Discrete Time to Event Models for Age At First Marriage in Namibia

***Lillian Pazvakawambwa**, *University of Namibia, lpazvakawambwa@unam.na*
Lawrence Kazembe, *University of Namibia, lkazembe@unam.na*
Nelago Indongo, *University of Namibia,nkanime@unam.na*

*corresponding author

The propensity to marry, the stability and duration of marriage have considerable implications for the organization of family life. The age at first marriage may also influence population growth, labour supply, consumption, wage rates, mortality, migration and to some extent fertility. This paper explores the age- period-cohort effects in Namibia by fitting discrete time-to-event models of age at first marriage. We explored a structured additive model for discrete time-to-event outcome derived from a retrospective cross-sectional data of the 2006-7 Namibian Health and Demographic Survey, to establish individual and structural effects, and simultaneously investigate non-linear effects of age, cohort and period on the timing of first marriage among women.

Various models were explored using Bayesian inference and the Cox proportional hazards model. We did not observe any significant nonlinear pattern of age at first marriage with age, cohort and period. First marriage timing among women in Namibia was influenced by the woman's age, birth cohort, period, place of residence, highest educational level, socio-economic status and region. Efforts to discourage early marriage should be stepped up especially in the Zambezi region by improving access to quality higher education.

Introduction

Marriage can be viewed as a social union or legal covenant between two people, normally of opposite sex, in which intimate sexual relationships are acknowledged. Marriage is usually formalized by a wedding or celebration ceremony. People marry for various reasons ranging from social legal, love, emotional, financial, spiritual to religious reasons. There is a general call world-wide to delay marriage and to discourage premarital sex because early marriage, especially among girls, is often associated with adolescent motherhood, school dropouts, maternal morbidity and mortality, and forfeited future life opportunities for the affected individual (Pathfinder International Report, 2006; Green, Makuria and Rubin, 2009). The propensity to marry, the stability and duration of marriage have considerable implications for the organization of family life. The age at first marriage may also influence population growth, labour supply, consumption, wage rates, mortality, migration and to some extent fertility (Mensch, Singh and Casterline, 2005). According to the Namibia Marriage Act No. 25 of 1961, Section 26, no boy under the age of 18 and no girl under the age of 15 years may contract a civil marriage without the permission of a designated government (CRC/C/ADD 12, 1993). The 1992, 2000, and 2006/7 Namibia DHS report showed that mean age at marriage was 24 in 1992, 26.2 in 2000 and 28.6 in 2006/7. In 1992, the median age at first birth was 21 years and 56% of the births were premarital. In Namibia like in most of Southern Africa, premarital child-bearing is a concern especially in terms of the financial responsibility to support the children born.

Junya (2005) established that higher educational career, namely high school to college made one's hazard ratio of marriage drop to approximately 65%, and those with no experience of living apart from their parents tended to marry early. Later marriage for highly educated women primarily reflects longer enrollment in school that university education increasingly is associated with later as less marriage (Raymo, 2003, Mensch, Singh and Casterline, 2005). These findings are in line with the argument that higher education should be negatively associated with marriage only in the countries in which gender relations make it particularly difficult for women to balance work and family. In Nepal, Aryal (2007) established that the risk of getting married early decreased gradually with increasing year of birth cohort, and was higher among females of high socio economic status compared with those of low economic status. This could be explained by the fact that high socio-economic status families were motivated, for religious and prestige, to get their daughters married at an early age, preferably before menarche. Education, occupation and age at menarche were the most powerful factors in deciding the timing of first marriage in Nepal. Other social and family background characteristics were also important determinants of age at first marriage; including how strongly traditional values and ties to the natal family were held by women (Wong, 2005). In Malawi, rising age at marriage was a combination of birth cohort and education effects, depended on the family and to some extent on the community in which a woman resided. These results confirm a downward trend in teenage marriage and that raising women's education levels in sub-Saharan Africa have the beneficial effect of increasing age at marriage, and by implication reducing total fertility rates (Manda and Meyer, 2005).

For men, the decision whether to get married was strongly negatively affected by holding unstable contracts or not working relative to when an indefinite contract was held. However, for women, holding fixed term contracts was not a deterrent factor for the decision whether to get married (De La Rica and Iza, 2005). Discrete time to event models have been widely used (Manda and Meyer, 2005; Raymo, 2003; Mensch, Singh and Casterline, 2005;Aryal, 2005; Wong,2005) to analyze the timing of first marriage, first sex and first birth due to their flexibility and robustness .

This paper explores the age- period-cohort effects on age at first marriage in Namibia by fitting discrete time-to-event models to retrospective cross-sectional data from the 2006-7 NDHS, to establish individual and structural effects that impact on the timing of first marriage among women in Namibia

Data and Methods

This study is based on the 2000 and 2006/7 Namibia Demographic and Health Survey (DHS). DHS is a national survey drawn on using a multistage cluster sampling. At first stage, a random sample of enumeration areas (EA), which are primary sampling units, was chosen from the census sampling frame. From the selected EAs, households were systematically drawn. Only women of reproductive age (15–49 years), in the selected households, were interviewed using a face-to-face questionnaire. The questionnaire included variables on individual bio-demographic factors, household characteristics, history of marital unions and births. Final samples included in the analysis were respectively, 6755 from the 2000 survey and 9800 women, from the 2006/7 round of surveys. The independent variables include age, period, cohort, place of residence, age-group, highest educational level, region, religion, and socio-economic status. We explored a structured additive model for discrete time- to-event outcome, to assess individual and structural effects, and simultaneously investigate non-linear effects of age, cohort and period on the timing of first marriage among women. The model was estimated using Bayesian inference.

The standard procedure for examining the effects of covariates (v_i) on survival times is the Cox proportional hazard model where the multiplicative structure

$$\lambda_i = \lambda(t, v_i) = \lambda_0(t)\exp(v_i',\gamma)$$

is assumed for the hazard rate, γ is a vector of regression coefficients and $\lambda_0(t)$ is the baseline hazard rate. The baseline hazard rate is re-parameterized through $g_0 = \log(\lambda_0(t))$ and the covariates are partitioned into groups of different types to extend the Cox model to a semi-parametric hazard rate model so that $\lambda_i(t) = \exp(\eta_i(t)),\ i = 1,2,\cdots,n$ is a geo-additive predictor predictor of the form

$$\eta_i(t) = v_i'\Upsilon + g_o(t) + \sum_{j=1}^{J} f_j(x_{ij}) + f_{spat}(s_i) + b_{gi}$$

where $f_j(x_{ij})$ is the non-linear effect of continuous covariates x_j, and $f_{spat}(s)$ is the spatial effect. The vector of linear effects is denoted by γ while b_g, $g \in \{1, \cdots, G\}$ are uncorrelated individual or group specific frailties. An extended geo-additive Cox model that addresses arbitrary combinations of left , right and interval censoring schemes and relaxes the proportional hazards assumption by allowing all covariates to be piecewise constant i.e. time varying was further proposed by Kneib (2006). Extensions of geo-additive models have been widely developed and adopted (Hennerfeind et al, 2006; Khatab and Fahrmeir, 2009; Claudio et al, 2012; Olubiyi and Olubusoye, 2013).

Evaluation of the posterior distribution of the model parameters was based on Empirical Bayesian inference. Model diagnostics were based on the Akaike Information Criterion (AIC) and the Bayesian Information criteria (BIC). The best model is the one with the smallest AIC and BIC. AIC and BIC regulate the trade-off between the goodness of fit of the model and the complexity by imposing a penalty that discourages over-fitting (increasing the number of free parameters in the data-generating process). All analyses were carried out in BayesX , a software for Bayesian inference in Structured Additive Regression models – version 2.0.1 (Berlitz et al., 2009).

Results

The background characteristics of the sample after restructuring the data are presented in Table 1.

Table 1: Sample Characteristics of women (N=82795)

Variable	**N**	**Percentage**
Age-group		
15-19	18175	22.0
20-24	15970	19.3
25-29	13350	16.1
30-34	12150	14.7
35-39	9325	11.3
40-44	8025	9.7
45-49	5800	7.0
Period		
2000	33775	40.8
2006/7	49020	59.2
Cohort		
1950-1964	15100	18.3
1965-1974	21770	26.3
1975-1984	29575	35.7
1985-1992	16350	19.7
Region		
Zambezi	4860	5.9
Erongo	5985	7.2

Hardap	5220	6.3
!Karas	4890	5.9
Kavango(East and West)	7525	9.1
Khomas	7730	9.3
Kunene	8105	9.8
Ohangwena	4660	5.6
Omaheke	5420	6.5
Omusati	6905	8.3
Oshana	7920	9.6
Oshikoto	7010	8.5
Otjozonjupa	6565	7.9
Place of Residence		
Rural	45260	54.7
Urban	37537	45.3
Level of education		
Primary or No Formal	31795	38.4
Secondary or Higher	51000	61.6
Religion		
Protestant	61985	74.9
Catholic	18835	22.8
No religion	1150	1.4
Other	475	0.6
Missing	350	0.4
Wealth Index		
Poor	14490	17.5
Poorer	14515	17.5
Middle	17425	21.0
Richer	18640	22.5
Richest	14910	18.0
Missing	2815	3.4

Age group composition was a s follows: 15-19 (22.5%), 20-24 (19.1%), 25-29 (15.9%), 30-34 (14.5%), 35-39 (11.0%), 40-44 (9.7%), and 45-49 (7.3%). More than half of the women resided in rural areas (55.1%). The distribution of the women's highest educational level was 7.9% no formal education, 26.7% primary education, 59.7% secondary education, and 5.7% higher education. The wealth index income quintiles comprised of the poorest (16.3%), poorer (17.9%), middle (22.7%), richer (25.0%) and richest (18.2%). The main languages spoken at home by the women were Afrikaans (9.2%), Damara/Nama (15.1%), Herero (8.1%), Caprivi and Kavango (11.4%), Oshiwambo (45.7%) , English and other languages (10.5%).

Figure 1 is a histogram showing the distribution of age at first marriage. The mean age at first marriage was 22.6 years with a standard deviation of 6.1 years.

Figure 1. Histogram of age at first marriage

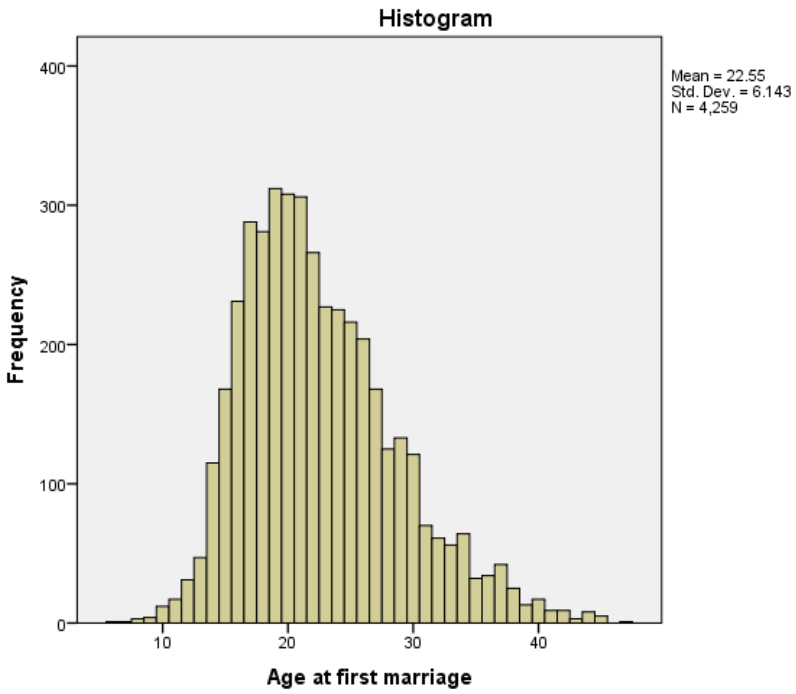


Figure 2 shows the survival function by age group. The function suggests that the probability of first marriage differs by age group

Figure 2. Survival function by age group

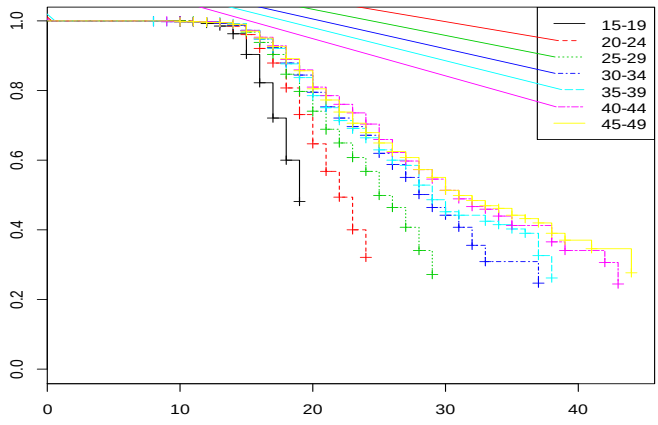
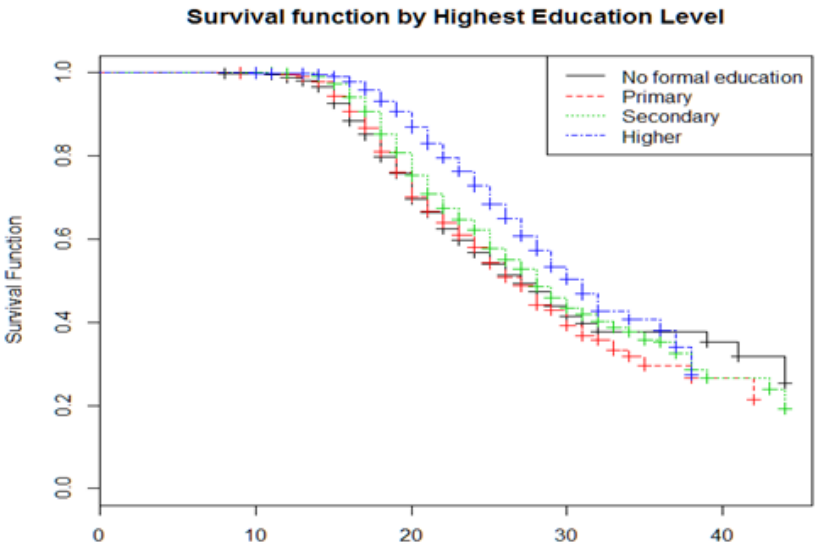


Figure 3 shows the survival function by highest educational level. Again the function also suggests that the probability of first marriage seems to differ by the educational level of the woman.

Figure 3 Survival function by Highest Educational level



Five hazard models were explored to investigate the effect of observed and unobserved heterogeneity on the timing of first marriage in Namibia. The fitted models were defined as follows:

Model 1: $\eta_1 = f(baseline)$

Model 2: $\eta_2 = f(baseline) + trend$

Model 3: $\eta_3 = f(baseline) + trend + fixed\ (cat) + fixed(Region)$

Model 4a: $\eta_4 = f(baseline) + trend + fixed + nonlinear + random\ (Region)$

Model 4b: $\eta_4 = f(baseline) + trend + fixed + nonlinear + spatial(Region)$

Model 5:
$\eta_5 = f(baseline) + trend + fixed + nonlinear + random(Reg) + spatial(Region)$

The nesting structure of the models is summarized in Table 2.

Table 2: Nesting structure of models 1 to 5.

Model specification	**Baseline** $g_0(t)$	**Time** t	**Fixed effect** V_j	**Non-linear effect**	**Random effect**	**Spatial effect**
1	X					
2	X	X				
3	X	X	X			
4a	X	X	X	X	X	
4b	X	X	X	X		X
5	X	X	X	X	X	X

Table 3 shows the model comparison statistics for all the fitted models. Model 3 had the smallest AIC and BIC was therefore chosen as the best model and was considered for discussion.

Table 3 : Model comparison statistics.

Model specification	**-2 Log-Likelihood**	**df**	**AIC**	**BIC**
1	38095.6	11.26	38118.2	38214.4
2	38095.6	13.26	38122.2	38235.5
3*	**36564.6**	**43.18**	**36650.8**	**37018.0**
4a	36564.4	48.01	36660.4	37068.8
4b	36564.4	47.37	36659.1	37062.0
5	36564.4	48.22	36660.8	37071.0

*Best model

Results of Cox Regression based on the best model

Table 4 displays the Cox regression results.

Table 4: Regression estimates under the best model

Variable	**Hazard Ratio**		**95% Confidence interval**	
Age				
15-19	7.205***		5.633	9.218
20-24	3.528***		2.921	4.260
25-29	2.093***		1.788	2.450
30-34	1.520***		1.326	1.742
35-39	1.235***		1.107	1.377
40-44	1.151**		1.051	1.259
45-49 (Ref)	1.000			

Period				
2000	1.143***		1.073	1.218
2006	1.074*		1.002	1.152
2007(ref)	1.000			
Cohort				
1950-1964	0.578***		0.457	0.730
1965-1974	0.612***		0.504	0.743
1975-1984	0.707***		0.605	0.828
1985-1992 (ref)	1.000			
Place of residence				
Rural	0.869***		0.817	0.923
Urban(ref)				
Educational level				
No Formal (ref)	1.354***		1.195	1.534
Primary	1.252**		1.121	1.398
Secondary	1.086		0.979	1.205
Higher	1.000			
Wealth Index				
Poorest	0.888*		0.795	0.992
Poorer	0.845**		0.765	0.934
Middle	0.877**		0.807	0.954
Richer	0.921*		0.855	0.993
Richest (ref)	1.000			
Religion				
Catholic	1.049		0.992	1.109
Protestant(ref)	1.000			
Region				
Zambezi	1.133*		1.003	1.280
Erongo	0.944		0.847	1.052
Hardap	0.900		0.800	1.013
Karas	0.856*		0.760	0.964
Kavango	1.022		0.920	1.136
Khomas	0.912		0.821	1.014
Kunene	0.975		0.859	1.107
Ohangwena	1.117		0.992	1.258
Omaheke	0.938		0.831	1.059
Omusati	0.728***		0.632	0.838
Oshana	0.800***		0.711	0.900
Oshikoto	0.765***		0.678	0.864
Otjozonjupa(ref)	1.000			

*****p<0.001, **p<0.01, * p<0.05**

Compared to women in the 45-49 age group, there was a significantly higher risk of first marriage among those women in the younger age groups namely 15-19 (HR=7.205), 20-24 (HR=3.528), 25-29 (HR=2.093), 30-34 (HR=1.520), 35-39(HR=1.235), 40=44(HR=1.151). The

risk of first marriage decreased as the age of the woman decreased. With regard to period, the risk of first marriage was higher in 2000 (HR=1.143), and reduced in 2006 (HR=1.074) compared to 2007. There were significant differences in the timing of first marriage between birth cohorts. Women born in the cohorts 1950 -1964 (HR=0.578), 1965-1974 (HR=0.612), and the 1975-1984 (HR=0.707) had lower risk of first marriage compared to their counterparts in the 1985-1992 cohort.

With regard to the highest educational level of the woman, risk of early first marriage was significantly higher among those women with no formal education (HR=1.354) and those with primary education (HR=1.252) compared to those with higher education. However, there were no significant differentials in the timing of first marriage between women with secondary education and those with higher education (p=0.120). Compared to the richest women, richer women (HR=0.921), women in the middle socio-economic quintile (HR=0.877) , the poorer (HR=0.845) and the poorest women (HR=0.888) had relatively lower risk of first marriage. There were no significant differentials in the timing of first marriage with respect to religion (p=0.091).

With regard to region, women in the Oshikoto region(HR=0.765), Oshana region (HR=0.800) and Omusati region (HR=0.728) had relatively lower risk of early first marriage compared to those in the Otjozonjupa region. However, women from the Zambezi region(HR=1.133) had significantly higher risk of early first marriage compared to their counterparts in the Otjozonjupa region. Compared to women in urban areas, rural women (HR=0.869) were at a significantly lower risk of early first marriage.

Discussion

Regression results indicated that there was a significantly higher risk of first marriage among those women in the younger age groups compared to those in the 45-49 age group. This is expected since most first marriages occur in the twenties to early thirties and by age forty most of those wishing to marry will have already done so. With regard to period, the risk of first marriage was higher in 2000 and decreased in 2006 compared to 2007. This reduction in the risk of first marriage could be attributed to the general decline in marriage rates over the years due to increasing cohabitation and singlehood (Copen etal., 2012). There were significant differences in the timing of first marriage between birth cohorts. Women born in the 1950 -1974 cohorts had lower risk of first marriage compared to their counterparts in the 1985-1992 cohort. This is somehow surprising as results from other studies suggest that women born in the older cohorts had higher risk of early first marriage (Aryal,2007).

With regard to the highest educational level of the woman, risk of early first marriage was significantly higher among those women with no formal education (HR=1.354) and those with primary education (HR=1.252) compared to those with higher education. However, there were no significant differentials in the timing of first marriage between women with secondary

education and those with higher education (p=0.120). These findings are in line with results from other parts of the world (Agaba, Atuhaire, and Rutaremwa, 2011;Kamchulesi, Palamuleni, and Kalule-Sabiti, 2011;Hymowitz et al., 2013; Haloi and Limbu, 2013; Hoq,2013)

Compared rich women, poor women had relatively lower risk of first marriage. These findings seem to suggest that in Namibia, women's riches may attract male marriage partners. Studies elsewhere suggest the opposite, with poor women having a relatively higher risk of first marriage (Haloi and Limbu, 2013; Saviram, Richard, and Rao, 1995; Hoq,2013). There were no significant differentials in the timing of first marriage with respect to religion (p=0.091). This could be because Namibia has become a secular society causing vast dilution of the once so strong religions like the Roman Catholic and protestant religions. However, in some societies, religion still plays a significant role in the timing of first marriage (Okeibunor, 1999; Hoq, 2013; Kamchulesi, Palamuleni, and Kalule Sabiti, 2011; Agaba, Atuhaire, and Rutaremwa, 2011; Rahman, Islam, and Hossain, 2008).

With regard to region, women in the Oshikoto region (HR=0.765), Oshana region (HR=0.800) and Omusati region (HR=0.728) had relatively lower risk of early first marriage compared to those in the Otjozonjupa region. However, women from the Zambezi region (HR=1.133) had a significantly higher risk of early first marriage compared to their counterparts in the Otjozonjupa region. Regional differentials in other countries (Adewole, etal, 2012, Rokonuzzaman and Chowdry, 2013; Pande, 2004).The regional differences in the timing of first marriage in Namibia could be due to different levels of economic development, clustering of regional ethnic groupings and varying levels of access to information which influences marital decision making. Compared to women in urban areas, rural women (HR=0.869) were at a significantly lower risk of early first marriage.These findings are unexpected as similar studies elsewhere suggest otherwise (Hoq, 2013; Sivaram et al., 1995; Agaba, Atuhaire, and Rutaremwa, 2011, Adir, 2007).

Conclusions

The effects of age, period and cohort in the timing of first marriage were established among women in Namibia. In addition, marriage timing among women was influenced by rural urban place of residence, highest educational level, socio-economic status and region. Efforts to discourage early marriage should be stepped up especially in the Zambezi region.

Acknowledgements

The authors acknowledge permission by Measure DHS and the Namibia Ministry of health and Social Services to use the data analyzed in this study. This research was made possible through funding from UNFPA and the University of Namibia.

References

Adair, T. (2007). HIV status and age at first marriage among women in Cameroon, Demographic and Health Research, DHS working papers No. 33.

Adewole, S.A., Fagbamigbe, F.A., Okare, T.O., and Lawal G.O.(2012). Survival analysis of the timing of first marriage among women of reproductive age in Nigeria, *African journal of Reproductive Health*, 16 (4) 95-107.

Agaba, P., Atuhaire, L.K., Rutaremwa, G. (2011). Determinants of age at first marriage among women in Western Uganda, Proceedings of the 6th African Population conference, Ouagadougou, Burkina Faso, 5-9 December 2011.

Aryal, T. R. (2007). Age at first marriage in Nepal: Differentials and determinants, *Journal of Bio-Social Sciences* 39 (5) 693-706.

Belitz, C., Brezger, A., Kneib, T. and Lang, S. (2009). Software for Bayesian Inference in Structured and Additive Regression Models. Version 2.0.1. http://www.stat.uni-muenchen.de/~bayesx

Claudio,F., Mar, R., Carmen, C., Kneib, T.,Guadalupe, G.and Luis, C.(2012). Flexible geo-additive survival analysis of non-Hodgkin lymphoma in Peru, *Statistics and Operations Research Transactions (SORT)*, 32(2) 221-230

Copen, C.E., Daniels, K., Vespa, J. and Mosher, W.D. (2012). First marriages in the United States: Data from the 2006 – 2010 National Survey of family Growth, National Health Survey Statistics Report Number 49.

De La Rica S. and Iza , A. (2005) Career Planning in Spain: Do fixed term contracts delay marriage and parentwood?, *Review of Economic of the household*, 3 49-73.

Green, C. A., Mukuria, A. and Rubin D. (2009). Addressing early marriage in Uganda, Washington D.C. Futures Group, Health Policy Initiative, Task Order 1.

Haloi, A. and Limbu, D.K. (2013). Socio-economic factors influencing age at first marriage of Muslim women of a remote population from North East India, *Antrocom Online Journal of Anthropology* 9 (1) 75-79.

Hennerfeind, A., Brezger, A. and Fahrmeir, L. (2006). Geo-additive survival models, *Journal of the American Statistical Association*,101(475) 1065-1075.

Hoq, M. (2013).Regional differentials in age at first marriage among women in Bangladesh, *Asian Journal of Applied Science and Engineering* 2 (2)76-83.

Hymowitz, K., Caroll, J.S., Wilcox, B., and Kaye, K. (2013). Knot yet. The benefits and costs of delayed marriage in America. What does the rising marriage age mean for twenty something women, men and families? The Relate Institute, The National Marriage Project, University of Virginia.

Junya, T. (2005). Factors of late marriage: A survival analysis of life courses for marriage in Japan, NUCB *Journal of Economics and Information Science*, 49(2).

Kamchulesi, G., Palamuleni, M. and Kalule-Sabiti, I. (2011). Factors affecting age at first marriage in Malawi, Proceedings of the 6th African Population conference, Ouagadougou, Burkina Faso, 5-9 December 2011.

Khatab, K., Fahrmeir, L. (2009). Analysis of childhood mortality with geo-additive probit and latent variable model: A case study of Egypt, *American Journal of Tropical Medicine and Hygiene*, 81 (1) 116-28.

Kneib, T. (2006). Mixed model based inference in geo-additive hazard regression for inter-censored survival times. *Computational Statistics and Data Analysis* 51 (2) 777-792. doi 10.1016/j.csda.2006.06.019.

Kreider, R. M. and Ellis, R. (2011). Number, Timing and Duration of marriages and divorces: 2009. Household economic studies, United States Census Bureau, 70-125.

Manda,S. and Meyer R. (2005) Age at first marriage in Malawi: A Bayesian multi-level analysis using a discrete time to event model, *Journal of the Royal Statistical Society*

Mensch, B. S., Singh, S. and Casterline, J.B. (2005). Trends in the timing of first marriage among men and women in the developing world, Population Council, Policy Research Division, Working Paper 202.

Namibia Demographic and Health Survey Report 1992

Namibia Demographic and Health Survey Report 2006/7

Namibia Demographic and Health Survey Report, 2000

National Laws and Policies on minimum ages in Namibia (1993). Initial report: CRC/C/3/ADD 12

Okeibunor, J.C. (1999). Religious differentials in trends in age at first marriage in Enugu State, Nigeria, *Journal of Humanities*, 10, 209-226.

Olubiyi, A.O. and Olubusoye, O.E. (2013). A new approach of presenting the predictor in a geo-additive model, *American Journal of Science Industrial Research*, 4 (5) 438-448.

Pande, G. (2004). Persisting young age at first marriage among women in India, ETD Collection for Fordham University. Paper AAI3116866.

Pathfinder International Report (2006). Report on the causes and consequences of early marriage in Amhara region, Addis Ababa, Ethiopia.

Rahman, M., Islam, M. and Hossain, M. (2008). Female age at marriage of rural-urban differentials in Bangladesh, *The internet Journal of Biological Anthropology*, 3 (2)

Raymo, J. M. (2003). Educational Attainment and the transition to first marriage among Japanese women, *Demography* 40 (1) 83-103.

Rokonuzzaman, M.D. and Chowdry, A.H. (2013). Determinants of age at first marriage of women in Nigeria, *Asian Journal of Research in social sciences and humanities*, 3 (10) 102-121.

Sivaram, M., Richard, J., and Rao, P.S. (1995). Early marriage among rural and urban females of South India, *Journal of Biosocial Science*, 27 (3) 325-331.

Wong, O.M.H. (2005). The Socio economic determinants of age at first marriage among women in Hong Kong, *Journal of family and Economic issues*, 26 (40 529-550.