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Judith Shamian

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From the Editor-in-Chief

ome sobering facts to consider.

Around the globe, an estimated 300-600 million people suffer from malaria each year. More than one million people die from the disease annually – most frequently children under five years of age. Approximately 90% of malaria cases occur in Sub-Saharan Africa. More than 40% of the world's population lives in malaria-risk areas (UNICEF 2015).

So, we need to ask ourselves how it is that in the 21st century, with the science, expertise and the global good will to build a better world, we still face such tremendous loss of life to an "old" and well-known illness like malaria? The paper by Oreoluwa Ojo et al. in this issue provides a glimpse of what is happening on the ground. As the authors discuss while effective prevention tools and treatments are available, yet not all communities will use them. The reality is that different communities and different cultures will have different values and believes that drive their decisions about whether or not to implement preventive measures. We have multiple global and regional guidelines and directives, yet unless we learn how to overcome the cultural barriers of some communities and households we will miss the benefits of relatively low cost and high impact opportunities to save lives.

During a press conference at the 59th Commission on the Status of Women, convened by the UN earlier this year, it was communicated that there is a "Collective failure of leadership on progress of women" (UN Women 2015). The report further states that in the past 20 years, progress on women's empowerment has been far too slow.

The paper by Oreoluwa Ojo et al. clearly demonstrates that education and income have an impact on the level of parents' preventive behaviors. By investing in the education of parents, and in women in particular, we can improve the global burden of malaria and many other infectious and non-infectious disease. Far too often programs are put in place without engaging the community in their design – particularly, the women in the community.

As we set, guide and monitor investments in global health, it is essential to ensure that health education is part of the funded initiatives. This must include ongoing engagement of the community particularly the women/mothers/caregivers which will ensure that there is contextual understanding of the barriers and practices. We also need to consider how to reinforce and reward the positive practices. It is those positive practices are the desired outcome, yet there is too often a stronger focus on the barriers and not on the accomplishments.

Let's make sure that we continue to focus on prevention and proven methods while respecting and working with each community's values and realities.

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Geographical/Ecological Differentials in InsecticideTreated Net Use among Under-Five Children in Somolu Local Government Area, Lagos State



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Geographical/Ecological Differentials in Insecticide-Treated Net Use among Under-five Children in Somolu Local Government Area, Lagos State



Abstract

Malaria control efforts currently lay emphasis on reducing transmission by limiting human-vector contact. More studies have been carried out on mosquito avoidance practices in the rural areas, leaving the urban areas understudied. This study was conducted to identify knowledge of malaria transmission and to investigate geographical/ecological differentials in the use of insecticide-treated nets (ITNs) among caregivers of under-fives in Somolu Local Government Area, Lagos State. A household survey was conducted by interviewing 394 female caregivers of underfives selected using the WHO Lot Quality Technique from communities stratified based on level of planning and drainage. The mean age of the respondents was 33.6 ± 7.7 years. Malaria transmission was attributed mostly to mosquito bites in all strata: S1 (58.3%), S2 (56.1%) and S3 (61.4%). Mosquito net was mentioned as a preventive measure by: 59.3% (S1), 80.7% (S2) and 64.3% (S3). Ownership of longlasting insecticidal nets was: 76.0% (S1), 75.4% (S2) and 68.6% (S3), and of these, 73.1% (S1), 70.7% (S2) and 72.4% (S3) reported that their child slept under the net the night before the survey. There is a need to reinforce education on transmission and ownership of ITNs especially among caregivers in unplanned, poorly drained communities.

Introduction

While child mortality rates (0–5 years) have declined from 12.0 million in 1990 to 7.6 million in 2010 globally, it is unequally distributed, with India and Nigeria together accounting for a third of such deaths worldwide (WHO 2011). Malaria is a disease known to be associated with poverty and underdevelopment, and is a major scourge in the vast majority of tropical and subtropical regions of the world. Malaria control requires an integrated approach, comprising prevention (including vector control) and treatment with effective antimalarial agents (WHO 2008).

The use of insecticide-treated nets (ITNs) is currently considered one of the most cost-effective methods of malaria prevention in highly endemic areas, and it is the main method of malaria prevention used in Nigeria. Free distribution of long-lasting insecticidal nets (LLINs) is conducted through mass campaigns, routine distribution in public health facilities, faith-based organizations and non-governmental organizations, with the

goal of achieving universal access for the at-risk population of children less than five years and pregnant women (FMOH 2008).

Poor perception and knowledge of malaria control are among the factors likely to influence use of ITNs. Currently, the Nigerian malaria control program emphasizes the behavioural change communication strategies as an integral part of the mass ITN distribution campaigns. Behaviour change communication refers to mobilizing the communities, local, regional and national, as well as political and religious leaders to play an active role in malaria control and ensuring proper understanding of the core interventions by the population and promoting positive change of behaviour (FMOH 2008). Understanding the local perceptions and practices could be of immense relevance to such interventions that seek to enhance the community's potential to adopt and sustain the use of ITNs.ITNs have been shown to reduce all-cause mortality among children <5 years by approximately 20% (Baume et al. 2005; Carol et al. 2007). This translates to the

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prevention of almost 0.5 million deaths each year in Africa south of the Sahara. ITNs also protect against the development of anaemia in both pregnant and young children, the groups at highest risk from malaria and malarial anaemia. This recent development from ITNs that need to be retreated to long-lasting, washresistant nets that will remain effective for up to 4 years has proven to be more effective (WHO 2010). Mosquitoes transmit the malaria parasite and hence, protecting humans (especially the vulnerable ones like pregnant women and children under the age of five) from mosquito bites would go a long way in reducing the malaria burden. Yet, despite the well-known benefits of ITNs and the efforts of the Nigerian Government to promote this intervention, many families and individuals at risk in the country do not own or use them (WHO 2008). Several national surveys have shown persistently low levels of ownership and use of ITNs. The proportion of Nigerian households that owned at least one ITN during the same period was 2.2% in 2003 and 8% in 2008, while the proportion of under-five children who used ITN during the same periods was 1.2% and 5.5%, respectively. In this study, we sought to obtain more information about the perceptions and knowledge of malaria and its control among caregivers of under-five children. The objectives of this study were to: (1) investigate perceived cause of malaria; (2) find out knowledge of the various preventive measures against malaria; (3) find out general knowledge on mosquito nets, its ownership and usage among caregivers of under-five children; and (4) determine ecological/geographical differentials in ITN use among under-five children in Somolu Local Government Area (LGA). The findings of the study can help to inform planning of an acceptable intervention and community-based program to improve malaria transmission prevention practices among under-five children.

Methods

Study Area

The study was carried out in Somolu LGA, which is one of the 20 LGAs in Lagos State and lies on the North of Lagos City. The LGA is densely populated (as at the last census, i.e., 2006, the population was 602,673) and it has an area of 12 km². Social infrastructures like roads, water, health facilities and educational institutions abound in the LGA. It is close to the lagoon, and it is predominantly an Ijebu settlement with some Ilajes and Ijaws along the shoreline of the lagoon. There are also other tribes due to the influx of people into the State.

Study Design

A descriptive, cross-sectional study was carried out to investigate geographical/ecological differentials in the knowledge of malaria transmission and use of ITNs among caregivers of under-five children.

Sampling Technique

The study site was stratified into three strata based on the level of planning and drainage observed across the study site using the geographic information system (GIS). This helped to control for the environmental and topographical variation that is assumed to influence mosquito ecology. The three strata were: Stratum 1: Planned, well-drained. In this stratum, the streets were planned with a very good road network with no potholes and no open drainages system. Stratum 2: Planned, poorly drained. In this stratum, the streets had a good road network system with the streets linking each other; however, there were open drainage systems, revealing the litter-filled drains. Stratum 3: Unplanned, poorly drained. Here, the road network was bad with potholes as well as blocked and waterlogged drainage systems serving as mosquito breeding sites.

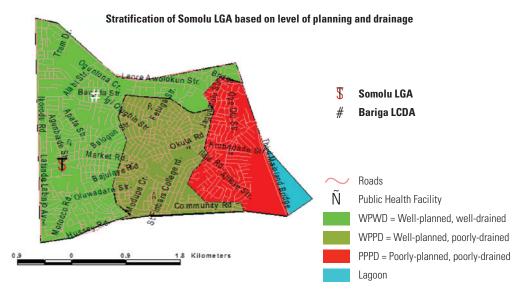
Sample Size and Sampling

The minimum sample size was estimated at 394 using the formula for a single population proportion (Leslie 1965), considering the use of the cluster sampling method and the 95% confidence interval assumption, 5% margin of error, 20% non-response rate and prevalence of use of ITNs among under-five children in South-western Nigeria as 28.8% (MIS 2010). The WHO Lot Quality Technique sampling method (WHO 2006) was used to select 394 caregivers of under-five children from the study communities.

The WHO Lot Quality Technique was selected so as to make judgements about individual stratum and hence formulate policies to direct resources to the stratum that needs them the most.

Firstly, the study LGA was stratified based on the level of planning and drainage observed across the LGA using the GIS. This resulted in: Stratum 1 (S1): planned, well-drained; Stratum 2 (S2): planned, poorly drained; and Stratum 3 (S3): unplanned, poorly drained. Figure 1 shows the LGA according to the level of planning and drainage system.

Figure 1. Map showing stratified, sampling scheme for Somolu Local Government Area (LGA)



The number of grids to sample in each stratum was selected proportionately, and the sample size was shared proportionately among the three strata. The sample size determined for each stratum was divided by the number of grid cells selected for each stratum to determine the number of caregivers to be studied per grid. A tossed coin with head up signals that data collection should start from the right of each grid and tail up signals that all houses on the left with care-givers of under-five children is sampled till the number of households in each grid was achieved. In households with more than one eligible caregiver, the random sampling method was used to select the caregiver to be interviewed.

Data Collection Methods

A pre-tested, interviewer-administered, semistructured questionnaire was administered to caregivers with at least one child under the age of five by trained research assistants who had sufficient information about the research and the area and who were closely supervised by the principal investigator. Each research assistant had a minimum of Secondary School Leaving Certificate, was a resident in the area and was thoroughly trained on the research, and all were fluent in both English language and Yoruba language. The research assistants duly informed the caregivers (as they went from house to house) about the purpose of the study and the benefits they stand to gain when the results of the study translate to policies that impact positively on their health and that of their under-five children. No incentive was given to the caregivers to encourage them to participate in this study.

The questionnaire was adapted from the study of Macintyre et al. (2002) in Kenya. The contents of the first section of the questionnaire were on the sociodemographic characteristics of the respondents, such as age, monthly income, marital status and occupation. Questions in the second section probed respondents' knowledge on the mode of malaria transmission, knowledge of signs and symptoms of malaria, its prevention and the various mosquito avoidance practices of the respondents. The third section contained questions that elicited information on respondent's knowledge of mosquito, ITNs ownership and usage and the suspected malaria episodes in the U-5C in the past 12 months (U-5C stands for children under the age of five years).

Data Analysis

The data was analyzed using SPSS 15.0 statistical software (SPSS Inc. USA). The outcome variable measured is usage of ITNs by underfive children the night before the survey. Independent variables include sociodemographic characteristics of the caregivers as well as their knowledge of signs and symptoms of malaria and its preventive measures. Descriptive statistics such as frequencies and means were used to summarize the data. Principal component analysis was used to calculate the household wealth index of

households by means of a list of household assets ownership. Categorical data were compared using the chi-square test, and a *p*-value of <0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Nigerian Institute of Medical Research Institutional Review Board. Prior to data collection, permission was sought from the Somolu Local Government. Informed consent was obtained from all respondents before the interview commenced.

Results

Sociodemographic Characteristics of Respondents

All respondents were female. The mean age of the respondents was 34 ± 7.7 years. Their ages were grouped into five, with the modal age group for all the strata being 30-39. In all the strata, more of the respondents reported that their monthly earning was difficult to say, with 134 (42.9%), 39 (68.4%) and 46 (65.7%) in S1, S2 and S3, respectively. Overall, 22.4% were in the richest quintile comprising S1 - 79.5%, S2 - 9.1% and S3 -11.4%. A majority of the respondents came from households with density of between three and five, with S1: 198 (63.5%), S2: 43 (75.4%) and S3: 48 (68.6%). More caregivers had just one under-five child: S1: 187 (59.9%), S2: 35 (61.4%) and S3: 48 (68.6%). Table 1 shows a summary of the sociodemographic characteristics of the respondents.



Table 1. Sociodemographic characteristics of the caregivers (N = 394)

Characteristic	S1 n (%) N = 207	S2 n (%) N = 89	S3 n (%) N = 98	Total n (%) N = 394
Age group				·
<20	8 (3.8)	0 (0)	0 (0)	8 (2.0)
20-29	56 (27.2)	12 (14.0)	22 (22.9)	90 (22.8)
30–39	107 (51.9)	56 (63.2)	15 (15.4)	178 (45.1)
40–49	27 (13.1)	17 (19.3)	20 (20.0)	64 (16.2)
<49	8 (3.8)	3 (3.5)	6 (5.7)	17 (4.3)
	$\chi 2 = 12.72$	1, df = 8, p = 0.122		·
Marital status				
Currently married	182 (87.8)	86 (96.5)	95 (96.5)	363 (92.1)
Others	25 (12.2)	3 (3.5)	3 (3.5)	31 (7.9)
	$\chi 2 = 4.186$	6, df = 2, p = 0.123		
Occupation				
Unemployed	45 (21.5)	16 (17.5)	13 (12.9)	74 (18.8)
Student	25 (11.9)	8 (8.8)	10 (10.0)	43 (10.9)
Artisan	21 (10.3)	6 (7.0)	10 (10.0)	37 (9.4)
Trader	102 (49.4)	58 (64.9)	62 (62.9)	222 (56.3)
Civil servant	14 (7.1)	2 (1.8)	4 (4.3)	20 (5.1)
	$\chi 2 = 9.530$), df = 8, p = 0.300		
Educational status				
No formal education	15 (7.4)	6 (7.0)	4 (4.3)	25 (6.3)
Primary	19 (9.3)	6 (7.0)	13 (12.9)	38 (9.6)
Secondary	111 (53.8)	58 (64.9)	62 (62.9)	231 (58.6)
Tertiary	61 (29.5)	19 (21.1)	20 (20.0)	100 (25.4)
	$\chi 2 = 6.339$	9, df = 6, p = 0.386		
Wealth quintile				
Lowest	43 (20.8)	12 (14.0)	20 (20.0)	75 (19.0)
Second	36 (17.3)	27 (29.8)	24 (24.3)	87 (22.1)
Middle	38 (18.3)	27 (29.8)	20 (20.0)	85 (21.6)
Fourth	44 (21.2)	11 (12.3)	21 (21.4)	76 (19.3)
Highest	46 (22.4)	12 (14.0)	14 (14.3)	72 (18.3)
	$\chi 2 = 13.89$	7, df = 8, p = 0.084		

Respondents' Perceived Causes and Signs/Symptoms of Malaria

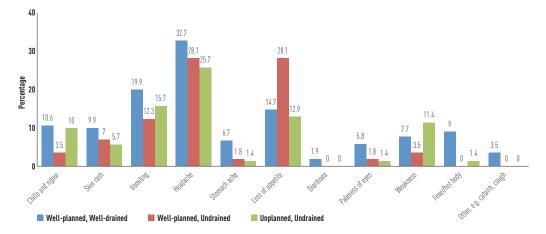
The proportion of the respondents who reported the cause of malaria is a mosquito bite was 234 (75%), 50 (87.7%) and 59 (84.3%) in S1, S2 and S3, respectively. Apart from mosquito bites, other causes mentioned include standing under the sun (S1: 12.8%,

S2: 10.5%, S3: 5.7%), eating bad food (S1: 4.6%, S2: 3.8%, S3: 1.8%), stress (S1: 6.4%, S2: 6.7%, S3: 7%) and dirty surroundings (S1: 10.5%, S2: 10.6%, S3: 7%). However, there was no significant difference in these other causes as reported across the three strata. Also, there was no significant association between the age of the caregiver

($\chi^2 = 7.918$, p = 0.095), education ($\chi^2 = 2.06$, p = 0.560) and the wealth quintile ($\chi^2 = 2.843$, p = 0.584) of the respondents and those who reported mosquito bites to be the

cause of malaria in S1, S2 and S3, respectively. Signs and symptoms of malaria that respondents mentioned are displayed in Figure 2.

Figure 2. Signs and symptoms (according to location) as reported by the respondents

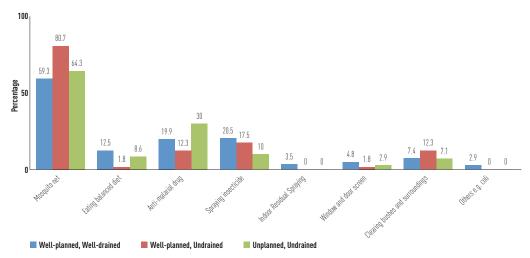


Respondents' Knowledge of Malaria Prevention Measures

A summary of respondents' knowledge of malaria prevention measures is given in Figure 3. Age had no significant association with those who reported the mosquito net as a preventive measure against malaria ($\chi^2 = 10.153$, p = 0.06); also, age had no significant association with knowledge of antimalarial

drugs as a malaria preventive measure ($\chi^2 = 0.792$, p = 0.673). However, a significant association was found between occupation ($\chi^2 = 16.421$, p = 0.03), wealth quintile ($\chi^2 = 9.964$, p = 0.04) and knowledge of antimalarial drugs as a malaria preventive measure. Figure 3 presents the malaria preventive measures mentioned by the respondents.

Figure 3. Respondents' knowledge of malaria prevention measures



Mosquito Net Ownership and Their Source

Table 2 shows the mosquito ownership status of the respondents as well as how they got the net. Mosquito nets refer to both retreatable nets and LLINs. Most of the households of the respondents had more than one mosquito net: S1, 171 (77.4%); S2, 29 (70.7%); and S3, 33 (68.8%).

Acquisition of mosquito nets was mainly at the health facility in the three strata, with 146 (62.1%) of the respondents in S1 having their nets from the health facility and 27 (62.8%) and 32 (66.7%) of the respondents in Strata 2 and 3, respectively, reporting likewise. This was followed by distribution by local government officials (civil servants) in S1 (26%), S2 (35%) and S3 (27.1%), respectively.

Table 2. Mosquito net ownership and their source

	Well-planned, well-drained n (%) N = 206	Well-planned, not well-drained n (%) N = 89	Not planned, not well-drained n (%) N = 98	Total
Do you have a mosqui	to net?			
Yes	157 (76.0)	67 (75.4)	67 (68.6)	291
No	49 (24)	22 (24.6)	31 (31.4)	102
*Which type do you h	ave?			
Untreated net	14 (8.9)	5 (7.0)	6 (8.3)	25
Retreatable net	55 (35.0)	14 (20.9)	10 (14.6)	79
Long-lasting insecticide-treated net	85 (54.4)	45 (67.1)	53 (79.2)	183
*How did you acquire	it?			
At health facility	98 (62.1)	42 (62.8)	45 (66.7)	185
Distribution by local government officials	41 (26.0)	23 (35.0)	8 (12.5)	72
Bought it	27 (17.0)	14 (35.0)	18 (27.1)	59

^{*}Multiple responses.

Geographical/Ecological Differentials in Insecticide-Treated Net Use among Under-five Children in Somolu Local Government Area, Lagos State

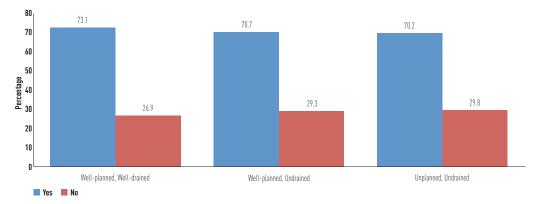
Mosquito Net Usage

12

More than 70% of the respondents in each stratum had their under-five child sleep

under the net the night before the survey (Figure 4).

Figure 4. Proportion of under-five children who slept under a bed net the night before the survey



A significant association existed between occupation ($\chi^2 = 19.606$, p = 0.001), monthly earning ($\chi^2 = 18.106$, p = 0.001), the type of house in which respondents live ($\chi^2 = 11.726$, p = 0.03), number of under-five children in the household ($\chi^2 = 35.709$, p = 0.00), the number of times the child had febrile illness in the past one year ($\chi^2 = 6.209$, p = 0.045) and the child slept under the net a night before the survey.

Relationship between Caregivers' Characteristics and Bed Net Usage among Under-Five Children

The relationship between caregivers' characteristics and bed net use among under-five children (the night before the survey) is given in Table 3.

Table 3. Relationship between caregivers' characteristics and bed net usage among underfive children

	Yes n (%)	No n (%)	Total N (%)	χ2	df	p
Occupation						
Unemployed	49 (88.3)	6 (11.7)	55 (100)	19.606	4	0.001*
Student	23 (89.3)	3 (10.7)	26 (100)			
Trader	113 (68.3)	52 (31.7)	165 (100)			
Artisan	21 (64.7)	11 (35.3)	32 (100)			
Civil servant	7 (50.0)	7 (50.0)	14 (100)			
Type of house				11.726	2	0.003*
One room	81 (68.9)	37 (31.1)	118 (100)			
Room and parlour	91 (82.6)	19 (17.4)	110 (100)			
Self-contained apartment	37 (60.9)	24 (39.1)	61 (100)			
Number of under-five children in the household				6.98	1	0.008*
1	116 (67.0)	57 (33.0)	173 (100.0)			
≥2	93 (80.5)	23 (19.5)	116 (100)			

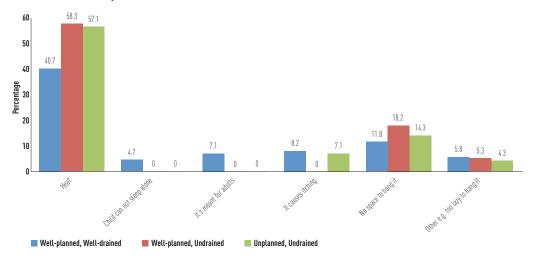
^{*}Significant at 95% level of significance.

N = 283 (number of respondents with bed net).

Reasons Why Under-Five Child Did Not Sleep under the Net the Night before the Survey

For the children who did not sleep under the net a night before the survey, the reasons given in the three strata include: the net generates heat, the child cannot sleep alone, the net is meant only for adults, the child reacts to the net or it causes itching in the child and lack of space to hang it in the room. However, the majority in each stratum mentioned the issue of heat generated by the net: 41%, 58% and 57% in S1, S2 and S3, respectively (Figure 5).

Figure 5. Reported reasons for under-five child not having slept under a bed net the night before the survey



Reasons for Not Owning a Net

For the respondents who reported not owning mosquito nets, in S1 and S2, a higher proportion (32.9% and 43.8%, respectively)

of the respondents reported that they owned a net but it was torn (Table 4). The unavailability of the net in the market was the main reason given in S3.

Table 4. Reasons given by under-five caregivers for not owning a net

	Strata			
Variable	S1 n (%)	S2 n (%)	S3 n (%)	Total
Reasons				
I can't afford it	6 (12.7)	0 (0)	6 (18.8)	12 (11.8)
I don't think it's effective	10 (20.3)	7 (31.3)	4 (12.5)	21 (20.6)
It's not available in the market	11 (21.5)	6 (25.0)	8 (25.0)	25 (24.5)
I had but it's torn	16 (32.9)	10 (43.8)	8 (25.0)	34 (33.3)
Others, e.g., I can't find it	6 (12.7)	0 (0)	5 (18.7)	11 (10.8)
Total	49 (100)	22 (100)	31 (100)	102 (100)

14 Geographical/Ecological Differentials in Insecticide-Treated Net Use among Under-five Children in Somolu Local Government Area, Lagos State

Factors Associated with Bed Net Use as a Mosquito Avoidance Practice

As shown in Table 5, there was no significant association between location ($\chi^2 = 0.46$, p = 0.795), monthly earning ($\chi^2 = 6.124$, p = 0.190), wealth quintile ($\chi^2 = 12.336$, p = 0.15)

and the use of a mosquito net. However, there was a significant association between its effectiveness ($\chi^2 = 7.081$, p = 0.008), its ease of use ($\chi^2 = 12.458$, p = 0.000) and its affordability ($\chi^2 = 9.209$, p = 0.002).

Table 5. Factors associated with bed net use as a mosquito avoidance practice

Characteristic			Ве	d net		
Location	Yes N = 256 n (%)	No N = 138 n (%)	Total N = 394 n (%)	χ²	df	P
Stratum 1	133 (64.4)	74 (35.6)	207 (100)	0.795	2	0.460
Stratum 2	61 (68.4)	28 (31.6)	89 (100)			
Stratum 3	62 (62.9)	36 (37.1)	98 (100)			
Monthly earning	Yes N = 256 n (%)	No N = 139 n (%)	Total N = 394 n (%)	χ²	df	Р
Difficult to say	135 (23.0)	62 (77.0)	197 (100)	6.124	4	0.190
≤ \ 20,000	72 (63.2)	42 (36.8)	114 (100)			
₩ 21,000- ₩ 40,000	30 (63.0)	18 (37.0)	48 (100)			
₩ 41,000- ₩ 60,000	7 (42.1)	9 (57.9)	16 (100)			
≥ \ 61,000	12 (59.1)	8 (40.9)	20 (100)			
It is effective	Yes N = 254 n (%)	No N = 140 n (%)	Total N = 394 n (%)	χ²	df	p
Yes	29 (50.0)	30 (50.0)	59 (100)	7.081	1	0.008*
No	225 (67.2)	110 (32.8)	335 (100)			
It is easy to use	Yes N = 253 n (%)	No N = 143 n (%)	Total N = 394 n (%)	χ²	df	p
Yes	1 (16.7)	11 (83.3)	12 (100)	12.458	1	0.000*
No	252 (66.0)	130 (34.0)	382 (100)			

^{*} Significant at 95% level of significance.

Discussion

In this study, more than 70% of the respondents had their child sleep under the net a night before the survey. This is quite encouraging but does not meet the target for malaria control during 2009–2013, which is to expand and sustain net usage to at least 80% of children under age 5 and to pregnant women by 2010 and to sustain the coverage until 2013 (MIS 2010).

The proportion of LLINs use among underfive children in this study is higher than in other studies conducted in Nigeria and Africa (MIS 2010; WHO 2010). For those children who did not sleep under the net, the major reason given in this study is similar to that reported in a study carried out in Ethiopia where factors like heat, absence of mosquitoes, LLINs preventing free air movement and difficulty hanging the nets were some of the reasons given for non-use of net in the study (Yared et al. 2008). Occupation of caregiver, type of house inhabited and the number of children under five in the household were significantly associated with the use of bed nets among the children under 5. Arogundade et al.

(2011) in their study in Nigeria reported other factors significantly associated with the use of bed nets and they are: education, geopolitical zone and misconception about causes and prevention of malaria. Worthy of note in this study is the association between accommodation type and use of bed net by the under-five children. Children who live in a one-room apartment may be unfortunate in that there may be just one bed (on which the parents sleep), while the children sleep on the floor. Alaii et al. (2003) in her study in Kenya reported that the use of bed nets was seasonal and was only meant for adults, not children. The respondents' geographical location had no direct association with ITN use among the under-five children. This could be as a result of free distribution by local government officials and when the respondents go for antenatal care visits.

Conclusion

This study sought to identify the perceived cause of malaria, knowledge of the various preventive measures against malaria, information on the general knowledge of mosquito nets and mosquito net ownership and usage among caregivers of under-five children, and to investigate ecological/geographical differentials in use of ITNs among caregivers of under-five children in Somolu LGA, Lagos State. Respondents' knowledge of the signs/symptoms of malaria in their under-five children and their perception of the cause of malaria and the various preventive measures against malaria is encouraging. However, it is disturbing that some still had misconceptions about the causes of malaria, like standing under the sun and eating bad food. This suggests an urgent need to strengthen educational programs on malaria that emphasize the causes and signs/symptoms of malaria. This improved knowledge will translate to uptake of malaria preventive services. As shown in Table 5, the stratification of Somolu LGA had no direct association with the use of bed nets by the

under-five children a night before the survey. This could be as a result of the free distribution done at antenatal care clinics and by local government officials. We can therefore conclude that with enactment and implementation of policies that encourage universal access to bed nets, the divide between the rich and the poor in terms of access to bed nets can be bridged, hence increasing the health status of the entire population. Over 70% of the respondents had their child sleep under a bed net a night before the survey, and this is encouraging as compared with the use of ITNs among under-five children in South-western Nigeria, which was only 28.8% (MIS 2010). This increase could be related to the increasing subsidy of healthcare services or free healthcare services and products by the government. From the findings in this study, it is obvious that but for free distribution of LLINs by the government, most of the households would have had no LLIN. More health education should be done on the importance of under-five children sleeping under bed nets to encourage its use. Even though the bed nets were given free of charge, some of the respondents still reported its unavailability in the market, and this could be due to their not being at home during distribution. The free distribution of the bed nets might be the reason why there was no statistical significance between monthly earnings, community measure of wealth and the use of bed nets. However, most of those whose children did not sleep under an ITN said it was as a result of the heat generated by the net, especially as there is usually sporadic power supply, which if it were stable, might have led to the use of electric fans. Therefore, LLIN material that does not absorb heat or is not heat-producing is highly recommended. It is important for malaria program managers to understand people's perceptions and knowledge about ITNs. It could be helpful if program managers encourage community participation so as to bridge the gap between planning and utilization. One limitation of

this study is the self-report of bed net use. All other previous studies were also based on self-reports. Given that bed net usage is not a very sensitive subject, there is not much to suggest that there would be a high level of false reporting on this subject. Nevertheless, it would strengthen future studies if objective observations of bed net use could be used along with self-reports to corroborate study findings. A larger study representing the geopolitical zones of the country is needed to provide more generalizable findings for all of Nigeria as well as a study in a community where there has not been free distribution of bed nets to determine the influence of community-level measure of wealth on bed net usage.

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Socioeconomic Determinants of Adult Mortality in Namibia Using an Event History Analysis



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Abstract

Adult mortality remains a neglected public health issue in sub-Saharan Africa, with most policy instruments concentrated on child and maternal health. In developed countries, adult mortality is negatively associated with socioeconomic factors. A similar pattern is expected in developing countries, but has not been extensively demonstrated, because of dearth of data. Understanding the hazard and factors associated with adult mortality is crucial for informing policies and for implementation of interventions aimed at improving adult survival. This paper applied a geo-additive survival model to elucidate effects of socioeconomic factors on adult mortality in Namibia, controlling for spatial frailties. Results show a clear disadvantage for adults in rural areas, for those not married and from poor households or in female-headed households. The hazard of adult mortality was highly variable with a 1.5-fold difference between areas, with highest hazard recorded in north eastern, central west and southern west parts of the country. The analysis emphasizes that, for Namibia to achieve its national development goals, targeted interventions should be aimed at poor-resourced adults, particularly in high-risk areas.

Introduction

Achieving better health has been a long-term agenda in public health. In the past two or plus decades, many health policy instruments, in most developing countries, have aimed to meet developmental issues, particularly the Millennium Development Goals (Bendavid et al. 2012; Jamison et al. 2006). Efforts in most countries have concentrated on child and maternal health as opposed to the general adult health (Bradshaw and Timaeus 2006; de Wilque and Filmer 2013). A lot has been done to improve children and maternal health, particularly the formulation of strategies, and scaling up of interventions aiming at improving health in children and mothers through disease prevention and control (Jamison et al. 2006). Little focus, though, has been drawn on adult health, specifically on adult survival and mortality (Kazembe 2013; Murray et al. 2010; Nikoi 2009; Obermeyer et al. 2010; Rajaratnam et al. 2010), yet adults are the economically active and productive group, with clear repercussions if neglected for long.

Whereas, the neglect in adult health, in part,

is due to lack of policy; on the other hand, studying adult mortality is further compounded by dearth of data, with few countries having reliable or complete civil registration and vital statistics (Mathers et al. 2005; Murray et al. 2010). In most countries, the population censuses have mostly been used in such an endeavour. However, these are limited in scope, with regards to having appropriate variables for meaningful epidemiological analysis.

What has been shown, elsewhere in Europe and the Americas, is that adult mortality is negatively associated with socioeconomic position. A similar pattern is expected in developing countries, but has not been extensively demonstrated. Literature documents a distinct relationship between adult mortality and socioeconomic factors, and the list is extensive. Particularly, socioeconomic factors contribute indirectly and/or exacerbate adult mortality. According to the theoretical framework proposed by Roger et al. (2005), socioeconomic factors are distal factors of adult survival. These factors act indirectly through proximate determinants like living

conditions, behaviour, health factors and socioeconomic and demographic variables, which, in turn, aggravate morbidity and mortality.

Studies, for example, Bassuk et al. (2002), noted an increased hazard of mortality among adults with lower education level regardless of the economic status, sex, race and neighbourhood. Nikoi (2009) observed that single adults, on average, were twice likely to die when compared to adults who were married. Sammy (2009) found that adults in the upper categories of socioeconomic status had lower hazard ratios (HR) for mortality compared to those in the poorest category. However, the differences were very small and not statistically significant. Moreover, individuals living in urban areas are thought to be socioeconomically better off, earning higher incomes and obtaining higher levels of education, factors considered to be robust predictors of health (Antonovsky 1967; Mackenbach et al. 1997; Marmot et al. 1984; Preston and Taubman 1994).

Moreover, in epidemiology or social science applications, survival data often contain geographic or spatial information such as community, district or region of residence. These factors make it possible for researchers to study the impact of the location on individual's survival, often modelled as random effects (Banerjee and Carlin 2003; McIntyre et al. 2002). The inclusion of random effects permits modelling of unmeasured and unobserved factors that have an effect on the outcome. These may act at various levels, be it at community, regional and national tiers, which may be attributed to differences in resource availability and accessibility (Magadi and Desta 2011; McIntyre et al. 2002), resulting in spatial inequalities that may negatively impact health outcomes. In random effect modelling, a possible extension is to assume that unobserved factors vary spatially to give spatial frailty survival models (Banerjee and Carlin 2003; Henderson et al. 2002). Bayesian frailty models have been used to

quantify the association between adult mortality and socioeconomic factors (Sartorius et al. 2013).

Moreover, metrical (continuous) variables may exhibit non-linearity, which should be captured if necessary. However, several models that have been applied to study adult mortality are not flexible enough to permit simultaneous estimation of fixed effects, non-linear effects and unstructured and structured random effects. The use of geo-additive survival models has been promising in this regard (Hennerfeind et al. 2006; Kazembe et al. 2007).

This study, therefore, was aimed at estimating the effects of socioeconomic factors on adult mortality in Namibia, by applying a geo-additive survival model. Specifically, we fitted a model that jointly estimated the effects of socioeconomic and geographical factors on adult mortality in Namibia. In our analysis, we use data from a recent national sample survey to examine hazard of adult mortality in Namibia.

Methods

Study Area and Context

Namibia is located in the south-western part of Africa, surrounded by Angola, South Africa and Botswana and partly to the north by Zambia and Zimbabwe (Figure 1). The current population is 2 million, which occupies a land mass of about 800,000 km². The country is ranked as a middle-income country, with life expectancy at birth of 63 years for women and 55 years for men. Adult mortality is estimated at 340 per 1,000 population (with 356 for male and 290 for female). The distribution of burden of disease as a percentage of total disability-adjusted life years, by broader causes, was 69% for communicable diseases, 25% for non-communicable diseases and 6% for injuries, as of 2009 estimates.



Figure 1. Map of Namibia showing its 13 regions and neighbouring countries

Data

This study used data from the 2006/2007 Namibia Demographic and Health Survey (DHS), which captured the household mortality data under the module "Support For Those Who Have Died" (MoHSS [Namibia] and Macro International Inc., 2008). The Namibia DHS applied a multi-stage sampling approach. Details of the survey can be found in the survey report (MoHSS [Namibia] and Macro International Inc., 2008). In brief, at the first stage, 500 enumeration areas, which were the primary sampling units (PSUs), were randomly selected with probability proportional to size. The PSUs were selected using the sampling frame from the 2001 Namibia Population and Housing Census. At the second stage, a random sample of 40 households was systematically drawn from each PSU. Then from the selected houses, at a third stage, women and men of the

reproductive age group, 15-49 years, were invited to participate in the survey.

Further, in all participating households, all household members were enumerated and information on socioeconomic variables, demographic characteristics and healthcare factors was recorded. Table 1 shows a list of variables included in the analysis. Age and sex of the head of the household were used to measure the resource base, with femaleheaded households and young-aged deemed more vulnerable than otherwise. The sex of the household member permitted to capture gender differences in mortality. Wealth index, education and marital status were further measures of socioeconomic position. Access and availability of healthcare were captured through variables: nearest health facility, means to nearest health facility and time to nearest health facility.

For the response variable, we used information on deaths in the household that occurred in the past 12 months preceding the survey date, and included full information on age and sex of the deceased. The questions used to

collect mortality data were: "Has any usual member of your household died in the last 12 months," and if yes, there was a follow-up question on: "How many members died in the past 12 months."

Table 1. Description of key variables included in the analysis

Covariates	Description
Outcome variable	
Event	Whether any household member died (1 = member died, 0 = member still living at the time of survey).
AgeHMbr	Age (in years) of household member at the time of death or survey
Socioeconomic factors	
SexHMbr	Sex of household member (1 = male; 2 = female)
SexHHead	Sex of household head (1 = male; 2 = female)
HHage	Age of household head (in years)
Educ	Education attainment of household member (1 = none; 2 = primary; 3 = secondary or higher)
Marital	Marital status of household member [1 = never married; 2 = married; 3 = others (divorced or widowed)]
Wealth index	Index showing the well-being of the household (1 = poorest, 2 = poorer, 3 = middle, 4 = richer, 5 = richest)
Spatial factors	
Reg	The region in which the household is situated (1 = Caprivi, 2 = Erongo, 3 = Hardap, 4 = Karas, 5 = Kavango, 6 = Khomas, 7 = Kunene, 8 = Ohangwena, 9 = Omaheke, 10 = Omusati, 11 = Oshana, 12 = Oshikoto and 13 = Otjozondjupa)
Urbanrural	Type of residence (1 = urban and 2 = rural)
Constituency	Administrative boundaries, there were 107 constituencies in Namibia, in 2007
Other factors	
TimeHF	Time to nearest health facility (1 = minutes, 2 = hours and 3 = days)
NearestHF	Nearest health facility (1 = hospital, 2 = health centre and 3 = clinic)
MeansHF	Means to nearest health facility (1 = car/motorcycle, 2 = public transport, 3 = walking)

Statistical Analysis

Descriptive analysis

Exploratory analysis used the Kaplan–Meier curves to assess the difference in probability of survival, for various covariates, with respect to age, assuming that the time at which the household member died was age in completed years. Log-rank test was used to assess the significance of survival at various levels of covariates.

Modelling the hazard rate and risk factors of adult mortality

In studying adult mortality, we assume T as the time to event (death), recorded as age in completed years. The probability that a survival time T is less than or equal to some value t is measured as $F(t) = P[Adult \text{ dies at age } \le t]$. An common approach, however, is to consider hazard rate or force of mortality, h(t). The hazard rate describes the risk or event of "failure" (i.e., death), given that the individual has survived all along up to point t (Box-Steffensmeier and Jones 2004).

Of interest is to extend the hazard rate to captures the effect of covariates. Here we propose a more general Cox model that captures random effects including spatial frailties (Banerjee and Carlin 2003). Assume that Tij is the observed number of years lived or the censoring time for j-th individual in area i. Under Cox's model, the hazard function at time T = t is given by:

$$h(t|\beta, \mathbf{v}_{ii}) = h_0(t) \exp(\beta \mathbf{v}_{ii}) \tag{1}$$

where $h_0(t)$ is the baseline hazard at age t, and the β s are a vector of regression coefficients for the fixed and time-invariant variables (v_{ij}) . As individuals are clustered in geographical regions, group-specific random frailty term, ψ_i , was introduced to augment the Cox model, that is:

$$h(t|\beta, \mathbf{v}_{ii}, \mathbf{\psi}_i) = \mathbf{h}_0(t) \exp(\beta \mathbf{v}_{ii} + \mathbf{\psi}_i)$$
 (2)

The above model indicated that adulthood survival was influenced by both individual-specific factors (v_{ij}) and group-specific environmental factors ψ_{i} . The group effects might include healthcare, socio-cultural and environmental differentials, which may impose geographical heterogeneity. We introduce two types of random effects to capture such geographical effects: (1) spatially distributed random effects, through s_i ; and (2) unstructured heterogeneity random effect, u_i , giving ψ_i = s_i + u_i (Besag et al. 1991). Fitting model (2) assumed a semiparametric additive predictor, which is known as a geo-additive survival model (Hennerfeind et al. 2006):

$$\eta_{ii}(t) = f_0(t) + \beta v_{ii} + u_i + s_i$$
 (3)

where η_{ij} is the log-additive predictor at time (age) t for adult j in area i. The term $f_0(t) = \log(h_0(t))$ is the log baseline hazard effect at time (age) t. The other terms are as defined above.

Various models, summarized as follows, were fitted:

```
\begin{split} &M0 = f(baseline) \\ &M1 = f(baseline) + \beta^T v \\ &M2 = f(baseline) + f_{spatial}(region) + \beta^T v \\ &M3 = f(baseline) + f_{random}(region) + \beta^T v \\ &M4 = f(baseline) + f_{spatial}(region) + f_{random}(region) + \beta^T v \\ &M5 = f(baseline) + f_{spatial}(consti) + \beta^T v \\ &M6 = f(baseline) + f_{random}(consti) + \beta^T v \\ &M7 = f(baseline) + f_{spatial}(region) + f_{random}(region) + \beta^T v \end{split}
```

where M0 is the basic model with the baseline component only, and M1 adds fixed effects, while model M2 includes spatially structured effects, at regional level (region), to model M1. Model M3 assumed spatially unstructured random effects at the regional level, whereas model M4 combines all effects at the regional level. These models (M2–M4) are repeated in models M5–M7, substituting random effects at the regional level to be considered at the constituency level (consti).

This model fitting strategy is commonplace in mortality literature and allows for the interpretation of mortality differentials within a multivariate context (Rogers et al. 2005). The idea is to have a basic model, then, it is adjusted for socioeconomic factors, to measure the effect of these covariates alone, and can further be adjusted for other factors. The risk of factors is estimated as hazard ratios, with hazard ratio of above 1.0 indicating a higher risk of dying for individuals in that particular category of variables, while HR below 1.0 signifies reduced risk of mortality.

Because of the complexity of the model, we applied a fully Bayesian approach via the Markov Chain Monte Carlo simulation technique for inference. The following prior distributions were assumed. The fixed effects were assigned diffuse priors, while the smooth functions were evaluated using penalized splines with second-order random walk priors. The unstructured random effects were assumed to follow an exchangeable normal distribution with mean zero and over-dispersed variance, whereas the structured spatial effects were modelled

using the conditional autoregressive prior. All variance components were then modelled using inverse gamma with parameters a=0.05 and b=0.01. For all the models, 12,000 iterations were run with a burn-in of 2,000 for each model. Model choice was based on the Deviance Information Criterion (DIC) developed as a measure of goodness-of-fit and model complexity (Spiegelhalter et al. 2002). Model with the lowest DIC was chosen as the best model.

The data were analyzed in two major software packages, BayesX (Belitz et al. 2009) and R software (R Development Core Team 2011). The BayesX was used to estimate geo-additive survival models. The R software was used primarily for explanatory analysis, particularly to generate Kaplan–Meier curves, and associated statistical tests.

Results

Table 2 gives a descriptive summary of mortality by region and across various covariates. There was a clear disadvantage for those in rural areas, for those of low wealth ranking and those not married. Kavango and Karas regions had the highest prevalence of adults who died, with significant difference observed among regions (p < 0.01). Survival curves (given in the Appendix [online at www.longwoods.com/content/24220], together with the log-rank test in Table A1) support the fact that adult survival differed across various socioeconomic factors including marital status, education level, type of residence (urban/rural), wealth index, sex and age of household head. Furthermore, significant differences were established for the healthcare factors (Table 2).

Table 2. Descriptive summary of demographic, socioeconomic and healthcare factors of adult mortality based on the χ^2 test

Variable	Percentage died	n	χ² test	ρ*
Region	'	•		
Zambezi	9.2	1,588	287.6	<0.01
Erongo	4.5	1,915		
Hardap	7.7	1,647		
Karas	5.9	1,532		
Kavango	13	2,550		
Khomas	4.1	2,752		
Kunene	7.4	1,299		
Ohangwena	12.5	2,334		
Omaheke	5.5	1,433		
Omusati	8	2,259		
Oshana	7.7	2,312		
Oshikoto	9.6	2,261		
Otjozondjupa	5.7	1,911		
Residence				
Urban	5.4	10,829	157.7	<0.01
Rural	9.7	14,964		
Sex of household member	'S			·
Male	7.3	12,020	12.8	<0.01
Female	8.5	13,773		

Table 2. Continued

Variable	Percentage died	n	χ² test	p*
Age of household member				
15–24	9.5	8,508	99.7	<0.01
25–34	6.6	6,264		
35–44	5.8	4,187		
45–54	6.6	2,846		
55–64	8.8	1,819		
65+	10.6	2,169		
Sex of household head		1		
Male	6	15,019	181.5	<0.01
Female	10.6	10,774		
Age of household head				
15–24	6.5	1,081	340.2	<0.01
25–34	4.4	4,546		
35–44	5.5	5,763		
45–54	7.1	5,197		
55–64	10.7	3,772		
65+	12.7	5,434		
Education of household member		1		l e
None	8.5	3,876	80.6	<0.01
Primary	9.9	8,230		
Secondary/higher	6.5	13,283		
Marital status of household mem	ber	1		
Never married	8.8	13,796	186.6	<0.001
Married	5.4	9,464		
Other	13.4	2,162		
Wealth index			'	1
Poorest	12	4,215	299.2	<0.001
Poorer	9.8	4,785		
Middle	8.8	6,126		
Richer	6.5	6,134		
Richest	2.9	4,533		
Time to nearest health facility	<u>'</u>			
Minutes	6.6	16,730	136	<0.01
Hour	10.6	8,174		
Days	12.1	612		
Nearest health facility	1	1		1
Hospital	6.3	5,531	27	<0.01
Health centre	8.4	1,933		
Clinic	8.5	17,909		
Means to nearest hospital		1		
Car	4.8	4,013	67.9	<0.01
Public transport/animal cart	7.9	4,968		
		16,021		

^{*}Test was carried out at p < 0.05

Figure 2 shows geographical distribution, at the constituency level, on percentage of adults who died in Namibia, 2006/2007, ranging between 0 and 8% at the sub-regional level. The percentage of adult mortality was high for constituencies in the north eastern, central west of Namibia as well as in the southern west part of the country, while, the

percentage of adult mortality was lowest for the constituencies in the northern east, north west and southern parts of the country. Evidently, these confirm the results in Table 2, showing regional disparities, but further reveal that large areas conceal the intra-regional variation as shown in Figure 2.

Figure 2. Prevalence of adult mortality at the constituency level in Namibia

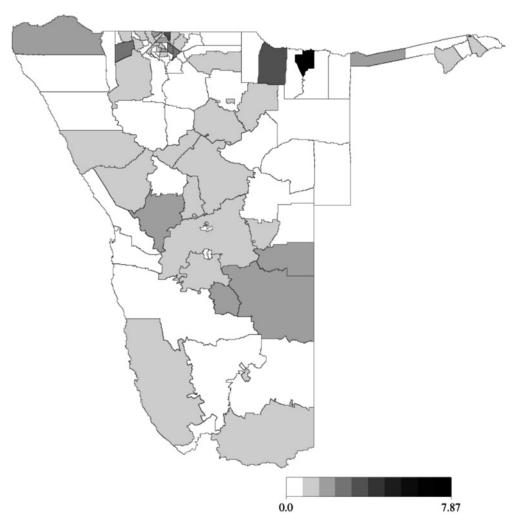


Table 3 presents the DIC values. The results indicate that Model 7 (M7) had the lowest DIC value. M7 incorporated the baseline, fixed effects, unstructured random effects and

spatially structured effects at the constituency level. Our subsequent reporting of results will be based on estimates from the best model (M7).

Table 3. Model comparison based on DIC for the models of a dult mortality $% \left(1\right) =\left(1\right) \left(1\right) =\left(1\right) \left(1\right)$

Model	Deviance	pD	DIC	ΔDIC
M0	14176.2	6.59	14189.4	993.01
M1	13416.5	33.92	13484.3	287.92
M2	13418.2	33.15	13484.5	288.14
M3	13417.8	32.74	13483.2	286.84
M4	13418	32.85	13483.7	287.25
M5	13002.5	97.62	13197.7	1.3
M6	13010.8	95.83	13202.5	6.09
M7	13001.7	97.36	13196.4	0

Figure 3 displays the baseline hazard for adult mortality in Namibia. The hazard of dying dropped from 15 years to about age 40 years, and then rose to age 80. At age 25–55,

the hazard remained overly below the HR of 1.0. Further, result shows that the intervals in the probability of dying widen from age 80.

Figure 3. The baseline hazard lines for the best model (M7).

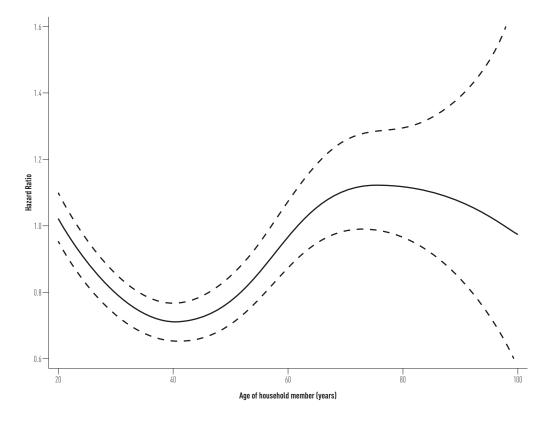


Figure 4 displays age curve for the household head, with age fitted as a non-linear smooth function. In the panel, the risk of mortality increased between 15 and 20 years and then decreased up to age 30 years, then rose again steadily up to age 65 years, with a little dip at age 50 years. A similar pattern of up and down continued from age of 65 to 70

years, with a final decrease at age of 80 years. From age of 15 to 55 years, the risk of death lay below zero, suggesting a reduced mortality risk in such households, whereas at 60 years to the end, we observed a risk of above 0, indicating an increased risk of mortality. Overall the dip in risk was at age of 30 years, and a peak in risk was at 65 years.

Figure 4. Non-linear effect of the age of the head of household

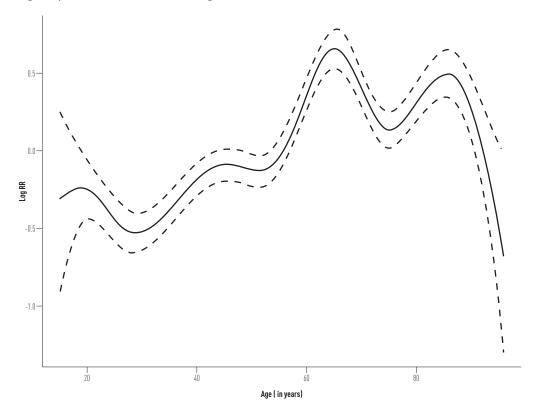


Table 4 shows risk factor of adult mortality. Generally the hazard of adult mortality was lower, as indicated by the intercept (HR = 0.02, 95% CI: 0.01-0.03). With regards to the sex of the head of the household, the

risk of adult mortality was likely to be lower for male-headed households than for female-headed households (HR = 0.65, 95% CI: 0.59-0.72).

Table 4. Fixed effects summary for the best model (M7)

Covariates	HR (95% credible interval)	
Intercept	0.02 (0.01, 0.03)	
Sex of household head		
Male	0.65 (0.59, 0.72)	
Female (REF)	1.00	
Age of head of the household	1.02 (1.02, 1.02)	
Education level of household member		
No education	0.99 (0.85, 1.17)	
Primary education	1.22 (1.09, 1.36)	
Secondary/higher education (REF)	1.00	
Marital status of household member		
Never married	0.82 (0.70, 0.99)	
Married	0.62 (0.53, 0.73)	
Others (REF)	1.00	
Wealth index		
Poorest	2.03 (1.51, 2.72)	
Poorer	1.78 (1.37, 2.31)	
Middle	2.00 (1.54, 2.54)	
Richer	1.78 (1.44, 2.23)	
Richest (REF)	1.00	
Type of residence		
Urban	0.91 (0.76, 1.10)	
Rural (REF)	1.00	
Time to nearest health facility		
Time in minutes	1.14 (0.80, 1.60)	
Time hours	1.53 (1.09, 2.18)	
Time in days (REF)	1.00	
Nearest health facility		
Hospital	0.95 (0.82, 1.10)	
Health centre	0.91 (0.73, 1.14)	
Clinic (REF)	1.00	
Means to nearest health facility		
Car/motorcycle	0.87 (0.72, 1.06)	
Public transport/animal cart	1.04 (0.90, 1.19)	
Walking (REF)	1.00	

Regarding the education level for a household member, for adults who had no education, there was a decrease in hazard of an adult dying than those with secondary/ higher education (HR = 0.99, 95% CI: 0.85-1.17); nevertheless, the decrease was not significant. In contrast, comparing adults with primary education to those with secondary education or higher, it was observed that there was a 22% increase in hazard (HR = 1.22, 95% CI: 1.09–1.36). Turning to marital status, for married adults, compared to the other marital categories (widowed and divorced), we observed a lower hazard (HR = 0.62, 95% CI: 0.53-0.73), which was much lower than that for the never-married compared to the others (HR = 0.82, 95% CI: 0.70-0.99).

In terms of the wealth status of a household, there was a significant increase in risk of an adult dying across all four levels compared to the highest level (richest household). For the poorest household, the risk was HR = 2.03; for the poor household, hazard ratio was

estimated at 1.78; for the middle quintile, we obtained an HR = 2.00; and for the richer quintile, we established a hazard ratio of 1.76 (Table 4). In general, there was a non-linear pattern in risk of adult mortality associated with wealth. As for the urban versus rural place of residence, we did not find any significant association, although urban areas were associated with reduced risk (HR = 0.91). Furthermore, there was no evidence of association between accessibility and availability of healthcare and adult mortality (Table 4).

Figure 5 shows the unstructured random effects for adult mortality at the constituency level. There was heterogeneity across constituencies in the hazard of an adult dying. Some constituencies had hazard of adult mortality above 1.00, while others had hazard of adult mortality below 1.00, suggesting significant variability in the hazard ratio across constituencies (sub-regions) in Namibia. These results agree with Figure 1, which shows adult mortality map at the constituency level.

Figure 5. Unstructured random effects at the constituency level in Namibia, based on the best model (M7)

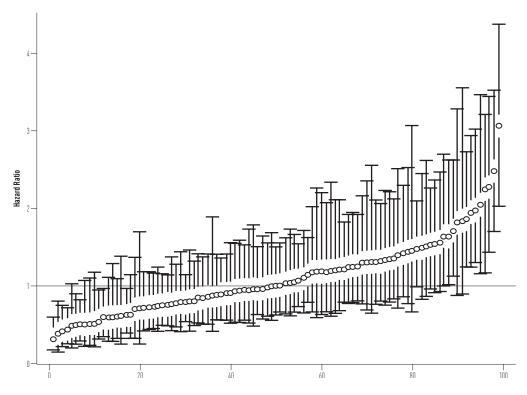
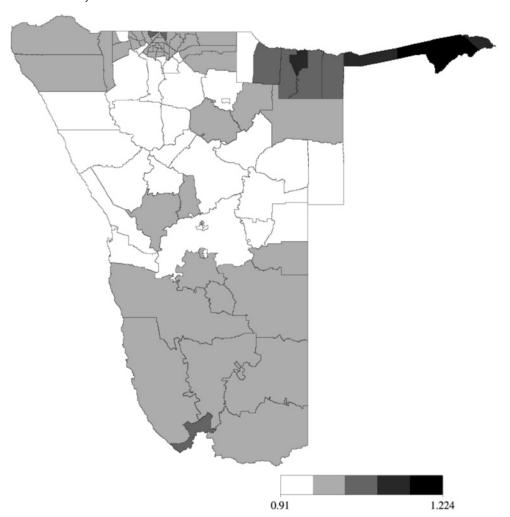


Figure 6 shows the spatial variability of hazards of adult mortality, with darker colours in the map signifying constituencies with increased hazard of adult mortality, while lighter colours show constituencies with reduced hazard. The force of mortality ranged between 0.91 and 1.23. The north eastern part of the country, north of the country and down

in the southern part of the country show high hazard of an adult dying, whereas areas of reduced risk are commonly found in the north west, central and towards eastern part of the country. Nevertheless, these effects were not significant after controlling for socioeconomic and demographic fixed effects in the model.

Figure 6. Spatial structured random effects (given as hazard ratios) of adult mortality at the constituency level in Namibia



Discussion

The aim of the study was to apply an event history discrete time survival analysis to explain effects of socioeconomic factors on adult mortality in Namibia. We fitted geoadditive survival models using the Bayesian

framework for joint modelling of fixed, non-linear effects and spatial frailties.

Keeping in mind the general objective, this study first adopted the conceptual framework by Rogers et al. (2005) for understanding socioeconomic differences in adult mortality in Namibia. Second, we documented the basic patterns of association between socioeconomic and adult mortality using survey data. Third, we give substantial attention to how the risk of adult mortality varies in space. The study found results that were consistent with what has been reported previously. The force of mortality, in our analysis, varied with marital status, place of residence, educational level, wealth ranking and availability and accessibility of healthcare (Bassuk et al. 2002; Davis et al. 1992; Nikoi 2009; Sudore et al. 2006).

In general, evidence shows that the poor are at more risk, a fact which may be attributed to lack of resources that may impede poorest adults and old age people to access health facilities and many basic needs that are essential for improving the health, well-being and living standards of adult people (Sammy 2009; Zhi and Xie 2007). On the contrary, we observed high risk of adult mortality at all levels of wealth, similar to what was reported by de Walque and Filmer (2013), a fact that still need to be investigated. Similarly, although we did not find significant association with urban/rural, studies generally find a higher mortality in rural than urban areas. This has been attributed to easy availability and accessibility of healthcare resources (Becher 2004). Often low level of literacy was associated with poor management of diseases and other health conditions that may consequently result in deaths (Sudore et al. 2006).

In addition to evaluating socioeconomic factors, this paper exploited the effects of geographical location on adult mortality by assuming structured spatial effects. Although we did not find significant differences in risk, our argument is that contextual neighbourhood factors may play a part in attenuating or exacerbating the effects of socioeconomic status on adult mortality. Area promotes or inhibits health, over and above individual socioeconomic characteristics (McIntyre et al. 2002; Ross and Mirowsky 2001). In their study "neighbourhoods and health," Diez-Roux and

Mair (2010) re-emphasized existence of effects of neighbourhood physical and social environments on health of residents of any community or location. They further indicated that a better understanding of heath or disease distribution requires both individual characteristics and characteristics of groups or of contexts to which individuals belong.

Although the study was carefully planned, there are some inevitable limitations that need to be acknowledged. First, we used selfreported data, which are subject to measurement error arising from the respondent's recall bias. Such recall tends to decrease with time, with distant past events often under-reported. To limit this error, this study was designed to record deaths that occurred only within 24 months preceding the survey year. Second, the 2006 NDHS did not collect information for all variables such as income of household head, behaviour and habit factors such as smoking and alcohol consumption, which may be considered important in measuring the impacts of socioeconomic factors on adult mortality. Third, the data used for the study were collected in 2006/2007, thus the findings might give a different picture on adult mortality and socioeconomic factors from the current situation on the ground. Finally, we assumed single hazard for all regions. Thus, there is a need to have region-specific hazard modelling.

In conclusion, this paper demonstrated the existence of socioeconomic disparities in adult mortality in Namibia. While a huge literature in Europe and USA has documented mortality and socioeconomic status patterns and trends over the past several decades, we actually know less about African countries, particularly for those that have high rates of HIV, like Namibia. This study actually fulfilled this objective. Socioeconomic differentials provide important clues regarding the etiology of a particular disease, and moreover, the magnitude of these relations is of importance. Furthermore, considerable heterogeneity in mortality patterns across

regions and sub-regions (constituencies) has been established. It is hoped that these should permit health planners and policymakers to design and evaluate programs and develop strategies aiming at improving the health and well-being of adults targeted for such hotspots. Adults are the economically active and productive age group for a population, thus if the Namibian Government is to meet its national development goals (NDPs) such as NDP4 or Vision 2030, then reducing adult mortality, taking into consideration socioeconomic factors, should be considered as a major public issue. Compared to those under 15 years, however, mortality is lower and, to some extent, not discounting other findings, this would support the policy argument of focusing on child mortality rather than adult mortality. Arguably, these efforts should be taken together with other interventions concentrating on infant and maternal health for optimal programming.

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Social Conditions and Disability Related to the Mortality of Older People in Rural South Africa



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Abstract

Background: South Africa is experiencing a health and social transition including an ageing population and an HIV epidemic. We report mortality experience of an older rural South African population.

Methods: Individual survey data and longer-term demographic data were used to describe factors associated with mortality. Individuals aged 50 years and over (n = 4085) answered a health and quality of life questionnaire in 2006 and were followed for 3 years thereafter. Additional vital events and socio-demographic data were extracted from the Agincourt Health and Demographic Surveillance System from 1993 to 2010, to provide longer-term trends in mortality. Cox regression analysis was used to determine factors related to survival.

Results: In 10967 person-years of follow-up between August 2006 and August 2009, 377 deaths occurred. Women had lower mortality {hazard ratio [HR] 0.35 [95% confidence interval (CI) 0.28–0.45]}. Higher mortality was associated with being single [HR 1.48 (95% CI 1.16–1.88)], having lower household assets score [HR 1.79 (95% CI 1.28–2.51)], reporting greater disability [HR 2.40 (95% CI 1.68–3.42)] and poorer quality of life [HR 1.59 (95% CI 1.09–2.31)]. There was higher mortality in those aged under 69 as compared with those 70 to 79 years old. Census data and cause specific regression models confirmed that this was due to deaths from HIV/TB in the younger age group.

Conclusions: Mortality due to HIV/TB is increasing in men, and to some extent women, aged over 50. Policy makers and practitioners should consider the needs of this growing and often overlooked group.

Introduction

To date there has been limited effort to investigate the way the HIV epidemic, the growing burden of non-communicable disease, and social conditions and disability affect older people's mortality in rural African settings.^{1,2} At the same time, there is limited knowledge of the health experience, quality of life and the factors associated with mortality in older people living in rural sub-Saharan Africa. The data reported in this paper were collected as part of the Study on Global Ageing and Adult Health (SAGE), which set out to improve knowledge on the health, disability and well-being of older populations in low- and middle-income countries.3 Adult mortality has been increasing in southern and eastern countries of sub-Saharan Africa since the 1990s, mainly as a result of the HIV epidemic.4,5 Most studies have focused on young adults, ignoring the fact that the older population is also directly and indirectly affected by the HIV epidemic.6,7,8 Existing data show that one effect of the HIV/AIDS epidemic is to increase the number of older people living alone. However, there has been limited attention in the literature to the prevalence of HIV in older people, despite calls to examine infection and mortality in the population aged 50 years and older.^{1,9} Negin *et al.* have called attention to the interplay between the ageing process and the double burden of HIV and non-communicable diseases, especially in Africa.¹⁰

This paper describes factors associated with mortality in people aged 50 years and over in a rural area of South Africa where HIV prevalence is high¹¹ and where gender differences in experience of quality of life, function and health have been described.¹² The objectives of this paper are twofold: first, to describe the mortality trends and identify possible HIV-related trends; and second, we aimed to identify the social and functional risks related to increased mortality risk in this cohort. In exploring the social and functional risks, we

considered both the well-known and frequently described 'distal causes of disease'13 including education, occupation13 and poverty,14 as well as other factors which have been previously associated with higher mortality risk in this or similar populations. Union (partnership) status has been related with poor self-reported health, quality of life and well-being in older people in different African settings.3,15,16 A single question on selfrated health and the composite measure on functionality (WHO-DAS) have been associated with higher risk of mortality in India17 whereas, in Agincourt HDSS, former Mozambican refugees have been found to suffer higher levels of child mortality.¹⁸ To further explore the patterns of mortality, we have included information from the sitespecific annual census from 1993 to 2010.

Methods

Ethical clearance for the MRC/WITS Rural Public Health and Health Transitions Research Unit (Agincourt) and its associated Health and Demographic Surveillance System, and for the Agincourt-INDEPTH Study on Global Ageing and Adult Health, was granted by the Committee for Research on Human Subjects (Medical) University of the Witwatersrand, Johannesburg, South Africa, Refs M960720 and R14/49, respectively.

The study population and general methods have been described in detail previously. ¹² Here, we describe them briefly.

Setting

In 1992, the MRC/Wits Rural Public Health and Health Transitions Research Unit initiated the Agincourt Health and Demographic Surveillance System (HDSS) in the rural Agincourt sub-district of Ehlanzeni district, Mpumalanga Province, South Africa. The total population under surveillance in 2006 was approximately 70,000 people distributed in 21 villages and 11,734 households. Despite

substantial socioeconomic development in the area since then, infrastructure remains poor and formal unemployment rate is high (36%) with continuing high levels of labour migration among men and, increasingly, women.¹⁹ The public health system in the sub-district consists of six clinics and one health centre, and three district hospitals situated between 25 and 45 km from the study site.20 In 2008 a private health centre was built in one village, intended mainly for the treatment and care of people with HIV. HIV prevalence among all ages from 15 years in the area was 19.4% in 2010, with a peak of 45.3% for males and 46.1% for females at ages 35 to 39. The population over 50 years of age had an HIV prevalence of 16.5% (17.7% for males and 16.1% for females).11

Basic demographic data (pregnancy outcome, deaths, migration) are collected every year by trained local fieldworkers, to update HDSS census information.²¹ Additional individual and household data (food security, labour participation, household assets) are collected at regular intervals to provide contextual information. Although the surveillance system includes information on all deaths, there is incomplete official death notification and very few people can report their relatives' cause of death. To determine cause of death, we use two independent clinician assessments of verbal autopsy interviews. Verbal autopsies are carried out by trained lay fieldworkers with closest caregivers of the deceased for every death in the area, allowing us to study mortality by likely cause of death.²²

Sample

In August 2006, there were 8,429 people aged 50 years or over enumerated in the Agincourt HDSS. Of those, we excluded 575 who had been randomly selected to participate in a previous recent study; and those who were temporary (often labour) migrants (n = 2223), living for less than 6 months of the year prior to the study in the sub-district. The remaining 5,631 individuals, who had

been permanently resident in the area for 12 months prior to the 2006 census round, were invited to participate. Each person was visited a maximum of three times to attempt to complete the interview. Due to the census field constraints, we were not able to follow up any further those individuals who were absent from their households on these three visits. As a result, 1,616 people (28.7%) were not interviewed although they were apparently permanently living in the study site. A further 458 (8.1%) individuals had died or were too sick to answer the questions, and 47 (0.8%) declined to take part. A total of 4085 individuals (response rate of 72.5%) participated.12

Data collection

We used a data collection tool that was adapted from the World Health Organization (WHO) –INDEPTH Network Study on Global Ageing and Adult Health (SAGE)23 to interview participants during 2006 census. The SAGE questionnaire included questions on self-rated health assessment, physical and cognitive function, well-being and quality of life. It was translated into the local language (Shangaan) and back-translated into English.

Additional data on gender, age, whether married or living with a partner, nationality, level of education and date and cause of death were extracted from the Agincourt HDSS (2006 census round). Employment status was indicated by being in paid work or not.

We also used HDSS census data, annually updated from 1993 to 2010, on population size and mortality to obtain the person-years of observation, and to determine out-migration and death dates.

Follow-up

A total of 2006 study participants were followed up at annual census updates from 2007 to 2009, providing information on deaths up to 31 July 2009. Of the 4085 respondents, 38 (0.9%) were lost to follow-up with no information and have been excluded from

analyses. The 4,047 remaining participants were followed up until out-migration, death or 31 July 2009, whichever came first. Out-migration was defined as an individual moving away from his/her original dwelling. All efforts were made to follow up those who moved within the sub-district, but those we could not find in a new dwelling (48, 1.2%) and those who left the study area (56, 1.4%) were censored at out-migration date. Main reasons for out-migration were moving to new houses, change of union status, or work-related issues.

Variables

We calculated age at interview from recorded date of birth and reported age. We assigned participants to 5-year age groups.

Education was categorized according to the WHO levels of education: 6 years or more of formal education; less than 6 years of formal education; and no formal education. This information was obtained from the 2006 Agincourt HDSS database.

Since many unions are traditional rather than civic, and polygamy is practised by some people, we decided to categorize union status into two groups: currently married or living as married (in a current partnership); and single, including anyone not in a current partnership (i.e. those who had never married or were separated, divorced or widowed).

To evaluate socioeconomic status (SES), we used an 'absolute SES' indicator constructed from the 2005 household asset survey. Each asset was given equal weight by rescaling so that all values of a given asset variable fell within the range [0, 1]. Assets were categorized into five broad groups: 'modern assets', 'power supply', 'water and sanitation', 'quality of housing' and 'livestock assets'. For each household and for each asset group, the asset values were added and then rescaled to arrive at a specific value in the range [0,1]. Finally, for each household these five group-specific scaled values were added to give an overall asset score with a value in the range [0,5].²⁴

Household asset scores were calculated using 2005 census data, since these were the most recent data available, and then grouped in quintiles for the entire Agincourt subdistrict population. As participants in this study are a sub-sample of the whole population (50 years and older), they are not equally distributed across the five quintiles.

Due to the war in Mozambique, the Agincourt area received a high number of Mozambican refugees before 1993. Those who elected to remain in the area were recorded as Mozambican. The variable 'nationality of origin' refers to whether the participant was originally from South Africa or Mozambique. The Mozambican group are separately identified in the HDSS data and differ from the original South African population in measures such as education, household assets and child mortality.18 Many Mozambicans have now taken South African nationality which allows them to work legally and receive state pensions.

The physical and social functions of each participant were measured using the WHODAS II scale (World Health Organization Disability Assessment Schedule II) which assesses daily functioning.²⁵ This scale is created by asking 12 questions on the difficulty experienced when performing certain activities in past 30 days. The score ranges from 0 to 100, with a high score indicating severe impairment of physical function. WHOQOL (Word Health Organization Quality of Life) was used to measure life satisfaction. WHOQOL includes questions on satisfaction with own health, personal and social relations, performing daily activities and overall satisfaction with life. It is presented on a scale of 8 to 40 (where 8 is the best quality of life).26,27 We used two single questions to measure self-rated health and working difficulty, where we asked the participants 'In general, how would you rate your health today?' with the options of very good, good, moderate, bad and very bad; and 'Overall in the last 30 days, how much difficulty did you

have with work or household activities?' with options being none, mild, moderate, severe and extreme/cannot do.

Data entry and analysis

We entered data using CSPro 3.1 data entry programme (http://www.census.gov/ipc/www/cspro/index.html) which includes validation checks. Data were then extracted to Stata10.1 (Stata Corp, College Station, TX, USA) for analysis.

Demographic analysis

A demographic analysis on the full Agincourt HDSS population from 1993 to 2010 was carried out to verify whether the sample mortality trend by age group was due to a sample bias or whether it is explained as a new mortality trend in the study site – that is, up to cohort recruitment. Hazard mortality ratios were computed using number of deaths that occurred within the HDSS as the numerator, and length of time lived in the HDSS over the period as the denominator, expressed in person-years. Individuals were considered residents when they spent more than 6 months per year in the HDSS area. In order to minimize effects on mortality of temporary migrants that return home to die,28 the mortality analysis did not included temporary migrants who died outside the HDSS or within 6 months of their return to the study site. The analysis of all-cause mortality was conducted by gender, 5-year age-group defined by age in August 2006 and 5-year time period. HIV/TB mortality was similarly analysed. This demographic analysis provided background mortality trends to compare with results from the participants in this study.

Cox regression model

We carried out a Cox's regression analysis to determine the factors related to the risk of death. We first carried out an age-adjusted analysis of the impact of the three composite measures to evaluate whether gender effects could be merely explained by age differences (Table 2). Then we performed a univariate analysis (Table 3) and then constructed a multivariate model, including age group (treated as a categorical variable), sex, whether in a union, education status and household asset score as a-priori variables. We then entered in turn each of the other variables listed in Table 3, where the univariate analysis returned a P-value of less than 0.1. In each case, we compared models with and without the variable, and discarded the variable if the likelihood ratio test returned a value of P > 0.1. Three models, for the whole population, for men and for women, were constructed. Proportional analysis was performed using proportion hazard assumption. We performed a test of proportionality for each predictor using the Schoenfeld and scaled Schoenfeld residuals. If the tests were not significant (P-values > 0.05), proportionality was not rejected and we assumed that there was no violation of the proportional assumption. Once we had constructed the model for the whole population, we further investigated the effect of three groups of causes of death (chronic disease; HIV and TB; and other infections) by running the model separately for each of these cause groups.

Results

There were 10 967 person-years of follow-up, with 377 deaths recorded. Participants were predominantly female (75.2%), which represents the demographics of this older population in the sub-district, with a mean age of 66.1 years at the time of interview. Less than half of the population had received any formal education. Men were more than twice as likely to be currently in a union. Most of the participants were retired and not looking for work, but 5.7% reported that they were

unemployed and looking for employment.¹² Most (56%) of the respondents in paid work were aged less than 60. A higher proportion of participants than expected, especially men, were living in households with no persons under 50 years of age (9.6%), or in a skip generation household (2.4%) where there were children (under 18 years) present but no adults aged under 50 years (Table 1).

We calculated death rates in 5-year age cohorts and found that in the period 2006–10, the male death rate increased steadily from age group 50-54 to age group 60-64 but then fell, only finally surpassing the 60-64 rates in the group over 85 years of age (see Supplementary Table 1, available as Supplementary data at *IJE* online). A similar but less marked pattern was observed in women. When we compared the study men and women death rates with the Agincourt census death rates for the periods 2003-06 and 2007-10, we only found a significant difference between the study [death rate 31.4/1000 (95% CI 17.4–56.8)] and the period 2003-06 [death rate 69.3/1000 (95% CI 57.6-83.3)] for men's age group 50-54 years (see Supplementary Table 1, available as Supplementary data at *IJE* online).

The relationship between age group and mortality led us to analyse mortality data over the entire period of the annual Agincourt census, from 1993. In Figure 1 we show the death rates per 1,000 person-years for men and women by age group in four time periods from 1993 to 2010. Death rates in the younger men increased in each of the first three time periods up to 74/1,000 in the 2003–06 period. This time period shows a drop in mortality for men aged 65–69 after an essentially flat line in the four younger age groups. In the final time period the death rates are lower, but with a similar pattern. Women showed a similar but less marked pattern.

In Figure 2 we show similar graphs for the cause-specific death rates from HIV and TB, as determined by verbal autopsy. These rates rose

markedly in the men aged under 65 years between the 1998–2002 period and the 2003–2006 period, but then fell in the later 2007–10 period. Again, women showed a similar but less marked pattern in HIV/TB death rate. When mortality contribution of HIV/TB is calculated as a percentage of all deaths,we observed that, in the peak period 2003–06 and in the youngest age group 45–49 years, HIV/TB contributes with 25% of the deaths in men and 50% of the deaths in women.

Because of this complex relationship between age, gender and risk of death, age could not be treated as a continuous variable with a linear relationship to survival. We therefore entered age into the Cox regression analysis as a categorical variable in 5-year age groups, allowing an independent estimation of risk for each age group.

The age-adjusted analysis of the three composite measurements, i.e. quality of life, functionality and health status, shows that gender effects are not the result of age differences for mortality or for composite health outcomes (Table 2).

Table 3 shows the results for the univariate analysis of mortality risk for all demographic and health variables, and for the fully adjusted model. In the univariate analysis, women had lower mortality risks and, as previously described, there was a complex relationship with age. Not being in a current partnership, living in a household of lower socioeconomic status and having no formal education were all related to increased mortality. In general, older people living in households with younger adults and/or in 'skip generation' households have lower mortality. This protective effect remained when the analysis was carried out separately by gender, but only the effect of living with younger adults had confidence intervals below 1. People who reported that they were suffering moderate or bad health and those who reported severe difficulty with work or household duties experienced higher

mortality, as did those who reported poor function, low quality of life and lowest health status.

As described in the methods section above, we constructed three multivariate Cox regression models: for the total population, for men and for women, separately (Table 3). We retained in the model all variables where the likelihood ratio test returned a value of P > 0.1. The survival advantage of women was maintained [HR 0.35) 95% CI 0.27–0.44)]. Age group, education status, union status, household asset score, WHOQOL and WHODAS were retained in all three models, whereas health status was discarded.

In the fully adjusted model for women, although there was no clear double peak of mortality with age, the mortality risk was similar for all ages between 50 and 79, suggesting that the younger age groups were experiencing higher mortality than would be expected. Poor physical function was associated with a greater risk of dying; those women reporting the worst function had nearly double the risk of dying compared with those in the highest function group [HR 1.92 (95% CI 1.16–3.16)]. In addition, lower socioeconomic status and not being in a current partnership were associated with a higher risk of dying independently of disability.

The fully adjusted model for men shows a clear double peak in age-related mortality, with an increased mortality risk up to age 69: 60–64, HR 2.10 (95% CI 1.00–4.39) and 65–69, HR 2.03 (95% CI 1.01–4.09). Only from age 85 onwards, the risk of dying was again higher than that in men in their 60 s.

We grouped cause of death into broad categories because there were relatively few deaths. These categories were chronic disease (164 deaths), HIV/TB (78 deaths), other infections (67 deaths), other causes (20 deaths) and unknown (48 deaths). In Table 4 we show the same general population model for each of the first three of these categories separately. The model is shown in more detail in

Supplementary Table 4 (available as Supplementary data at IJE online). Whereas the models for chronic diseases and other infections show the expected age gradient with increasing risk at older ages, the model for HIV/TB shows an inverted relationship with age such that older people are at lower risk.

Discussion

We have presented the results of 3 years of follow-up on over 4000 older people living in rural South Africa. We set out to describe some of the factors associated with mortality in a cohort of older people living in an area of rural South Africa with high HIV prevalence. One of the strengths of this study is that it is based in a sub-district that is covered by a health and demographic surveillance system, where the population has been followed for 18 years and there is access to high-quality mortality and cause of death data. Moreover, we achieved high follow-up of the participants in the study, with only 1.2% lost to follow-up at 3 years. All those recruited at baseline had been permanently resident in the research site for at least 12 months before recruitment, thus reducing the likelihood of including labour migrants who had 'returned home to die'. There is inevitably some bias in recruitment at baseline, in that those who were unable to respond, usually because they had died or were too sick (8.1%), were not included as were those who were not present to be interviewed (28.7%). Excluding people who were ill will result in under-representation of those in poor health, whereas the exclusion of the much larger number of individuals who were not available could influence the results either positively or negatively.

For rural sub-Saharan Africa, there was a high proportion of participants living in households without younger adults, including those older persons living in 'skip generation' households. This might be related to the impact of the HIV epidemic on younger adults as well as the increasing number of young men

and women joining the migrant work force.²⁹ The situation is likely to impact on the wellbeing and health of the older population, although only the univariate analysis shows higher mortality in those people living in households without younger adults or children, possibly due to the weight of other socio-demographic factors such as education and socioeconomic status. Moreover, we observed the lowest mortality in the small group of individuals (2.4%) living in 'skip generation' households, although this might be accounted for by selection bias, in that only fitter older people become sole caregivers for children.

People of Mozambican origin have a higher risk of mortality in the univariate analysis, an effect that it is not observed in the multivariate analysis. This may be because people of South African origin suffer higher levels of HIV.¹¹

Our results demonstrate higher survival in women. Individuals who were not in a partnership had lower survival, as did those with lower socioeconomic status, higher levels of disability and lower quality of life. We have previously demonstrated that women in this cohort report higher disability and lower quality of life even after adjusting for the effect of age.12 These findings reflect the 'malefemale health survival paradox'30,31 frequently observed in high-income countries, where women report poorer health and quality of life and yet have lower death rates. It may be related to some other set of health protective mechanisms, whether biologically-based or involving health-promoting behaviours or forms of social protection in families, but we are unable to investigate this further with these data.

A striking finding is the pattern of mortality, particularly in men, with an apparent fall in mortality with increasing age after an earlier rise. We do not believe that this is due to errors in recorded date of birth. Although all participants in this study were born before 1992 when the first census round

was undertaken, and birthdates were not certified by the HDSS field team, those dates were later compared and corrected with those in the National ID cards that most of the population hold. Moreover, ages were further analysed looking for trends that could indicate age misreporting (for example, low numbers in a specific age group compared with others), but no evident trend in misreporting was found.

We have shown, using HDSS data from 1993 to 2010, that mortality rose dramatically in this older population (Figure 1). The effect is more pronounced for men than for women and is probably accounted for by an increasing number of deaths from HIV and TB (Figure 2). This is confirmed by comparison of the different causes of death models (Table 4). There is highest mortality in the age group 50–54 years for the model including HIV/TB deaths, but the more usual higher mortality at older ages for models including chronic diseases and other infections.

Our observations suggest that older people in the Agincourt sub-district are experiencing overall worsening of mortality. These changes are probably due to a combination of the direct effect of the HIV epidemic on older adults, and the effects of the HIV epidemic on the survival of younger adults. Whereas mortality remains higher than in the earliest time period, the most recent period—from 2007 to 2010 (Figures 1 and 2)—has seen reduction from the highest levels of mortality in both men and women. This may be related to the introduction of antiretroviral therapy in the area from 2007.

This population is continuing to age and moreover, as highly active antiretroviral therapy becomes more available, growing numbers of people living with HIV will survive to enter the older age groups. Efforts to enhance the well-being of older persons will become increasingly important. These findings have important implications for rural South African communities and for the development of health and social systems. Policy

makers and practitioners should consider the needs of this growing and often overlooked group.

Supplementary Data

Supplementary data available here: http://ije. oxfordjournals.org/content/suppl/2014/03/29/dyu093.DC1

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