0)
Median age (years)	14.0
% of maternal orphans (<18 years)	3.4%
% under five years	17.0
% under 15 years	50.2
% over 65 years	3.1
% of paternal orphans (<18 years)	3.9%
% of double orphans (<18 years)	0.6%
Number of households	194
Mean household size ^c	7.4 (SD 6.1)*

Notes: ^aDe jure population: the permanent population plus temporary migrants. These are people who usually stay in the household for three or more months each year; ^bMinimum age in years is 0 and maximum is 90; ^cBased on de jure population; *SD = standard deviation.

Figure 1: Relationship to head of household, Nahuche HDSS pilot census, 2010.

Note: "Others" include siblings (1.6%); parent (1.2%); niece (1.0%); nephew (0.9%); sister-in-law and son-in-law (0.4% each); step/foster child and step parent (0.2% each); parent-in-law, grandparent, uncle, brother-in-law and other unspecified relationship (0.1% each).

Figure 1 displays the relationship to the head of the household of all the members enumerated in the 194 households. The predominant relationship was that of a child representing 50.6% of the household members followed by 17.2% of the members who were wives to the head. These households were headed by 13.3% of the members with 6.5% comprised of "other" relationships (see the note below Figure 1). Another 5.5% of the household members were residing with grandchildren and 4.8% of the members being *Almajiris*, that is, children who are taught the Islamic religion. The *Almajiris* are known to come from as far as Niger Republic. A few households were staying with daughters-in-law (2.1%) and also their parents and brothers (1.2% each).

The pilot census collected information on a number of household possessions in form of durable goods and other assets as well as livestock. This information is important since it provides an indicator of the wealth status of the household. Table 2 presents a summary of this information. The results show that few households owned some of the more expensive assets compared with the less expensive assets. For example, 50% of the households owned a bicycle, followed by a motorcycle (46.9%), a refrigerator (27.3%), a motor vehicle (16.5%), a satellite dish for television (6.2%), a computer (1.6%) and a tractor (1%). A majority of the households possessed a cutlass (94.3%), a mattress (95.4%) and a torch.

Being a largely agricultural and animal husbandry area, information was also sought on livestock ownership as well as other characteristics. Table 3 shows that the highest proportion of

livestock ownership was reported for sheep (78.4%) with an average of 6.2 sheep per household. About 52% owned goats (mean=4.4) and 20.6% owned cattle (mean=9.2). Ownership of poultry was reported by 60.3% of households (mean=10.9). Donkeys were owned by 26.8% of households (mean=1.3) whereas camels were owned by 5.2% of households (mean=1.8) and another 5.2% owned other unspecified livestock (mean=3.4).

In an area where malaria is rife, households were asked about ownership of mosquito nets as an indicator of malaria prevention. Table 3 shows that 52.1% of households owned mosquito nets (mean=2.3) with the average number of rooms occupied by households being 4.6 and the average number of rooms used for sleeping being 2.7.

Antenatal and delivery care

Antenatal care (ANC) from a trained provider is important in order to monitor the pregnancy and reduce morbidity and mortality risks for the mother and child during pregnancy and delivery. Table 4 shows that 19.8% of women who gave birth in the five years preceding the census received ANC from a trained health professional (i.e., doctor or nurse/midwife) at least once. ANC coverage was highest among women aged 20 years and below (23.2%), followed by those aged 20–34 (21.4%) and those aged 35 years and above (15.2%). The differences in ANC attendance by education level were not huge. The most important observation was that ANC attendance among the uneducated was 33.3% whereas roughly one out of every 5 women within the other education categories had received ANC.

Table 2: Percentage distribution of households (n=194) by possession or access to selected durable household goods and other possessions, Nahuche HDSS pilot census, 2010.

Asset	Percent
Mattress	95.4
Hoe	95.4
Clock/Watch	94.9
Cutlass	94.3
Torch	92.8
Electricity	87.1
Kerosene/Paraffin lamp with glass	86.1
Table	84.0
Kerosene/Paraffin stove	79.9
Radio/Stereo	75.8
Sofa set	75.3
Mobile phone	74.2
Access to pay phone/Mobile	71.1
Electric fan	70.1
Electric/Charcoal iron	67.5
Video deck/DVD player	56.2
Bicycle	50.0
Television	48.5
Motorcycle	46.9
Gas stove	27.8
Refrigerator	27.3
Motor vehicle	16.5
Satellite dish/receiver	6.2
Computer	1.6
Tractor	1.0

Table 3: Percentage distribution of households (n=194) by ownership of livestock and other characteristics, Nahuche HDSS pilot census, 2010.

Characteristic	Percent	Mean	Median	Range
Cattle	20.6	9.2	2	[1, 100]
Sheep	78.4	6.2	4	[1, 50]
Donkey	26.8	1.3	1	[1, 10]
Goats	51.6	4.4	3	[1, 20]
Camel	5.2	1.8	1	[1, 4]
Horse	0.0	-	-	-
Poultry	60.3	10.9	10	[1, 50]
Other livestock	5.2	3.4	1	[1, 10]
Mosquito nets	52.1	2.3	2	[1, 14]
Rooms occupied by household	-	4.6	4	[1, 24]
Rooms used for sleeping	-	2.7	2	[1, 9]

Tetanus toxoid injections are given during pregnancy to prevent neonatal tetanus (a major cause of early infant death in many developing countries), which may occur because of failure to observe hygienic procedures during delivery. The infant is protected from tetanus by two or more anti-tetanus injections given at least one month apart during pregnancy. Table 4 shows that among women who received ANC, 74.5% of last births had received at least one anti-tetanus vaccination. Anti-tetanus vaccination rates were highest for births of young mothers (82.4%) followed by the 20–34 age group (81.8%) and the older mothers (63.2%).

The mean number of tetanus injections received among all women was low at 1.2, whereas the highest was recorded among young mothers at 1.9. Among all women (irrespective of whether they received ANC or not), Table 4 shows that 26.7% of women received tetanus injections, about 48 percentage points lower than women who attended ANCs.

Access to proper medical attention and hygienic conditions during delivery can improve maternal and child survival by reducing the risk of complications and infections that may lead to death or serious illness for the mother and/or baby. Table 4 shows that for

all live births in the past five years, only 9.2% of women reported that their births were delivered by a health professional. An even lower proportion (6.6%) delivered in a health facility with 93.4% of all births occurring at home (not shown). Fifteen percent of births to older mothers were attended to by a health professional and 13.6% were delivered in a health facility. Disaggregating the results by education level showed that 14.3% of births among women with secondary schooling were attended to by a health professional and 9.5% were delivered in a health facility.

Quality of antenatal care

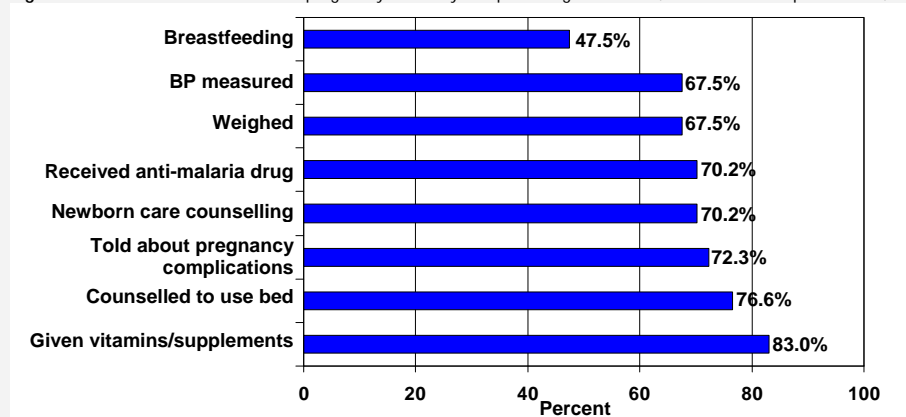
The pilot census asked questions about particular services that were received during pregnancy at the ANC provider. These included whether the woman's weight was recorded, whether the woman's blood pressure was measured, breastfeeding and newborn care counselling, *etc.* Figure 2 shows that among the births in the last five years that involved some type of ANC during pregnancy, 47.5% received breastfeeding counselling, 67.5% of mothers each had their weight and blood pressure measured, 70.2% each received newborn counselling and antimalarials, 76.6% were counselled to use bed nets, 83.0% were given vitamins or other supplements and 72.3% were informed of complications which can occur during pregnancy.

Table 4: Maternal care indicators by mother's age and education, Nahucho HDSS pilot census, 2010.

Background characteristic	Percent whose last live birth protected against neonatal tetanus ¹	Percent with ANC from a health professional ²	Percent receiving a vaccination against neonatal tetanus during their ANC visit ³	Mean number of tetanus injections received ⁴	Number of women	Percent delivered by a health professional	Percent delivered in a health facility	Number of births
Mother's age								
<20	40.0	23.2	82.4	1.9	43	4.7	2.5	79
20–34	25.7	21.4	81.8	1.3	42	7.1	2.6	70
35+	34.3	15.2	63.2	0.9	46	15.2	13.6	76
Education								
None	3.1	33.3	33.3	1.5	3	0.0	0.0	4
Primary	9.4	16.7	16.7	1.8	18	0.0	0.0	29
Secondary	21.9	23.8	33.3	2.4	21	14.3	9.5	35
Higher	12.5	21.4	28.6	1.7	14	7.1	0.0	28
Quranic	53.1	17.9	25.4	1.7	67	11.9	9.7	120
Total	26.7	19.8	74.5	1.2	131	9.2	6.6	225

Notes: ¹Irrespective of whether they received ANC or not; ²Doctor or nurse/midwife; Some numbers for sub-categories may not add up to the total due to reference to specific categories; ³Among women who received ANC; Some percentages refer to specific group of women and not the sample sizes reported here.

Figure 2: ANC content for most recent pregnancy in the 5 years preceding the census, Nahucho HDSS pilot census, 2010.



Knowledge of danger signs during childbirth

Women with a recent birth occurring anytime within the 5 years preceding the census were also asked about their knowledge of complications which can occur during labour and delivery. This information is presented in Table 5. Results showed that 15% did not mention any complication whereas 9.2% of women mentioned prolonged labour (>12 hours) only. About 4% of women mentioned high fever only with 1.7% each mentioning excessive vaginal bleeding and bad smelling vaginal discharge only. Baby's hand or feet coming first was mentioned by 2.5% of women as a

complication. Less than 1% each of women mentioned baby turning or rotating and ruptured uterus as complications.

One of the goals of ANC is to ensure that women know about multiple complications which can occur during labour and delivery. Table 5 further shows that 16.7% of women mentioned two complications and another 19.2% were able to mention three complications. Women who were able to mention four complications accounted for 14.2% with 7.5% able to mention five complications. The results generally show that the higher the

number of multiple complications known, the smaller the proportions of women. For example, 0.8% of women were able to mention nine complications.

Table 5: Percentage distribution of knowledge of complications during childbirth, among women with recent pregnancy in the previous 5 years before the survey, Nahuche HDSS pilot census 2010

Type of delivery complication	Percent (n=131)
No complication	15.0
Excessive vaginal bleeding only	1.7
Bad smelling vaginal discharge only	1.7
High fever only	4.2
Baby's hand or feet come first only	2.5
Baby turned or rotated only	0.8
Prolonged labour (>12 hours) only	9.2
Placenta does not come out right away only	0.0
Ruptured uterus only	0.8
Prolapsed cord (i.e., cord outside uterus) only	0.0
Cord around neck only	0.0
Convulsions only	0.0
Other complication only	0.0
<i>Number of complications known</i>	
2 complications	16.7
3 complications	19.2
4 complications	14.2
5 complications	7.5
6 complications	0.8
7 complications	2.5
8 complications	2.5
9 complications	0.8
10 complications	0.0
11 complications	0.0
12 complications	0.0

Note: Percentages do not add up to 100% due to rounding of figures.

DISCUSSION

The Nahuche HDSS pilot census was conducted to test the feasibility of enumerating and tracking a northern Nigerian rural population over time. The pilot population was enumerated and core system indicators enabling tracking of the population (such as generation of unique identifiers) were developed. This will enable health and demographic events to be monitored as well as assessments to be made regarding the impact of interventions aimed at reducing maternal and child mortality rates. Interviews were conducted with respondents from 194 households of which 131 were women of reproductive age with a recent birth during the five years preceding the pilot census. The results showed that the population was largely young, with poor socio-economic indicators, low ANC uptake levels as well as having majority of births occurring at home. The poor socio-economic status was evidenced by few households which owned some of the more expensive assets compared with the less expensive assets. For example, half of the households owned a bicycle, followed by a motorcycle (46.9%), a refrigerator (27.3%), a motor vehicle (16.5%), a satellite dish for television (6.2%), a computer (1.6%) and a tractor (1%). The majority of households possessed a cutlass (94.3%), a mattress (95.4%) and a torch. About 20% of women who gave birth in the five years preceding the census received ANC from a trained health professional (i.e., doctor or nurse/midwife) at least once, with majority of women (93%) delivering their babies at home.

The results documented here have demonstrated the capacity of Nahuche HDSS to generate evidence-based information for health programme planning as well as the capacity of the surveillance model to track individuals, health and demographic

events over time. Tracking of individuals will be possible since the data generated from the pilot were used to produce identification numbers of individuals which can be used during follow-up visits. The Nahuche HDSS is the backbone of the PRRINN-MNCH Programme's approach to delivering and assessing the impact of selected interventions.

That poor socio-economic status, lack of access to ANC and supervised delivery are critical factors sustaining high maternal morbidity and mortality cannot be overemphasized (Graham et al., 2001; Maine 2007; Ronsmans et al., 2007; Pembe et al., 2009). With maternal, newborn and child health bottlenecks on the one hand and the Nahuche model of surveillance on the other hand, the PRRINN-MNCH will, until 2013, investigate the role of the following selected broad interventions in reducing maternal and child mortality:

- Increasing access and availability of skilled ANC providers and birth attendants, emergency obstetric care as well as newborn care;
- Folic acid supplementation;
- Expanding provision of and access to evidence-based preventive and curative health interventions such as insecticide-treated materials and vitamin A supplementation, among others; and
- Establishing women's groups focusing on savings to improve their access to health services.

Generally, these interventions have been found to be effective in other settings (e.g., Jones et al., 2003; Darmstadt et al. 2008). However, replication of these interventions in a resource constrained environment with strong traditional and cultural beliefs that undermine efforts to reduce maternal and child mortality (e.g., the belief and preference for home deliveries) is an enormous task. To overcome this, the PRRINN-MNCH Programme is addressing maternal and child health challenges through an integrated approach that focuses on bottlenecks associated with governance, human resources within the health care system, delivery of MNCH services, operations research, information and knowledge management, and generating health service demand and supply. Successful efforts in achieving this agenda will accelerate progress towards achieving the Millennium Development Goals of maternal and child mortality reduction.

CONCLUSION

The Nahuche HDSS will monitor longitudinal health and demographic dynamics under exceedingly complex circumstances. Cultural factors restrain married women from being interviewed by men, low levels of educational attainment result in largely male-dominated fieldworker teams, and age distortions and other biases occur in the recall of information. Despite these essential difficulties, information will be recorded, edited and reported on population dynamics in a large population. Findings from the pilot census showed a largely young population associated with poor maternal and child health indicators. The successful replication of surveillance technology in an impoverished northern Nigerian population provides the opportunity to study the determinants of poor maternal and child health behaviours, and generates realistic interventions to address health problems in such settings. The Nahuche HDSS pilot census activities have demonstrated the replication of surveillance technology in a resource-constrained environment and become a model for other longitudinal health and

copyright

demographic research projects in Nigeria. Nahuche has not only replicated a capacity for conducting longitudinal research; it has developed a platform for testing feasible interventions as we draw closer to the Millennium Development Goals.

ACKNOWLEDGEMENTS

PRRINN-MNCH is funded and supported by UKaid from the Department for International Development and the State Department of the Norwegian government. Specifically, the Nahuche HDSS is funded and supported by the Norwegian Government, Zamfara SMOH and Bungudu LGA. We also acknowledge the support received from the PRRINN-MNCH management and staff (national and state level), senior technical advisors for the operations research unit, the INDEPTH Network technical team, the leadership of Zamfara State at all administrative levels, the traditional chiefs of Bungudu LGA, fieldworkers, data entry clerks, and community members for their continued support during the pilot census. An earlier version of this paper was presented at The INDEPTH Network Annual General Meeting in Accra, Ghana, September 27–30, 2010.

REFERENCES

- Binka FN, Ngom P, Phillips JF, Adazu K, MacLeod BB (1999). Assessing population dynamics in a rural African society: The Navrongo Demographic Surveillance System. *Journal of Biosocial Science* 31: 375–391.
- Darmstadt G, Walker N, Lawn J, Bhutta Z, Gaws R, Cousens S (2008). Saving newborn lives in Asia and Africa: cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy and Planning* 23: 101–117.
- D'Souza S (1984). Population laboratories for studying disease processes and mortality: The Demographic Surveillance System, Matlab. In: *Methodologies for the Collection and Analysis of Mortality Data*, pp. 65–88. Edited by J. Vallin, J.H. Pollard and L. Heligman. Liège: Ordina Editions.
- Garenne M, Das Gupta M, Pison G, Aaby P (1997). Prospective community studies in developing countries: introduction. In: *Prospective Community Studies in Developing Countries*, pp. 1–15. Edited by M. Das Gupta, P. Aaby, M. Garenne and G. Pison. Oxford: Clarendon Press.
- Graham W, Bell JS, Bullough CHW (2001). Can skilled attendance at delivery reduce maternal mortality in developing countries? In: *Safe motherhood strategies: a review of the evidence*, pp. 97–129. Edited by: V. De Brouwere and W. van Lerberghe. Antwerp: ITG Press.
- Hogan MC, Foreman KJ, Naghavi M, et al. (2010). Maternal mortality for 181 countries, 1980–2008: A systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 375(9726): 1609–1623.
- Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS (2003). Bellagio Child Survival Study Group. How many child deaths can we prevent this year? *Lancet* 362(9377): 65–71.
- Maine D (2007). Detours and shortcuts on the road to maternal mortality reduction. *Lancet* 370(9595): 1380–1382.
- Mosley WH (1989). Population laboratories for community health research. In: *Community Based Health Research, Documents de Trabajo*, No. 21, pp. 1–17. Mexico City: The Population Council.
- Pembe AB, Urassa DP, Carlstedt A, Lindmark G, Nyström L, Darj E (2009). Rural Tanzanian women's awareness of danger signs of obstetric complications. *BMC Pregnancy and Childbirth* 9:12.

Ronsmans, C Vanneste AM, Chakraborty J, van Ginneken J. 1997. "Decline in maternal mortality in Matlab, Bangladesh: A cautionary tale." *Lancet* 350: 1810–1814.

UNICEF (2008). *The State of the World's Children 2009*. New York: United Nations Children's Fund.