Introduction
Sub-Saharan Africa (SSA) is the world’s fastest urbanizing region (UN-Habitat 2010). Research from the past 50 years shows that SSA’s urban residents have enjoyed a child survival advantage over rural areas. However, there is some evidence that rapid rates of urbanization in SSA have contributed to worsening health outcomes for urban children and a decline or reversal of the urban under-5 mortality advantage (Gould 1998; Fotso 2007; Bocquier et al. 2011).

This paper assesses whether the urban health advantage in SSA has decreased during the past two decades of rapid urbanization. By using data from a group of countries at two comparable time points, this is the first study to measure changes in the rural-urban child mortality differential at the regional level over a standardized time period of time. Moreover, no research since the mid-1990s has examined variation in the differential across city size. Given that SSA has the world’s highest rates of urbanization and under-5 mortality, understanding patterns of under-5 mortality by residence is critical to informing decisions on how best to allocate resources for addressing high child mortality rates in the region.

Background
Historical data from Europe and the U.S. shows evidence of an urban penalty with mortality rates substantially higher in cities than rural areas, particularly for infants and children (Preston and Haines 1991). Conversely, African cities in the 19th and 20th centuries generally experienced an urban mortality advantage; in the mid-20th century, data shows child mortality rates were lower in urban areas than rural in Zambia (Moore 2009), Senegal (Antoine and Mbojdi 1991) and Sierra Leone (Kandeh 1989). However, extremely high rates of urbanization and urban growth in SSA may be eroding the urban health advantage; evidence from the past few decades indicates worsening health outcomes for urban children in SSA (Antai et al. 2010) and suggestions of a decline in the urban under-5 mortality advantage (Gould 1998).

At the regional level, the urban child mortality advantage holds. Urban children in SSA have been shown to have a net under-5 survival advantage over children in rural areas in several multi-country studies, with the rural-urban differential highest in SSA (van de Poel et al. 2007). However, some of these studies (van de Poel et al. 2007; Bocquier et al. 2011) used cross-sectional data and therefore cannot speak to whether there have been recent changes in this advantage. Studies that used data from more than one time point did not use standardized time
periods for cross-country comparisons (Fotso 2007; Gunther and Harttgen 2011), and thus may not accurately reflecting regional trends over the same period.

A handful of time series country-level studies from SSA point to recent declines in the urban child health advantage in Senegal (Antoine and Mbojdi 1991) Mozambique (Macassa et al. 2003) and Kenya (Gould 1989). As these studies are limited to single-country experiences at different times and it is not clear if they represent the overall trend throughout the region.

Worsening urban child health outcomes in SSA are thought to be linked to increases in urban populations and crowding, decreased access to safe water, lower vaccination rates and greater pollution (Faye et al. 2005; Fotso 2007). Individual and community characteristics also play an important role in explaining rural-urban differences in child mortality. Once known correlates of under-5 mortality are included, the advantage decreases or disappears, most notably among the urban poor (van de Poel et al. 2009), suggesting the urban advantage is due primarily to differences in population characteristics between urban and rural areas.

The size of the urban area may also influence the degree of the urban health advantage. Child survival differences have historically been largest in the largest urban areas (Williamson 1982); however, in contemporary SSA it may be smaller cities that are at greatest risks for declines in child health as smaller urban areas are often relatively underserved by government services, particularly those related to health and hygiene (NRC 2003). Therefore, in this analysis I further segment urban areas to investigate whether changes are uniform by city size.

**Data**

This analysis uses data from twelve SSA countries\(^1\) that had a Standard Demographic and Health Survey (DHS) carried out between 1995-2000 and again between 2005-2010. The study population consists of two groups: children born within the five years preceding the survey (N=78,056 in 1995-2000 and N=129,758 in 2005-2010) and their mothers (N=50,430 in 1995-2000 and N=84,440 in 2005-2010). The dependent variable here is survival of the child from birth to age five. All control variables refer to the mother, as the majority of children under the age of five live with their mothers (Bocquier et al. 2011).

The two key variables are child survival and urban/rural residence. Urban and rural areas are defined in the DHS using each country’s definition of what constitutes rural or urban residence. Control variables referring to characteristics of the mother are: children ever born

---

\(^1\) Benin, Ghana, Guinea, Kenya, Mali, Niger, Nigeria, Senegal, Tanzania, Uganda, Zambia and Zimbabwe.
Urban Advantage or Urban Penalty?: Under-5 Mortality and Urbanization in Sub-Saharan Africa

(CEB), educational attainment, and household wealth. Women who have moved within the past five years are considered to be recent migrants in this analysis.

Methods
First, I show descriptive statistics for the pooled sample. Next, I estimate Kaplan-Meier survival curves to test whether there are differences in survival to age by residence, to produce survival estimates for the most recent time period (i.e. the past five years). Under-5 mortality rates within urban areas (RGLCs and all other areas classified as urban) are then Last, I use Cox proportional hazards models to model the relationship between survival to age 5 by residence and a set of demographic and socio-economic variables known to impact under-5 mortality.

The analysis is segmented at two levels: 1) stratified by urban and rural residence and 2) stratified within urban areas by: a) rapidly-growing large cities (RGLCs): those that have experienced an average annual growth rate of 2.5% or more for the period 1995-2010 among cities with estimated populations greater than 750,000 and b) all other areas designated as urban in the DHS. The averages of under-5 survival probabilities used here may conceal substantial heterogeneity within populations, but they still provide a useful measurement of the combined effect of geographically specific variations in on survival probabilities for children.

Results
Descriptive Statistics. Just under a third of respondents live in urban areas; of those only a minority (approximately one-third) live in the RGLCs. The most salient difference is wealth, which is concentrated in urban areas and particularly in RGLCs (over 70% of RGLC residents in both time periods are in the highest wealth quintile, with only 1% or fewer in the lowest). Approximately one-quarter to one-third of women in both periods had moved in the past five years (and are considered migrants), with a slightly higher proportion of these women living in urban areas.

Kaplan-Meier Survival Estimates. Results show the urban advantage holds but has narrowed slightly. Under-5 survival probabilities have improved at the aggregate between 1995-2000 and 2005-2010, but greater improvements in rural areas (from .830 to .869) relative to urban areas (.868 to .900) have eroded the urban advantage slightly, decreasing the absolute difference in urban and rural under-5 survival chances by -.006, or -0.6%. The comparison of urban areas
shows an increase in the survival estimates of RGLCs (.878 to .916) over other urban areas (.864 to .896) by the same amount but in the opposite direction, at .006. While these changes are small, they are both significant at the .05 level for the log-rank test of equality. There is some, but not much, country-level variation in increases in under-5 survival rates and changes in the urban advantage.

*Cox Proportional Hazards Models.* When all covariates are included, the under-5 survival differential is statistically significant (p<.001) only in the 2005-2010 period (.910 for urban compared to rural areas). This emergence of significance in the urban child survival advantage in 2005-2010 suggests that geographic-specific factors are increasingly influential on average under-5 survival differentials not found in the previous periods. For the intra-urban comparison, differences in survival hazards are not statistically significant in the full model in either period.

Adjusting for demographic and socio-economic covariates strengthened the association between the migration and under-5 mortality risks in all the models. There is an increase in the magnitude of the migration coefficient in the rural-urban model between the two periods (from 1.164 to 1.313, p<.001), implying that migration poses an increasing hazard of dying before five.

As expected, higher levels of education are associated with significantly lower hazards of under-5 mortality. Household wealth is not significantly associated with under-5 survival rates in all but one case (the richest quintile), which is surprising given the extensive literature linking household wealth to increased child survival chances.

**Discussion**

The long-held urban child survival advantage over rural areas in SSA remains but has decreased slightly. Despite unprecedented population growth, the combined effect of urban living in SSA still offers children better chances, on average, of surviving to age five. Controlling for socio-demographic indicators attenuates but does not erase this advantage. The overall decrease in the urban advantage is the result of slower improvements in survival rates in smaller cities, suggesting that in contemporary SSA, unlike the early experiences of Europe and America, better under-5 survival chances in the largest cities play a key role in the persistence of this urban advantage. These findings support the growing literature which finds that rapid urbanization and population growth in SSA poses the greatest risk to improvements in child survival in the smaller cities – which are likely to see the greatest proportional population growth in coming decades.