PNG Med J 2011 Sep-Dec;54(3-4):154-163

Sociodemographic factors associated with maternal health care utilization in Wosera, East Sepik Province, Papua New Guinea

S. Maraga[1,2], E. Namosha[1], H. Gouda[1,3], L. Vallely[1,3], L. Rare[1] and S. Phuanukoonnon[1]

Papua New Guinea Institute of Medical Research, Goroka and School of Population Health, University of Queensland, Brisbane, Australia

SUMMARY

This retrospective study sought to describe the utilization of maternal health services in a rural community in Wosera, East Sepik Province, Papua New Guinea. Interviews were undertaken with a convenience sample of 391 women of reproductive age. We examined the relationship between socioeconomic and demographic characteristics and the use of antenatal clinic services and delivery at a health centre. Despite uptake of antenatal care services by 79% of women, two-thirds of women gave birth at home. Women's education was an independent predictor for maternal health care utilization, for both antenatal care and delivery at a health facility. At least one visit to an antenatal clinic was the strongest predictor of delivering at a health care facility. Women expressed barriers to assisted childbirth such as distance to health facilities, especially when labour came fast, and feelings of shame in presenting to a facility to give birth. This study provides important information relating to the uptake of maternal health care services. Despite the uptake of available antenatal care services, intrapartum services are not well accessed.

Introduction

With only three years left to achieve the Millennium Development Goals (MDGs), many countries are focusing their population health efforts on reducing the number of maternal and child deaths (1). Globally, declines in maternal mortality have been reported (2) as have declines in child mortality (3). However, the rates of decline are not consistent over time or between and within countries and regions (3). Of the 342,900 maternal deaths that take place every year, 99% occur in developing countries (2). The majority of these deaths are in rural areas with the poorest and most remote communities bearing the biggest burden (4,5). The main causes of maternal deaths are haemorrhage, sepsis, unsafe abortion and pregnancy-related hypertension (6). The major factors associated with maternal deaths are absence of skilled health professionals during childbirth, lack of services to provide emergency obstetric care and to deal with complications of unsafe abortion, and ineffective referral systems (6).

A maternal death is frequently accompanied by either a stillbirth or early neonatal death (4). Every year an estimated three million infants are stillborn; one-third of these stillbirths occur during labour. An estimated four million neonatal deaths occur every year (7), three million within the first week of life, of which one million occur in the first twenty-four hours (7,8). As with maternal deaths, 98% of all neonatal deaths occur in low-income and middle-income countries (7,8). Therefore to make any further significant impact on infant and maternal mortality, health care during the perinatal period is a crucial factor and must be addressed (9).

In developing countries an estimated 79% of women attend antenatal care at least once during a pregnancy, yet only 59% of births are attended by skilled birth attendants (7). Lack of antenatal care and skilled attendants at the time of birth are predictors of a poor outcome for both the mother and infant (4). In various regions of the world studies have shown that sociodemographic characteristics influence

1 Papua New Guinea Institute of Medical Research, PO Box 60, Goroka, Eastern Highlands Province 441, Papua New Guinea

2 seri.maraga@pngimr.org.pg

3 School of Population Health, University of Queensland, Herston, Queensland 4006, Australia

the use of maternal health services (10-21). However, findings are not always consistent. For example, the association between maternal age and use of health services varies: while some studies have found a positive correlation with age (12,13,19) others have found a more complicated relationship with age (12,15). Similarly for education attainment: studies from South America (14,17) have shown that higher levels of education predicted greater utilization of health care, while others in Asia (10,18,19) showed no difference across the different education levels. Distance to health facility (from place of residence) and parity have often been found to have a strong negative correlation with health service utilization (11,21). Marital status, culture and ethnicity have also been noted to play an important role in the use of maternal health services (16,20).

With 733 maternal deaths per 100,000 live births, Papua New Guinea (PNG) has the second highest maternal mortality ratio (MMR) in the Asia-Pacific region and one of the highest in the world (22). This high and increasing MMR is likely to be due to deteriorating rural health services and poor uptake of available health services (23). The cultural and geographical diversity in PNG is an added barrier to availability, access and uptake of professional skilled health care during pregnancy and delivery (23).

In PNG an estimated 78% of women receive antenatal care at least once from a health provider and just over half report attending for the minimum recommended four visits (7,22). According to National Department of Health data, only 37% of women are assisted during labour and childbirth by a skilled health professional; one-third of women report being assisted by a female relative during childbirth and 7% report giving birth with no assistance at all (22). Serious birth complications, including excessive bleeding, prolonged labour, vaginal infection, fever and convulsions were reported by 43% of women in the most recent demographic and health survey (DHS) in 2006 (23). As with the MMR, the neonatal mortality rate (NMR) in PNG is high with 29 deaths per 1000 live births (23). In PNG 10% of neonates are of low birthweight (LBW); these newborn infants are particularly vulnerable and at risk of neonatal death.

Maternal and infant mortality remains a health priority in PNG (23). Current estimates of burden are likely to be underestimated, with the majority of morbidity and mortality occurring in the rural and remote areas of PNG where they remain unreported (23). In order to strive towards improving outcomes for women and their newborn infants there is a need to understand the determinants of utilization of maternal health services, particularly in the more remote and rural locations.

The overall objective of this study was to describe the utilization of maternal health services and to examine some of the individual factors related to these trends among women in Wosera, East Sepik Province, PNG.

Methods

Study area and population

The study was conducted from June 2009 to December 2009 through the Wosera Health and Demography Surveillance System (HDSS) in the Wosera/Gawi District in East Sepik Province, PNG. The Wosera HDSS is located 75 km west-southwest of the provincial capital Wewak and is situated at 50-100 m above sea level on the large alluvial plain situated between the Torricelli Mountains in the north and the flood plain of the Sepik River in the south; it covers an area of 12 km by 16 km (24,25).

The Wosera HDSS was initially set up as part of a large Malaria Vaccine Epidemiology and Evaluation Project for PNG in the early 1990s (24,25). It started baseline investigations into malaria epidemiology and immunology in nine villages surrounding the Kunjingini Health Centre (26, 27). The value of the Malaria DSS and other health research was realized and in order to have capacity to concurrently run other studies in the area, the DSS area was rapidly expanded (28) and now comprises 30 villages with 23,000 registered inhabitants.

People in the Wosera are Abelam speakers and are predominately subsistence farmers. Health services in the area are provided through one government health centre (Wombisa), two church health subcentres (Kaugia and Kunjingini) and six government aid posts. Antenatal clinics are held once a week at the health centre and subcentres. At the time of this study, services offered at the aid post were hampered by insufficient staff and medical supplies. Poverty in the area was

and remains pronounced and the population health status is poor (29,30).

Study population

The present study examined the utilization of maternal health care services among women of reproductive age in rural PNG. The Wosera HDSS dataset was used to identify women who had given birth in the previous five years. A convenience sample of women aged between 15 and 49 years was selected for inclusion in the study. Women were interviewed in their homes by trained nursing officers using a structured questionnaire. Information relating to uptake of antenatal services, delivery and care practices of the newborn was collected.

Data processing and analysis

Socioeconomic and demographic predictors including age of the woman at interview, her educational attainment, parity and marital status were included as predictor variables in this study. The woman's age at interview was categorized into three groups. The youngest mothers were between 19 and 24 years of age at the interview and about a third of these were under 18 when they gave birth to their first child. The extent of missing dates of birth and ages of children prevented a full analysis of the women's age at time of first birth. Women's educational attainment was categorized into 'no education', '1-6 years' corresponding with primary education in PNG and '7-12 years' which corresponds to secondary education. Only one woman reported being divorced. Marital status was therefore categorized as either currently married or currently single. All women included in the study had given birth to at least one child in the last five years.

Completed questionnaires were entered into MySQL by a research assistant. Bivariate analysis using chi-squared tests of significance were employed to identify associations between the selected socioeconomic and demographic characteristics and utilization of maternal health care services. Binary logistic regression was applied to examine which characteristics best predict antenatal clinic (ANC) attendance and the use of a health care facility for childbirth. Multivariate regression was also employed to account for the relationship between the factors of interest. Estimated odds ratios with 95% confidence intervals (CIs) are presented. All analyses were performed using Stata version 11.

Ethical approval

The Wosera HDSS operated under the PNG Institute of Medical Research (PNGIMR). All medical studies conducted within the HDSS are reviewed and approved by the IMR Internal Review Board (IRB) and the PNG Medical Research Advisory Committee (MRAC).

Results

Population demography

A total of 391 women between the ages of 15 and 49 were interviewed during the six-month period of the study; 1 was dropped in analysis due to missing data. Very few younger mothers were identified or were willing to be interviewed. The youngest woman interviewed was 19 years old. Nearly two-thirds of the women interviewed (60%) were aged between 25 and 34 years; a similar proportion (67%) had given birth to between two and five infants. More than half of the women (55%) interviewed reported having had no formal education and the majority (96%) were married (Table 1).

Uptake of antenatal care

79% (307/390) of women reported attending ANC at least once during their last pregnancy (Table 2) and two-thirds reported attending more than three times (Figure 1). Of all the women who attended ANC, 48% (148/307) stated that they knew how often they should attend ANC. Only 25% reported attending antenatal clinic in the first trimester (Figure 2). Primary level education and marriage were significantly associated with ANC clinic attendance (Tables 2 and 3). Education was also significantly associated with giving birth in a health centre. ANC clinic attendance strongly predicted the subsequent use of a health care facility for childbirth: $\chi^2 = 33.69$ (Table 2) and OR = 10.22 (CI 4.02-25.98) (Table 3). The relationship with primary education extends to the number of ANC visits a woman makes. Education and age were significantly associated with women's likelihood to have attended an ANC clinic more than three times during their pregnancy: OR 1.76 (CI 1.29-2.41) and OR 0.63 (CI 0.45-

TABLE 1

BACKGROUND SOCIODEMOGRAPHIC CHARACTERISTICS OF THE STUDY SAMPLE

Variable	Categories	Frequency (n = 390)	Percentage
Maternal age at interview (years)	19-24	35	9.0
	25-34	235	60.3
	≥35	120	30.8
Years of education	0	214	54.9
	1-6	138	35.4
	7-12	38	9.7
Marital status	Currently married	375	96.2
	Currently single	15	3.8
Parity	1	32	8.2
	2-3	126	32.3
	4-5	135	34.6
	≥6	97	24.9

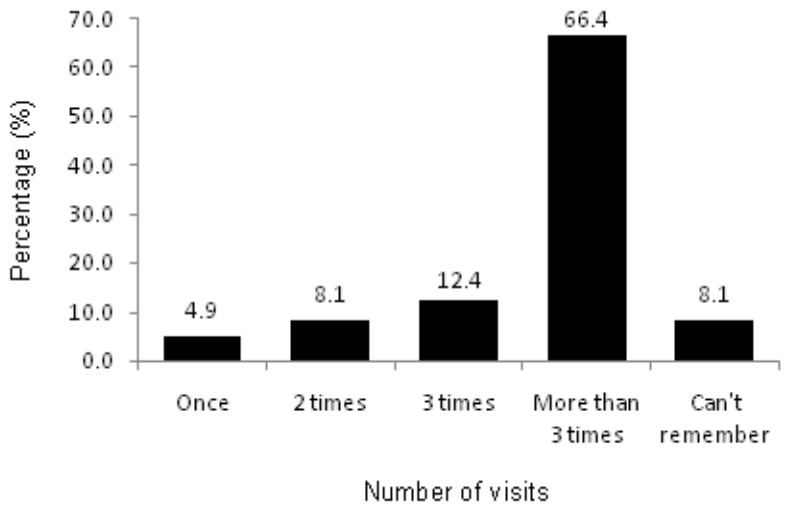

Figure 1. The number of antenatal clinic visits during the last pregnancy.

0.89), respectively.

Table 4 presents the significant predictor variables using both a bivariate analysis and a multivariate analysis of ANC attendance and delivery in a health care facility. Women's education remained an independent predictor of maternal health care utilization in both cases and marital status remained significantly associated with ANC attendance. At least one previous visit to an ANC clinic was the strongest predictor of delivering at a health care facility while age did not reveal a significant relationship with the decision to

TABLE 2

PERCENTAGE OF WOMEN WHO HAD AT LEAST ONE BIRTH IN THE LAST FIVE YEARS PRECEDING THE SURVEY BY ANTENATAL CARE CLINIC ATTENDANCE AND DELIVERY AT A HEALTH CARE FACILITY BY BACKGROUND SOCIODEMOGRAPHIC CHARACTERISTICS

	Antenatal clinic attendance	Delivery at health centre
Age (years)	(1.32) ns	(3.36) ns
19-24	85.7	45.7
25-34	78.7	33.2
35+	76.7	29.2
Education (years)	(12.92)***	(35.93)***
0	72.0	22.2
1-6	87.0	40.2
7-12	86.8	68.4
Marital status	(6.00)**	(0.29) ns
Single	53.3	26.7
Married	79.7	33.3
Parity	(5.28) ns	(5.34) ns
1	65.6	45.2
2-3	82.5	36.8
4-5	76.3	26.7
6+	81.4	33.3
ANC attendance		(33.69)***
Never attended	-	6.2
Attended ANC at least once	-	40.2
Total	78.7	33.1

Note: Figures in parentheses are the chi-squared statistics
Level of significance: *p <0.10; **p <0.05; ***p <0.01
ns = not significant
ANC = antenatal clinic

seek a professionally assisted birth.

Assistance during home births

Two-thirds of all women interviewed (257/390) reported giving birth to their last infant at home. Of these 46% gave birth alone, 27% were assisted by their mother or mother-in-law and 11% were assisted by a village birth attendant (Table 5). Of all the women who delivered outside a health facility 53% had attended the antenatal clinic three times or more (Figure 3).

Of the individual factors examined, older women and those of higher parity were more likely to give birth at home, without assistance. Our analysis also indicates that the mother's age and parity played significant predictive roles in deciding whether the mother would give birth at home without assistance.

When asked why they gave birth at home only 46% (117/257) of women gave a

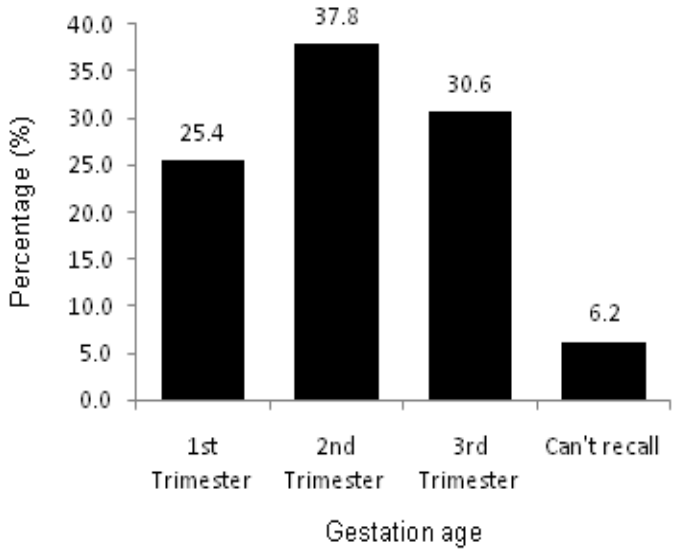

Figure 2. Women attending antenatal clinic for first time, by trimester.

TABLE 3

BIVARIATE ANALYSIS SHOWING ODDS RATIO (95% CONFIDENCE INTERVAL) FOR RECEIVING SOME ANTENATAL CARE AND FOR DELIVERING A BABY AT A HEALTH CENTRE AMONG WOMEN WHO HAVE HAD AT LEAST ONE BIRTH IN THE LAST FIVE YEARS PRECEDING THE SURVEY

	Antenatal clinic attendance Odds ratio (95% CI)	**Delivery at health centre Odds ratio (95% CI)**
Year of education		
0 ®	1	1
1-6	2.60*** (1.46 - 4.63)	2.36*** (1.47 - 3.77)
7-12	2.57* (0.96 - 6.90)	7.61*** (3.57 - 16.21)
Marital status		
Single ®	1	1
Married	3.93** (1.34 - 11.56)	1.25 ns (0.38 - 4.07)
ANC attendance		
Never ®	-	1
Attended ANC at least once	-	10.22*** (4.02 - 25.98)
Number of ANC visits	-	1.18 ns (0.92 - 1.50)

Note: ® Reference category
Level of significance: *p <0.10; **p <0.05; ***p <0.01
ns = not significant
ANC = antenatal clinic

TABLE 4

BIVARIATE AND MULTIVARIATE ANALYSIS OF THE DETERMINANTS OF ANTENATAL CLINIC (ANC) ATTENDANCE AND DELIVERY AT A HEALTH CARE FACILITY

	ANC attendance		Delivery at a health care facility	
	Bivariate analysis	**Multivariate analysis**	**Bivariate analysis**	**Multivariate analysis**
Age	0.81 ns (0.53 - 1.22)	NI	0.74* (0.52 - 1.06)	0.89 ns (0.60 - 1.32)
Education	2.02*** (1.32 - 3.11)	1.99*** (1.30 - 3.06)	2.60*** (1.87 - 3.63)	2.37*** (1.67 - 3.36)
Marital status	3.93** (1.34 - 11.56)	3.78** (1.25 - 11.44)	1.25 ns (0.38 - 4.07)	NI
Parity	1.11 ns (0.86 - 1.45)	NI	0.85 ns (0.68 - 1.08)	NI
ANC attendance	NA	NA	10.27*** (4.04 - 26.12)	9.04*** (3.50 - 23.36)

NA = not applicable
NI = not included because of non-significance
Level of significance: *p <0.10; **p <0.05; ***p <0.01
ns = not significant

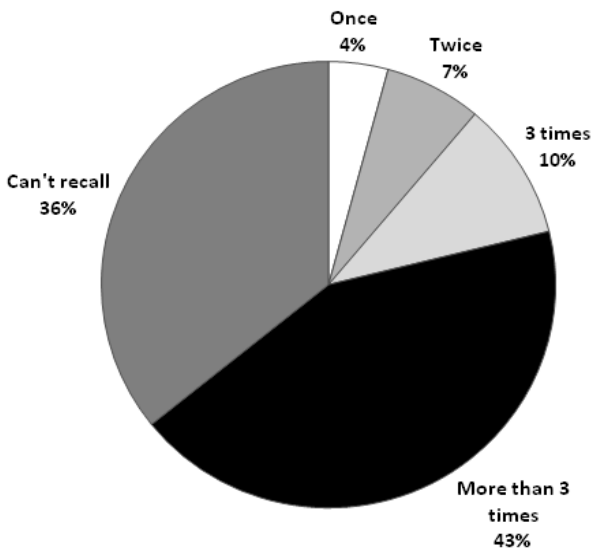

Figure 3. Percentages of deliveries outside a health facility by antenatal clinic attendance.

response. Of these women, 45 (38%) stated that the clinic was too far or they were too lazy to make the trip. A further 22 (19%) indicated that either labour came on too fast or they did not feel much pain. The issue of 'shame' arose in only 9 (8%) of the responses. This referred to either the shame of being a single mother or because a male nurse was present at the health centre.

Discussion

The study found that while there was high attendance at antenatal clinics, only one-third

TABLE 5

BIVARIATE ANALYSIS SHOWING ODDS RATIO (95% CONFIDENCE INTERVAL) FOR TYPES OF ASSISTANCE DURING HOME DELIVERIES

	No assistance/self n = 117	Mother/mother-in-law n = 69	VBA n = 27	Friend n = 44
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age at interview (years)				
15-24 ®	1	1	1	1
26-34	3.68** (1.09 - 12.45)	1.28 ns (0.50 - 3.26)	0.72 ns (0.23 - 2.25)	0.55 ns (0.21 - 1.47)
≥35	8.73*** (2.53 - 30.06)	0.64 ns (0.23 - 1.81)	0.20** (0.04 - 0.94)	0.64 ns (0.23 - 1.81)
Mother's education				
None ®	1	1	1	1
Primary	0.58** (0.36 - 0.93)	0.62* (0.35 - 1.09)	1.74 ns (0.77 - 3.94)	0.63 ns (0.32 - 1.26)
Secondary	0.33** (0.13 - 0.83)	0.31* (0.09 - 1.06)	0.93 ns (0.20 - 4.33)	0.17* (0.02 - 1.25)
Marital status				
Single ®	1	1	1	1
Married	5.38 ns (0.69 - 41.82)	0.71 ns (0.19 - 2.66)	0.89 ns (0.11 - 7.15)	0.69 ns (0.15 - 3.24)
Parity				
1 ®	1	1	1	1
2-3	2.95 ns (0.65 - 13.34)	0.81 ns (0.34 - 1.93)	1.50 ns (0.32 - 7.10)	1.14 ns (0.36 - 3.65)
4-5	8.28*** (1.90 - 36.12)	0.52 ns (0.21 - 1.27)	1.79 ns (0.38 - 8.31)	0.91 ns (0.28 - 2.94)
≥6	15.50*** (3.51 - 68.42)	0.28** (0.10 - 0.77)	0	0.66 ns (0.19 - 2.35)
ANC				
Never ®	1	1	1	1
Attended ANC at least once	0.35*** (0.21 - 0.59)	0.59* (0.33 - 1.07)	0.75 ns (0.31 - 1.84)	0.90 ns (0.43 - 1.91)

VBA = village birth attendant
Note: ® Reference category
Level of significance: *p <0.10; **p <0.05; ***p <0.01
ns = not significant
ANC = antenatal clinic

of women returned to the health facility to give birth. For the women who attended the ANC but delivered outside a facility, most had attended antenatal clinic three times or more. Attendance at the antenatal clinic was likely to be influenced by the mother's educational level, marital status and parity. These findings are similar to those reported elsewhere in PNG that indicate that women attend antenatal care as a means of ensuring that all is well with the pregnancy, and that once antenatal care has been initiated women do tend to return for further visits (31,32).

Within this study population 66% of all births took place at home, findings that reflect national data for supervised deliveries (23). This emphasizes the need for health care workers in antenatal clinics to focus on assisting women to understand the critical importance of facility-based supervised births. Attending ANC clinics was the strongest predictor of giving birth in a health facility, followed by the years of education attained by the mother. Marriage played a significant role in ANC attendance but was not significantly associated with delivery at a health facility. This raises questions about the role of the husband in decisions made to visit clinics for antenatal care but not for the birth. Future research should examine the husband's perspective on health facilities as well as his background characteristics such as educational attainment.

Women who gave a reason for giving birth at home mostly stated that distance (from home to the health facility) was a barrier to their health-care-seeking behaviour; shame at being cared for by a male health care worker was also mentioned. Other studies both from PNG and in the international literature have identified similar findings; other factors that play important roles include road quality, transport availability, cultural barriers (16,31-34) and a lack of perception by both health workers and women of the dangers of home birth and how even a first-level health centre can have a significant impact on preventing both maternal and neonatal death.

This retrospective study has a number of limitations worth noting. Firstly, recall bias may have influenced the responses from women. Those who had given birth more recently or those who had experienced problems during their pregnancy or childbirth may be more accurately able to recall events. In reality it may be difficult for a woman to remember whether she attended antenatal clinic three or four times. Secondly, convenience sampling was conducted to select the 391 women included in the study presented here. Largely due to cultural attitudes about young and single mothers no women under the age of 19 were interviewed. This age group is likely to be at particular risk of under-utilization of maternal services. Furthermore, due to the small sample size in this study the survey did not collect information on birth or infant health outcomes. Such information would have added substantially to our analyses and provided some indication of the extent of protection afforded by maternal services in Wosera.

Lastly, women who gave birth at home were asked about their reasons for not using a health centre. Many women did not answer this open-ended question and this may have biased our analysis. A more in-depth qualitative study of women in this region may be warranted. Educational attainment is particularly low in this sample and a better understanding about the motivations and barriers experienced in this community may help to develop better services and more appropriate health messages about the importance of supervised births.

Conclusions

This study provides important information relating to the utilization of maternal health care services in this setting. While the results suggest that women appear to be aware of available antenatal services they do not utilize them to maximum benefit, especially at the time of birth. While it could be argued that there is a need for further in-depth research in this area, especially in relation to the reasons why women do or do not utilize maternal health services to give birth, this study does highlight several policy-relevant issues that could be addressed within the current health system. Initial contact with the health care workers at the antenatal clinic needs to be utilized to its full potential. This opportunity needs to be seized by the health care workers to educate the mothers about the potential dangers associated with childbirth, especially in the community setting, and the need for birth planning with particular attention to distance to health facilities and access and availability of transport. In addition health care workers need to be considerate of the

educational level and cultural and traditional beliefs of women in their care and provide care and advice appropriate to the individual's needs.

REFERENCES

1 **World Health Organization.** The Millennium Development Goals. Geneva: World Health Organization, 2008.

2 **Hogan MC, Foreman KJ, Naghavi M, Ahn SY, Wang M, Makela SM, Lopez AD, Lozano R, Murray CJ.** Maternal mortality for 181 countries, 1980-2008: a systematic analysis of progress towards Millennium Development Goal 5. *Lancet* 2010;375:1609-1623.

3 **Rajaratnam JK, Marcus JR, Flaxman AD, Wang H, Levin-Rector A, Dwyer L, Costa M, Lopez AD, Murray CJ.** Neonatal, postneonatal, childhood, and under-5 mortality for 187 countries, 1970-2010: a systematic analysis of progress towards Millennium Development Goal 4. *Lancet* 2010;375:1988-2008.

4 **World Health Organization.** Beyond the numbers: reviewing maternal deaths and complications to make pregnancy safer. Geneva: World Health Organization, 2004.

5 **Costello A, Osrin D, Manandhar D.** Reducing maternal and neonatal mortality in the poorest communities. *Br Med J* 2004;329:1166-1168.

6 **World Health Organization.** The World Health Report 2005 - Make Every Mother or Child Count. Geneva: World Health Organization, 2005.

7 **World Health Organization.** Maternal mortality in 2005: estimates developed by WHO, UNICEF, UNFPA and the World Bank. Geneva: World Health Organization, 2007.

8 **Lawn JE, Cousens S, Zupan J; Lancet Neonatal Survival Steering Team.** 4 million neonatal deaths: When? Where? Why? *Lancet* 2005;365:891-900.

9 **Paxton A, Maine D, Freedman L, Fry D, Lobis S.** The evidence for emergency obstetric care. *Int J Gynaecol Obstet* 2005;88:181-193.

10 **Raghupathy S.** Education and the use of maternal health care in Thailand. *Soc Sci Med* 1996;43:459-471.

11 **Pebley AR, Goldman N, Rodríguez G.** Prenatal and delivery care and childhood immunization in Guatemala: do family and community matter? *Demography* 1996;33:231-247.

12 **Obermeyer CM.** Culture, maternal health care and women's status: a comparison of Morocco and Tunisia. *Stud Fam Plann* 1993;24:354-365.

13 **Magadi MA, Agwanda AO, Obare FO.** A comparative analysis of the use of maternal health services between teenagers and older mothers in sub-Saharan Africa: evidence from demographic and health surveys (DHS). *Soc Sci Med* 2007;64:1311-1325.

14 **Goldman N, Pebley AR.** Childhood immunization and pregnancy-related services in Guatemala. *Health Transit Rev* 1994;4:29-44.

15 **Gage AJ.** Premarital childbearing, unwanted fertility and maternity care in Kenya and Namibia. *Population Studies* 1998;52:21-34.

16 **Gabrysch S, Campbell OM.** Still too far to walk: literature review of the determinants of delivery service use. *BMC Pregnancy Childbirth* 2009;9:34.

17 **Elo IT.** Utilization of maternal health-care services in Peru: the role of women's education. *Health Transit Rev* 1992;2:49-69.

18 **Dharmalingam A, Hussain TM, Smith JF.** Women's education, autonomy and utilization of reproductive health services in Bangladesh. In: Mundigo AI, ed. Reproductive Health: Programmes and Policy Changes Post-Cairo. Liège, Belgium: International Union for the Scientific Study of Population (IUSSP), 1999.

19 **Celik Y, Hotchkiss DR.** The socio-economic determinants of maternal health care utilization in Turkey. *Soc Sci Med* 2000;50:1797-1806.

20 **Bloom SS, Wypij D, Das Gupta M.** Dimensions of women's autonomy and the influence on maternal health care utilization in a north Indian city. *Demography* 2001;38:67-78.

21 **Bhatia JC, Cleland J.** Determinants of maternal care in a region of South India. *Health Transit Rev* 1995;5:127-142.

22 **National Statistical Office of Papua New Guinea.** National Health and Information System PNG. Demographic and Health Survey – Papua New Guinea 2006. Port Moresby: National Statistical Office, 2008.

23 **Papua New Guinea Department of Health.** Ministerial Taskforce on Maternal Health in Papua New Guinea. Port Moresby: Department of Health, 2009.

24 **Genton B, Anders RF, Alpers MP, Reeder JC.** The malaria vaccine development program in Papua New Guinea. *Trends Parasitol* 2003;19:264-270.

25 **Alpers MP, Al-Yaman F, Beck HP, Bhatia KK, Hii J, Lewis DJ, Paru R, Smith TA.** The Malaria Vaccine Epidemiology and Evaluation Project of Papua New Guinea: rationale and baseline studies. *PNG Med J* 1992;35:285-297.

26 **Genton B, Al-Yaman F, Beck HP, Hii J, Mellor S, Rare L, Ginny M, Smith T, Alpers MP.** The epidemiology of malaria in the Wosera area, East Sepik Province, Papua New Guinea, in preparation for vaccine trials. II. Mortality and morbidity. *Ann Trop Med Parasitol* 1995;89:377-390.

27 **Genton B, Al-Yaman F, Beck HP, Hii J, Mellor S, Narara A, Gibson N, Smith T, Alpers MP.** The epidemiology of malaria in the Wosera area, East Sepik Province, Papua New Guinea, in preparation for vaccine trials. I. Malariometric indices and immunity. *Ann Trop Med Parasitol* 1995;89:359-376.

28 **INDEPTH Network.** Objectives and priority research areas: Wosera DSS, Papua New Guinea. Accra, Ghana: INDEPTH Network. http://www.indepth-network.org/dss_site_profiles/woseraprofile.pdf

29 **Gibson RS, Heywood A, Yaman C, Sohlström A, Thompson LU, Heywood P.** Growth in children from the Wosera subdistrict, Papua New Guinea, in relation to energy and protein intakes and zinc status. *Am J Clin Nutr* 1991;53:782-789.

30 **Garner P, Smith T, Baea M, Lai D, Heywood P.** Maternal nutrition depletion in a rural area of Papua New Guinea. *Trop Geogr Med* 1994;46:169-171.

31 **Failing F, Ripa P, Tefuarani N, Vince J.** A comparison of booked and unbooked mothers delivering at the Port Moresby General Hospital: a case-control study. *PNG Med J* 2004;47:174-180.

32 **Larsen GL, Lupiwa S, Kave HP, Gillieatt S, Alpers MP.** Antenatal care in Goroka: issues and perceptions. *PNG Med J* 2004;47:202-214.

33 **Griffiths P, Stephenson R.** Understanding users' perspectives of barriers in maternal health care use in Maharashtra, India. *J Biosoc Sci* 2001;33:339-359.

34 **Amooti-Kaguna B, Nuwaha F.** Factors influencing choice of delivery sites in Rakai district, Uganda. *Soc Sci Med* 2000;50:203-213.