Title: Determinants of Internal Migration in Africa: Does Human Capital Necessarily End up in Cities? Comparative Analysis of Health and Demographic Surveillance Systems

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ABSTRACT
Education is one of the major determinants of migration, with studies suggesting that human capital accumulates in urban areas at the expense of rural areas. Using longitudinal data representing approximately 500 000 people living in nine Health and Demographic Surveillance Systems in Sub-Saharan Africa (HDSS), this paper aims to precisely measure the effect of education on in- and out-migration by age-group and sex, over the period 2009 to 2011. Between 7% and 27% of these local populations are moving in- or out- of the HDSS over this period. Among young adults, this may exceed 30%, confirming internal migration as a major event marking entry into adulthood. Education is positively associated with both in- and out-migration in urban Kenya, however education effect has no clear pattern in Burkina Faso. Educated female migration is an important flow and has effects on human capital distribution. We conclude that education is not necessarily linearly related to migration, and the educated are not always more likely to migrate compared to the less educated. Migration systems in Sub-Saharan Africa vary depending on the regional contexts, leading to different patterns of human capital redistribution.

INTRODUCTION

International migration of skilled individuals has received much attention amongst migration scholars and in economic, development and policy discourses. Debate has focused on the consequences of such mobility on origin and destination locations (Clemens, 2009; Gibson and McKenzie, 2011; World Bank, 2009), with theoretical and empirical research suggesting potential detrimental economic and development impacts of skilled migration on sending countries. Nevertheless, the majority of human population movements are observed to take place within national boundaries (Skeldon, 2008). As in the case of transnational migration, such movement flows are often amongst the relatively better educated who relocate from a country's periphery to the bigger cities (World Bank, 2009). This "internal brain drain" may have significant consequences on a region's economic growth, service provision and domestic policy, however, these dynamics have been little researched. In Sub-Saharan Africa, where economic growth and poverty reduction continue to be regional priorities in the post 2015 United Nations development agenda, understanding the relationships between human capital and internal migration is highly relevant.

The urban transition in Sub-Saharan Africa has resulted in rapid growth of urban populations with substantial rises in urbanisation projected over the coming decades (United Nations Development Programme, 2009; United Nations Population Fund, 2010). Such high levels of urbanisation have led to a growing concern amongst policymakers about urban poverty and the ability of cities to sustain the demands placed by a growing urban population (Mabogunje, 2007). However, the urban expansion in Sub-Saharan Africa has its own distinct features (White, et al., 2008). Studies have suggested that reported rates of urbanisation are over estimated and that increases in urbanisation are in fact occurring at a much slower rate than projected (Bocquier, 2005; Potts, 2009). The sizable impact of natural increases on urban growth has been emphasised, while it has also been argued that the dominance of an urban-rural internal migration stream cannot be assumed in all settings (Potts, 2012), (Tacoli, 2008). In particular, less permanent forms of urban settlement and high levels of circular mobility have been observed in the Sub-Saharan African region (Potts, 2009). Given the well-established link between migration and economic development, this declining contribution of migration to urban growth has been attributed to a lack of economic opportunity in the cities (Potts, 2009). Another contributing factor concerns the temporary nature of urban residence for many, who employ such migration as a livelihood strategy to maintain rural households to which they will ultimately return (White, et al., 2008). These more temporary forms of migration and circulation are difficult to measure and not well documented in all parts of the region. Consequently, an examination of the patterns of human capital distribution and the associated channels of internal migration would be of value in exploring economic motives and impacts of relocation.

Educational attainment is a primary determinant of internal migration, particularly in the rural to urban direction (World Bank, 2009). Economic theories of migration hold that skills flow to the place of highest return (see Massey, et al., 1993; World Bank, 2009). Thus levels of education act as an enabler of migration by improving employment opportunities and the likelihood of securing work. Migrants are most commonly found to be positively selected on human capital characteristics with relatively higher levels of education and occupational status as compared with non-migrants of a particular population (Findley, 1977; Speare and Harris, 1986). Nevertheless, research has also shown a positive association between high and low skilled international migration (Gibson and McKenzie, 2011) indicating that some variations in observed patterns may be present.

In Sub-Saharan Africa there is limited evidence concerning the educational structure of internal migration although studies of international migration have revealed a high rate of skilled immigration from the region (Docquier and Marfouk, 2006). Smaller country or area specific studies have corroborated the relationship between mobility and the accumulation of skills in urban areas (Brockerhoff and Eu, 1993; Oucho and Gould, 1993). Such migration flows tend to vary by age and sex in accordance with different life stages or life course events (see Kulu and Milewski, 2007; Sandefur and Scott, 1981). In Sub-Saharan Africa, internal migration tends to follow a uni-modal distribution on age with peaks in early adulthood and declines upon exit from the labour market

(Collinson, 2009; Oucho and Gould, 1993). The levels of movement and associated age distributions have also been observed to differ by gender (Collinson, 2009).

Internal migration trends are also strongly influenced by factors related to a country's economic and structural context. Despite projections of sustained economic growth across the region, Sub-Saharan African countries continue to experience widespread poverty and inequality (United Nations Economic Comission for Africa, 2013; World Bank, 2013). Some parts of the region are marked by political instability, limited resources and adverse climate conditions (World Bank, 2013). With regards to the region's educational landscape, Sub-Saharan Africa has seen an increase in enrolment rates into primary-level education, however levels of secondary school enrolment and school completion rates remain low (UNESCO, 2011; United Nations Economic Comission for Africa, 2013). Adult literacy rates display strong regional variation with levels falling below world averages in some settings (UNESCO, 2008; UNESCO, 2011). Furthermore, significant gender disparities in educational attainment, participation and adult literacy persist in some areas (UNESCO, 2011; United Nations Economic Comission for Africa, 2013). The ways in which these factors may impact on the distribution and mobility of skills is little known.

Studies of the patterns and determinants of migration across Africa have been hampered by a lack of consistency in definitions, measures, timing and analysis techniques. Censuses or DHS surveys are the most common sources of data on internal migration in Africa at the national level but these are conducted infrequently and in some countries not at all (Brockerhoff, 1995; Potts, 2008). Population censuses are further designed to address more permanent forms of relocation occurring across larger spatial boundaries. These instruments may thus fail to identify frequent or temporary movements, or moves occurring over shorter distances between more homogeneous settlement areas. Cross-sectional data has limitations when applied to analyses of migration because of the repeatable nature of movement over time. In internal migration studies, much emphasis has been placed on rural-urban flows and this focus may overlook the variety of circular movements and patterns of return migration that are being documented in smaller population-specific studies (Beguy, et al., 2010). Consequently, researchers and development agencies have highlighted the need for more robust analyses and comparisons of internal migration patterns and determinants within the African region (Gibson and McKenzie, 2011). Health and Demographic Surveillance Systems (HDSSs) provide an important source of detailed prospective, longitudinal data on migration and health measures, and individual-level characteristics.

Against the background outlined, the objective of this paper is to conduct a multi-centre analysis of dynamics of migration in relation to levels of human capital, using HDSS data. The paper will comprise two parts. The first part of the paper will investigate, by HDSS site, the patterns of in- and out-migration by age and sex. The second part of the paper will examine the association between in- and out-migration and educational attainment by centre and by sex, in order to determine whether human capital necessarily accumulates in urban areas at the expense of rural areas. This analysis will include an exploration of regional differences and similarities concerning the ways in which human capital affects changes in settlement patterns through migration. The paper aims to examine the hypothesis that more educated individuals migrate from rural areas to settle in urban areas across Sub-Saharan Africa.

METHODS

Study Sample

The findings presented in this paper are based on data from nine HDSS centres that are members of the International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH). The INDEPTH network is an initiative that has brought together HDSS sites from low- and middle-income countries with the purpose of standardising data and techniques to allow for cross-country comparative research (see Sankoh and Byass, 2012 for more details concerning the methods and objectives of the INDEPTH organisation). The HDSS centres represented in the current analysis

yield from five Sub-Saharan African countries, and represent a mix of rural and urban localities. These are Nanoro, Nouna and Ouagadougou in Burkina Faso; Navrongo in Ghana; Kilifi, Kisumu and Nairobi in Kenya; Manhiça in Mozambique and Agincourt in South Africa. These HDSS centres are part of the Multi-centre Analysis of the Dynamics In Migration And Health (MADIMAH) initiative which commenced in 2011 with the aim of producing comparative studies on questions concerning migration and health (see Gerritsen, et al., 2013). These sites represent sub-district populations of a country. Through detailed examinations of the dynamics attached to these demarcated geographical areas, important insights about regional-level migration flows may be elicited. Key characteristics of the nine HDSS sites are outlined in Table 1. The analytical sample includes approximately 273 000 individuals who were resident in an HDSS site within the 2009 – 2011 analysis period. Table 2 includes a set of contextual indicators of the five countries represented in the analyses. The primary school completion rate provides some indication of the disparities in education between countries in the region. Notably, the level of educational attainment in Burkina Faso is substantially lower than those in the other countries represented in the analyses. The characteristics of the analytical samples by centre are presented in Table 3. Sample characteristics including mean age, gender distribution and educational attainment, have been derived at two time points; one on the start date of the analysis and the other on the end date.

Variables

In- and out- migration

For the purposes of this study, migration is defined as a move that crosses the geographical boundaries of the HDSS site (in either an inward or an outward direction). Definitions of in- and out-migration may differ according to HDSS site in relation to the specified time thresholds used to determine HDSS membership (varying from 1 to 6 months of residence within the boundaries of the HDSS). In order to achieve consistency, residency in an HDSS was standardised using a more conservative 6 month residency threshold. Migration as analysed in this study therefore excludes moves within the HDSS boundaries, or moves for short durations outside of the HDSS.

Educational attainment

Individual-level data representing educational attainment were collected for each site. In order to standardise measures of education across the HDSS sites, a variable representing educational attainment was derived from this education status data. This variable contrasts those individuals who had achieved no formal education with those who had either some primary or some secondary (or higher) levels of education. Given the different thresholds of education that are achievable in relation to age, the analysis of educational attainment and migration excludes children who would not yet have commenced schooling (0 – 4 years of age), as well as a school-aged group of children (aged 5 – 14 years) who would potentially be enrolled in the school system. The analytical sample is therefore based on a young and adult group of individuals aged 15 to 65 years who may be employed or seeking employment over the period of analysis. Educational attainment has been included in the analyses as a time-variant measure, however, the date associated with a change in educational status generally relates to the observation date rather than the specific date on which the change took place. Gaps in individuals' educational histories were interpolated with known values according to the sequence of available data for that individual. This was achieved by applying a series of decision rules to handle inconsistencies and/or missing data[1].

[1] Missing values that appeared after known values of educational attainment were populated with the last known value, while missing values that preceded a known value were populated with the first known value. Where all values for education were missing for an individual, the case was treated as missing. Inconsistencies in the sequence of educational histories were corrected by assuming the lower level of education where the inconsistency related to a single level/category difference. For example, if a value of primary schooling was followed by a value of no formal education, the value no formal education was assumed rather than the primary level. Where an inconsistency in the monotonic sequence of education resulted in a two level/category difference, the higher level was assumed. For

Statistical Analysis
The models presented in this paper have been analysed using event-history analysis techniques (EHA). This approach is appropriate for the examination of repeated events (such as migration) within the context of an individual's life course (Kulu and Milewski, 2007; Yamaguchi, 1991). Prior to commencing with EHA analyses, detailed data consistency and quality checks were necessary, and data were transformed into a biographical "residency episode" structure (see Gerritsen, et al., 2013). This structure implies that events (including in- and out-migration) for individuals are recorded sequentially and in continuous-time (ie: dates are attached to each event). The models allow for repeatable migration events over an individual's life course, thus some individuals may contribute more than one event over time. In order to analyse in-migration, analysis time is reversed from age 65 (the upper age limit of the analysis) until the occurrence of an in-migration event, or to birth/enumeration if no in-migration event occurs.

The analyses presented in this paper are based on the three years 2009-2011 for all centres with the exception of Nanoro and Ouagadougou whose data were left-censored on 1 Jan 2010. These two centres conducted their initial censuses in the year 2009 and complete migration data for this year is not available. A right-censoring date was fixed at 1 January 2012 for all datasets. Education data were merged into the core dataset in sequence according to the corresponding date of observation.

EHA techniques were employed to compute in- and out-migration hazard rates by 5-year age categories for each centre, stratified by sex. Hazard rates are expressed as the number of events (in- or out-migrations) divided by the person time of the population at risk, expressed in years (PYAR). In the case of out-migration, the population at risk corresponds to the time contributed by individuals within the HDSS over the corresponding age range. Where an individual leaves and re-enters the population through return migration, the individual is included in the population at risk from the time of re-entry until censoring. For in-migration, this denominator represents the population at risk of "receiving" an in-migrant, as opposed to the population from which the migrant originated (see Beguy, et al., 2010 for further discussion of this method). A set of Cox semi-parametric proportional hazards models were produced for each site in order to examine formal educational attainment as a determinant of in- and out-migration. These models control for age in the non- parametric part of the Cox model and calendar year as covariates. Models were stratified by sex because of the presence of gender compositional effects in the patterns of in- and out-migration and educational attainment.

RESULTS

Age-sex profiles
The in- and out-migration rates by centre are presented in Figures 1 – 4, with rates for males and females shown in separate figures. An inspection of the rates of out-migration by centre indicates that between 7 and 21 per 100 PYAR of these local populations are moving over the period, however, the rates vary substantially by age group. Out-migration rates across all centres reach a peak in early adult years (ages 15 – 24) for both males and females in the sample. Within this age range, rates of mobility reach as high as 37 per 100 PYAR amongst 20 – 24 year-old males out-migrating from Nanoro, and 31 per 100 PYAR of 20 – 24 year-old females out-migrating from Nairobi. The centre displaying the lowest relative rates of out-migration is Nouna where the modal rate of out-migration for males is 13 per 100 PYAR and occurs between ages 20-24 years.

The rates for in-migration are of a similar magnitude to those of out-migration with between 7 and 27 per 100 PYAR of individuals in-migrating over the period. The distribution of in-migration resembles that of out-migration with movement occurring most frequently between ages 15 – 24. The Nairobi

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example: if a value of secondary education was followed by a value of no education, the secondary level was assumed.

HDSS exhibits the highest ratio of in-migration over the period, with approximately 43 per 100 PYAR of males and females aged 20-24 entering the HDSS site. Children are also seen to participate in movement. For example, in-migration rates into the Nairobi HDSS are high amongst 0 – 5 year olds (approximately 38 per 100 PYAR of males and females), which corresponds to movement of connected adults. Within the Nouna HDSS, the rate of in-migration amongst females exceeded that of males with 24 per 100 PYAR of in-migration into the Nouna HDSS occurring amongst 15 – 19 year-old females, which may be connected to marriage. The age-sex profiles of in- and out-migration by site suggest high circulation.

The Cox Proportional Hazards models are displayed in Table 4. Models are presented by site and have been stratified by sex.

Urban Centres

The Cox regression models of the Nairobi HDSS reveal a strong positive association between both in- and out-migration and education in the slums. Males and females with some secondary schooling have 2.55 and 3.21 times the risk of out-migration compared to those with no schooling. Primary and secondary levels of education are even stronger predictors of in-migration, with males and females displaying 4.62 and 6.32 times the risk of in-migrating into the Nairobi HDSS, relative to those residents in the HDSS with no formal education. The coefficient of 6.32 represents the largest change in human capital for the Nairobi HDSS population. Given the higher coefficients for secondary schooling in the models, it appears that secondary-level educated individuals circulate more than individuals with primary-level education.

A contrasting set of relationships are evident in the Ouagadougou HDSS. In this mix of slum and non-slum areas, educational attainment is negatively associated with both in- and out- migration for both sexes. For instance, males and females who had achieved some secondary schooling have a 22% and 33% lower risk of in-migration compared with those in the population holding no formal education. Nevertheless, education does not appear for either sex to be a strong determinant of migration to or from the study area. The rural perspective illustrated in the next set of models helps to refine the Burkina Faso urban perspective on human capital distribution.

Rural Centres

The Nanoro rural site in Burkina Faso displays a more balanced pattern of results for male and female in and out-migration. Generally, the primary-educated are those who migrate less. In contrast to those with no education, and even more so compared to those with primary education, females with some secondary schooling have the highest risk of in- or out-migrating from Nanoro (1.56 times higher risk of in-migration and 1.33 times the risk of out-migrating relative to the existing population).

This U- or J-shape is also seen in the Nouna HDSS, except for female out-migration, for which primary and secondary education do not display much difference. Thus males with secondary schooling have a 1.95 times higher risk of out-migration and 1.46 times higher the risk of in-migration relative to those in the population who are unschooled, while the estimated hazard ratio of secondary-schooled females out-migrating from the Nouna HDSS is 1.33, indicating positive selection on education.

DISCUSSION

This is the first multi-country comparative study of education as a determinant of migration based on internal migration data from multiple HDSS centres in Africa. The study employs longitudinal analysis techniques, applied to migration data that were standardised across HDSS centres. These data are unique in allowing for in- and out-migration to be measured simultaneously in relation to a defined geographical area. The study finds that while education is positively associated with in- and out-migration in urban slums in Kenya, its effect on internal migration in urban and rural Burkina Faso is less prominent and not linear. The analysis suggests that migration systems vary depending on the regional contexts, leading to different patterns of human capital redistribution.

The paper aimed to examine the role of in- and out-migration in changing the distribution of human capital in relation to nine HDSS sites within Sub-Saharan Africa. The two urban centres, Nairobi and Ouagadougou, present a contrasting picture. In Nairobi, Kenya, where migration is formal labour market driven, migration is highly selected upon education level. Conversely, in Ouagadougou, there is no evidence of positive selectivity in relation to education and in- or out-migration. This may be explained by the fact that in Burkina Faso, migration is far less labour market driven due to the weak formal labour market. Higher educated individuals do not migrate out of the city due to limited opportunities elsewhere. Of the two rural Burkina Faso sites investigated, migration is positively selected on education where individuals have achieved some secondary or higher levels of schooling. But the effect of primary level education appears to be negatively predictive of in- and out-migration, while people with no education are situated somewhere between the primary and the secondary educated. The education-migration relationship is not linear and follows roughly a J-shape in rural Burkina Faso.

It is clear from the wide diversity of results by site that models reflect the different contexts in which they are based. These include different phases in the migration system, different economic opportunities in a country at a given time, different education levels within the country etc. In the two countries represented in the present analysis, education levels are dissimilar with high levels of school enrolment reported in Kenya, and relatively low levels of school participation evident in Burkina Faso (see Table 2; UNESCO, 2008). These contextual factors seem to play an important part in the observed patterns.

Studies of internal migration in Sub-Saharan Africa have emphasised high levels of internal mobility, in particular in a rural to urban direction. The findings of the present study corroborate these trends by demonstrating high levels of both in- and out- migration occurring amongst males and females, particularly during the young adult years. Migration literature on Sub-Saharan Africa has highlighted differential patterns of migration by sex, and emphasised feminisation of migration streams (Cross, et al., 2006). Female migration is usually not conceived of as being driven by education levels to the same extent as male migration, with women sometimes accompanying men to the workplace or relocating to care for other family members such as an older relative (Collinson, 2009). However, the present analyses show that educated female migration is an important flow. In Nairobi slums as well as in rural Burkina Faso, educated female migration has an even greater impact on human capital distribution than educated male migration.

The results of this study are also able to offer some insight into patterns of circulation. Scholars have emphasised the importance of this flow relative to that of permanent migration, however, measurement challenges have prevented conclusive evidence concerning circulation from emerging in published literature. By documenting the levels of in- and out-flows to and from the HDSS populations, the present set of analyses shows that internal migration is far from uni-directional. The patterns of mobility observed within these populations are consistent with high circulation: for every flow there is a counter-flow at both ends of the migration rural-urban continuum.

This study presents important insights on the process of selection and how migration flows may contribute to human capital redistribution in transitioning societies. The results highlight some useful directions for further research, while certain study limitations should also be noted. In order to allow for comparability across a diversity of regions and to bridge variations in data collection methodologies, it was necessary to sacrifice some detail in the data and inclusion of measures into the models. In particular, it should be noted that education in the models is not only measuring human capital net of other dimensions, but it is also a proxy for a number of other unobserved socio-economic covariates. Therefore the effects observed in relation to education may be confounded with other covariates (such as occupational status, marital status, socioeconomic status, etc.) that are excluded from the analyses. The results presented would be usefully extended by investigating the relationship between net-migration and education. It is envisaged as part of goals set out by the MADIMAH initiative, that HDSS sites will follow up on this paper with site-specific analyses. These

would allow for the inclusion of more detailed measures of human capital and socioeconomic context which would add depth of interpretation to this study of human capital and internal migration dynamics.

HDSSs provide unique and valuable sources of detailed migration data, however, the question of how representative these HDSS sites are of the larger population in each country should be considered. These populations represent small sub-districts from which detailed longitudinal data are collected. Such longitudinal data provides valuable complementary insights of active migration patterns, which can be interpreted alongside national-level or cross-sectional findings. In addition, the comparative nature of this paper allows for a broader perspective.

The overall aim of this paper is to contribute comparative evidence from nine sub-district populations represented by nine HDSS centres in Sub-Saharan Africa. The following HDSS centres are in progress preparing data for this analysis: Navrongo in Ghana; Kilifi, Kisumu in Kenya, Manhiça in Mozambique and Agincourt in South Africa. The four centres presented are those whose data were ready for analysis by the time of writing this paper.

In conclusion, this paper offers a unique perspective on the distribution of human capital through internal migration in Sub-Saharan Africa. It concludes that human capital does not necessarily accumulate in urban areas, and the educated are not always those who are on the move. These results suggest an alternative perspective on the "internal brain drain" which may have important policy and development implications.

Table 1: HDSS sites included in the multi-centre analysis

HDSS Centre	Population Size (approximate)	Size of Site (km^2)	Settlement Type	Population Density Estimate (persons per km^2)	Inception Year	Current Configuration (year)	Contiguity and Location
Agincourt HDSS South Africa[1]	91 178	420	Rural	217.1	1992	Extended in 2007 and 2013	Contiguous site situated in northeast South Africa close to border with Mozambique
Kilifi HDSS Kenya[3]	261 919	900	(Mostly) Rural	291	2000	~	Contiguous site situated north of Mombasa on Indian Ocean coast of Kenya
Kisumu HDSS Kenya[5]	223 406	700	Rural	319.2	2001	Extended in 2007	Contiguous site located in Rarieda, Siaya and Gem districts, northeast of Lake Victoria, Nyanza Province, western Kenya
Manhiça HDSS Mozambique[6]	90 000	500	Rural	180	1996	Extended in 2002 and 2005	Contiguous site located in southern Mozambique, 80 km north of capital, Maputo
Nairobi HDSS Kenya[7]	71 000	0.97	Urban	73 195.9	2002	~	Non-contiguous site comprising Viwandani and Korogocho slum settlements (7km apart) in capital, Nairobi
Nanoro HDSS Burkina Faso[8]	61 000	594.3	Rural	102.6	2009	~	Contiguous site situated in centre of Burkina Faso, 85km from capital, Ougadougou
Navrongo HDSS Ghana[9]	152 000	1 675	Rural	90.8	1992	~	Contiguous site located in Kassena-Nankana district of northern Ghana
Nouna HDSS Burkina Faso[10]	84 336	1 756	(Mostly) Rural	48	1992	Extended in 2000 and 2004	Contiguous site situated north west of Burkina Faso, 300km from capital, Ougadougou
Ouagadougou HDSS Burkina Faso[11]	81 717	14.73	Urban	5 547.7	2008	~	Non-contiguous site comprising three informal areas: Nonghin, Polesgo and Nioko 2, and two formal areas: Kilwin and Tanghin, north of city.

Table 2: Country indicators

HDSS Centre	GDP Per Capita (2012)	Educational Indicator: Adult Literacy Rate (%) 2008-2012*		
		Male	Female	Total
Burkina Faso	634.32	46.7	33.1	28.7
Ghana	1604.91	88.3	83.2	71.5
Kenya	942.54	83.2	81.6	72.2
Mozambique	565.15	79.8	56.5	50.6
South Africa	7507.68	98.4	99.2	93
Sub-Saharan Africa	1435.13	75.6	63.7	59.1

*Data refer to the most recent year available during the period specified in the column heading

Sources: http://www.childinfo.org/country_list.php
http://data.worldbank.org/indicator

Table 3: Characteristics of members of the analytical sample by HDSS Centre

	Total: 1 Jan 2009/2010*	**Mean Age (Years)**	**Sex**		**Education**				**Total: 1 Jan 2012**	**Mean Age (Years)**	**Sex**		**Education**			
HDSS Centre			Male (%)	Female (%)	None (%)	Some Primary (%)	Some Secondary (%)	Missing (%)			Male (%)	Female (%)	None (%)	Some Primary (%)	Some Secondary (%)	Missing (%)
Burkina Faso																
Nanoro HDSS *	54836	22.7	23965 (43.7)	30871 (56.3)	40541 (73.9)	10146 (18.5)	2132 (3.7)	2017 (3.7)	56787	22.9	24412 (43.0)	32375 (57.0)	42322 (75.0)	9887 (17.4)	1870 (3.3)	2708 (4.8)
Nouna HDSS	81704	21.8	40808 (50.0)	40896 (50.0)	51500 (63.0)	17807 (21.8)	5037 (6.2)	7360 (9.0)	90341	21.9	45057 (49.9)	45284 (50.1)	62698 (69.4)	17328 (19.2)	5443 (6.0)	4872 (5.4)
Ouagadougou HDSS *	76250	22.1	38202 (50.1)	38048 (49.9)	36173 (47.4)	21804 (28.6)	14364 (18.8)	3909 (5.1)	79468	22.6	39744 (50.0)	39724 (50.0)	35758 (45.0)	24320 (30.6)	16882 (21.2)	2508 (3.2)
Kenya																
Nairobi HDSS	60129	24.1	33600 (55.9)	26529 (44.1)	6805 (11.3)	29536 (49.1)	14380 (23.9)	9408 (15.7)	67790	24.2	37728 (55.7)	30062 (44.4)	5572 (8.22)	31657 (46.7)	16465 (24.3)	14096 (20.8)

Figure 1: Male out-migration: all centres

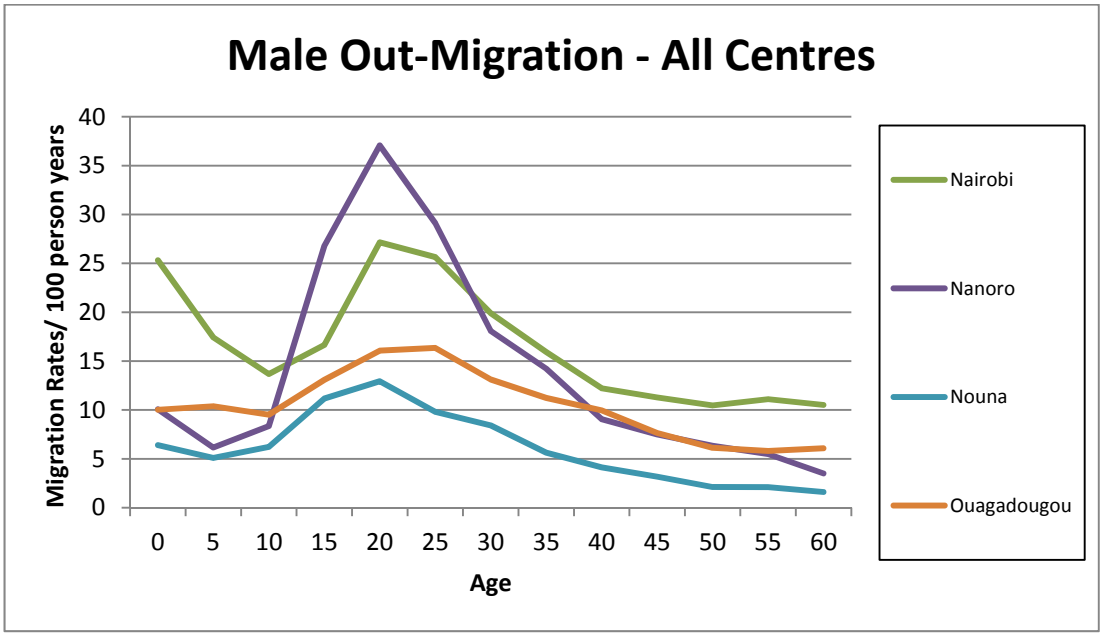

Figure 2: Female out-migration: all centres

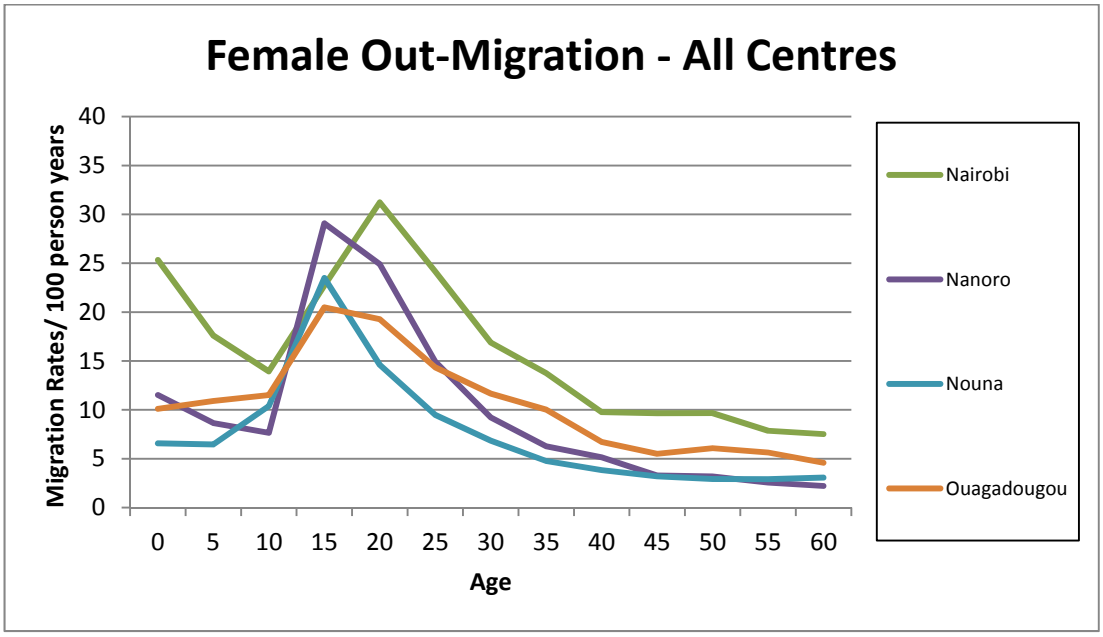

Figure 3: Male in-migration: all centres

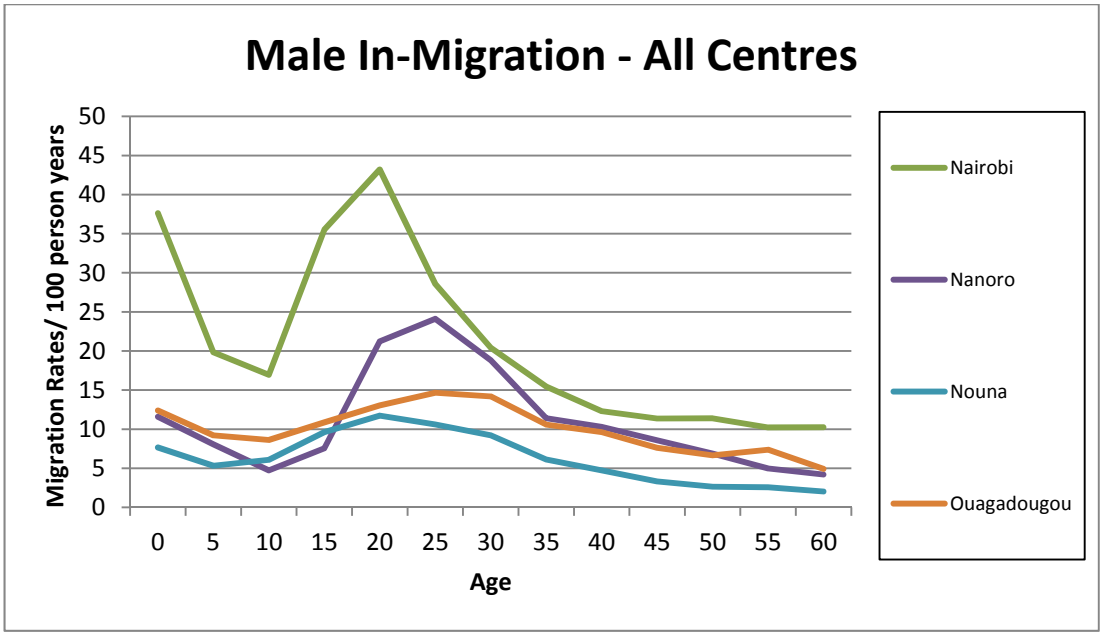

Figure 4: Female in-migration: all centres

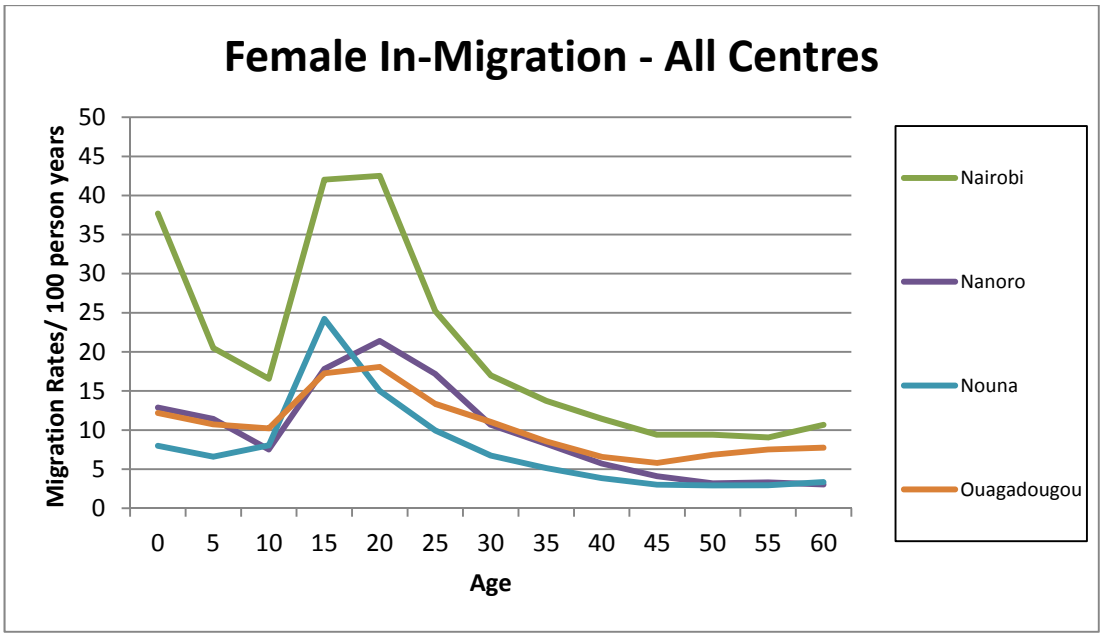

Table 5: Cox proportional hazards models for 15 years and older: In- and out-migration by sex and site

	Nairobi HDSS Kenya				Ouagadougou HDSS Burkina Faso			
	Male		Female		Male		Female	
	In-Migration	Out-Migration	In-Migration	Out-Migration	In-Migration	Out-Migration	In-Migration	Out-Migration
Calendar Year: 2009	1	1	1	1	~	~	~	~
	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)	~	~	~	~
Calendar Year: 2010	0.93***	1.07***	0.91***	1.09***	1	1	1	1
	(0.90 - 0.97)	(1.03 - 1.11)	(0.88 - 0.95)	(1.04 - 1.14)	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)
Calendar Year: 2011	0.89***	1.13***	0.91***	1.16***	0.98	1.11***	0.92***	1.15***
	(0.86 - 0.93)	(1.09 - 1.18)	(0.88 - 0.95)	(1.11 - 1.22)	(0.92 - 1.04)	(1.05 - 1.18)	(0.87 - 0.97)	(1.08 - 1.21)
Education: Some Primary	3.80***	2.39***	5.11***	2.99***	0.79***	0.72***	0.83***	0.93**
	(2.95 - 4.89)	(1.92 - 2.98)	(3.98 - 6.56)	(2.43 - 3.67)	(0.73 - 0.86)	(0.67 - 0.78)	(0.77 - 0.89)	(0.86 - 1.00)
Education: Some Secondary	4.62***	2.55***	6.32***	3.21***	0.78***	0.70***	0.67***	0.78***
(Ref: No Formal Education)	(3.59 - 5.95)	(2.05 - 3.18)	(4.92 - 8.12)	(2.60 - 3.96)	(0.73 - 0.84)	(0.65 - 0.75)	(0.63 - 0.72)	(0.73 - 0.84)
Observations	444774	444817	326396	326406	57328	57332	55301	55305
Wald Chi-square	406.1	140.7	499.9	221.1	51.38	107.8	131.7	65.25
Log Likelihood	-148117	-117283	-114856	-90235	-30449	-28960	-33760	-33396
Subjects	41407	41411	30634	30634	27088	27089	26790	26793
Time at risk	77375	77385	55060	55065	43670	43681	42324	42335
Failures	19194	15183	15109	11878	4315	4097	4706	4632

CI in parentheses

*** p<0.01, ** p<0.05, *p<0.1

Table 5 Cont.: Cox proportional hazards models for 15 years and older: In- and out-migration by sex and site

	Nanoro HDSS Burkina Faso				Nouna HDSS Burkina Faso			
	Male		Female		Male		Female	
	In-Migration	Out-Migration	In-Migration	Out-Migration	In-Migration	Out-Migration	In-Migration	Out-Migration
Calendar Year: 2009	~	~	~	~	1	1	1	1
	~	~	~	~	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)
Calendar Year: 2010	1	1	1	1	1.27***	1.23***	1.17***	1.24***
	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)	(1.00 - 1.00)	(1.19 - 1.36)	(1.14 - 1.32)	(1.10 - 1.25)	(1.16 - 1.33)
Calendar Year: 2011	1.95***	1.14***	2.01***	0.87***	1.08**	1.27***	1.14***	1.31***
	(1.76 - 2.16)	(1.06 - 1.23)	(1.86 - 2.17)	(0.82 - 0.93)	(1.01 - 1.16)	(1.18 - 1.37)	(1.07 - 1.21)	(1.23 - 1.39)
Education: Some Primary	0.70***	0.81***	0.86**	0.93	0.50***	0.88***	0.67***	1.23***
	(0.60 - 0.81)	(0.73 - 0.89)	(0.75 - 0.98)	(0.84 - 1.04)	(0.46 - 0.54)	(0.82 - 0.95)	(0.62 - 0.72)	(1.15 - 1.32)
Education: Some Secondary	1.18***	0.98	1.56***	1.33***	1.46***	1.95***	0.94*	1.33***
(Ref: No Formal Education)	(1.04 - 1.34)	(0.89 - 1.08)	(1.38 - 1.77)	(1.19 - 1.48)	(1.36 - 1.56)	(1.82 - 2.09)	(0.87 - 1.01)	(1.23 - 1.43)
Observations	21812	21818	41706	41709	75565	75569	73258	73270
Wald Chi-square	210.9	31.4	372.9	46.07	589.5	458.7	147.4	147.8
Log Likelihood	-9699	-18454	-18581	-23796	-37741	-35305	-49977	-44520
Subjects	11189	11190	18977	18978	26921	26923	28030	28034
Time at risk	16446	16463	29948	29966	60798	60829	60704	60742
Failures	1675	2990	2836	3553	5092	4724	6676	5945

CI in parentheses

*** p<0.01, ** p<0.05, *p<0.1

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