The Rise and Prominence of Skip-Generation Households in Lower- and Middle-Income Countries

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Investigations into changes in household formations across lower- and middle-income countries (LMICs) rarely consider skip-generation households. Yet, demographic, social, and economic forces increasingly encourage skip-generation household formations. We examine trends *and* changes in the prevalence *of skip-generation households from 1990 to 2016, examining households, adults aged 60+, and children under 15, across 49 countries using household roster data from Demographic and Health Surveys. Analysis takes place in stages, first describing trends in skip-generation households across countries and next providing explanatory analyses using multilevel modeling to assess whether, and the degree to which, country-level characteristics like AIDS mortality and female labor force participation explain trends in the probability that a household is, or that an individual resides in, a skip-generation household. Results indicate extensive increases in skip-generation households in many LMICs, although there is also variation. The increases and variations are not well-explained by the country-level characteristics in our models, suggesting other underlying reasons for the rise and prominence of skip-generation households across LMICs.*

Study aims

Monitoring past- and forecasting future trends in household structure across lower- and middle-income countries (LMICs) is of relevance for those who may require various forms of support frequently provided by co-resident household members. Therefore, it is consequential that recent observations of household formations in LMICs at times allude to the possibility

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that the skip-generation household, a living arrangement not traditionally considered as a dominant configuration, may be on the rise. The current study explores whether skip-generation households are indeed on the rise across LMICs. It does so by examining national-level trends in prevalence of skip-generation households and in the probability that a child under 15 or adult aged 60+ is living in a skip-generation household. The type of skip-generation household we consider is one where one or more grandparent(s) co-reside(s) with one or more grandchild under 15, with both parents of the grandchild absent, and no other household member present.

Studies that refer to a possible increase in skip generation households in LMICs span literatures. One area of concern is implications of such arrangements for the health of older adults and their economic security (Bengtson and Lowenstein 2003; Gassmann et al. 2012; Hayslip and Kaminski 2005; Knodel et al. 2010; Knodel and Nguyen 2015; Knodel and Pothisiri 2015; Maradik Harris and Kim 2014; Zimmer 2009; Zimmer and Dayton 2005; Minkler and Fuller-Thomson 1999; Minkler 1999). Another area of concern focuses on younger generations and the tendency of children to be "left behind" when parents migrate, or to be orphaned as a result of parental mortality; events that may have consequences for childhood development, particularly related to health or educational achievement (Gaydosh 2015, Cheianu-Andrei et al. 2011, De La Garza 2010, Gao et al. 2010, Jampaklay 2006, Madhavan and Schatz 2007, Madhavan 2004, Ingersoll-Dayton et al. 2018, Jingzhong and Lu 2011, Mokomane 2013, Zhang et al. 2018, Zhou et al. 2015). Few studies look at the older and younger generations simultaneously (an exception is Chen, Liu, and Mair 2011). Moreover, few directly measure the proportion of households that are skip-generation, and the small number that do largely focus on the consequences of AIDS mortality (Ciganda, Gagnon, and Tenkorang 2012, Hosegood 2009, Richter and Desmond 2008, Richter et al. 2009). Although a number of recent studies make important contributions toward identifying trends in household composition, none of these explicitly examine global trends in skip-generation households (Pesando et al. 2018, Ruggles and Heggeness 2008, Esteve et al. 2020, Reher and Requena 2018, Dasré, Samuel, and Hertrich 2019). Comparative studies of skip-generation households are virtually nonexistent and, to our knowledge, there are no systematic studies either confirming whether increasing trends in skip-generation households are occurring or evaluating the magnitude of change in prevalence of skip-generation households across countries.

The current study addresses these gaps while aiming to bring together the two literatures: on children and older persons. It does so using data from household components of nationally representative Demographic and Health Surveys (DHS) from 49 countries. We report on trends in the probability of living in skip-generation households between 1990 and 2016

and assess whether an increase or decrease has occurred, whether it is consistent across countries, and whether such changes are a function of individual- and country-level factors reflecting social, economic, and demographic dynamics.

Theoretical background

A rise in skip-generation households would conflict with a number of traditional and longstanding viewpoints in demography and sociology that often focus on the probability that households become nuclearized in response to the social changes that typically accompany development in LMICs (Burch and Matthews 1987, Burch 1995, Bongaarts and Zimmer 2002, Aykan and Wolf 2000, Martin 1989). These changes are predicted to include a movement toward lower fertility and smaller family sizes, economic growth and urbanization that comes with industrialization, and the transformation in family values that are concomitant to these changes (Freedman, Takeshita, and Sun 1964, Goode 1963, Kirk 1996, Glaser et al. 2006, Murphy 2011, Bongaarts and Casterline 2013, Montgomery 2008, Ram 2012). However, those who have taken a closer look at what is occurring to household structures across LMICs often conclude that the reality is more complex and nuclearization and a decline in intergenerational coresidence is not inevitable (Ruggles and Heggeness 2008, Lloyd and Desai 1992, Frankenberg, Chan, and Ofstedal 2002, Kennedy and Ruggles 2014, Pesando et al. 2018, Bongaarts 2001). For instance, studies of children's living arrangements point to a diverse set of possible formations progressively influenced by demographic and social forces that are rarely addressed by traditional theories like Demographic Transition. These include AIDS mortality, migration, and child fostering (Gaydosh 2015, Nobles 2013). Similarly, studies of older persons point to traditional values associated with filial piety and respect for the older generation which can be resistant to change, resulting in gradual and inconsistent moves away from intergenerational co-residence (Zimmer and Kwong 2003, Ruggles and Heggeness 2008).

There are indeed forces existing within today's demographic context that might compel an increase in nonnuclearized living arrangements. One is the emergence of the "translocal" experience, whereby individuals migrate while remaining economically and emotionally connected to their household of origin (Datta 2016, Caces et al. 1985). Translocality brings into question traditional notions about the function of household composition; a family may work together economically while living apart, "do[ing] family across distance" (Baldassar and Merla 2013). In such a scenario, individual living arrangements within the family may not be indicative of the social, financial, and emotional bonds that characterize the workings of the family. The skip-generation household is an arrangement

encouraged by translocality. Young adult family members seek labor opportunities in cities or other countries to improve the family's overall economic status and benefit all family members, including older and younger generations (Nguyen, Yeoh, and Toyota 2006). Their children remain in the household of origin in the care of grandparents, with parents providing financial support for the left-behind household via remittances, creating a household that is skip-generation, yet operates as multigenerational as parents provide financial and emotional support for both generations left behind.

The translocal experience associates with other factors that encourage the formation of skip-generation households. First, there are changes related to fertility and mortality. In some settings, the emergence of skip-generation households is a function of increased mortality of the middle generation as a result of AIDS deaths (Knodel and Chayovan 2012, Zimmer and Dayton 2005). When parents die, their children often end up living with grandparents, who take up the responsibility for the upbringing and caretaking of the child (Merli and Palloni 2001, Kespichayawattana and VanLandingham 2002, Ssengonzi 2009). Second, reductions in infant and old-age mortality influence dependency ratios, which make available a larger number of younger and older members of society, resulting in greater opportunity for living with each other. Third, while it is common to assume that economic development is associated with nuclearization, some factors that accompany economic growth facilitate the formation of skip-generation households. For instance, increasing female labor force participation (FLFP) rates can encourage migration of both parents, not just fathers, obliging the older generation to act as child caregivers (Asis et al. 1995, Cortes 2015).

It is also noteworthy that given the ratio of older persons to children in most LMICs, which is a small number, a change in the likelihood of skip-generation households will affect probabilities of older and younger generations differently, justifying a study that considers both generations simultaneously. For instance, take a family with multiple children. If one child co-resides with a surviving grandparent, this means a fraction of the children in that family are in a skip-generation household in comparison to 100 percent of grandparents. Thus, if increases in skip-generation households are occurring broadly, proportional increases may result in more rapid change for the older versus the younger generation.

Data characteristics and definitions

The DHS, which provides the data for this study, is a multiple purpose global data collection program funded by the United States Agency for International Development (USAID), providing a wide range of information on households and individuals around the world. These repeated

cross-sectional data collection efforts are meant to offer statistics for monitoring and evaluating population and health indicators for developing countries. The current study uses the household roster component of the DHS, which lists all household members, their age, sex and relationship to the household head (ICF International 2012). For children under age 15, there is often information on the whereabouts of their biological parents; whether they are living in the same household, living elsewhere, or are deceased. Using the household sample weights, this information becomes generalizable to the country observed. For all statistical procedures, we account for the DHS survey design and/or apply DHS sampling weights as appropriate according to the most up-to-date recommendations provided in recent DHS publications (Croft et al. 2018).

The DHS website (The DHS Program 2019) has data for 91 independent countries. Dating from the late 1980s to present, these data have been collected in seven "phases." Some countries have participated in one phase; others in multiple phases. For instance, data are available from Tanzania during DHS phases 2 through 7, while data for Myanmar are only available for phase 7. During any DHS phase, there may be multiple data collection "rounds" for any one country, with each round representing a distinct data collection effort. Any of these data collection rounds may take place across two observation years. For instance, a survey that began late in one year and ended in early in the next year will contain data across two observation years, whereas a survey that began in one year and ended before the end of the same year involves one observation year.

We use household roster information to create three analytical datasets, one of which consists of households, one of which contains the data for children under age 15 from these households, and a third for adults aged 60+ living in these households. Characteristics of these datasets are presented in Table 1. For the current study, we selected countries for inclusion using criteria that are based upon timing and available information: data were collected during at least two survey rounds between the years 1990 and 2016 (with the possibility of a 2016 round spanning to 2017); at least five years passed between the earliest to the most recent survey round; the most recent survey round began during or after 2004; each survey round contains data on whether the biological mother and father of children under 15 were alive and/or living in the household at time of the survey. As noted in Table 1, there are 49 countries that meet these criteria. Across these countries, data were collected in 167 survey rounds spanning 243 observation years. This means that the average number of observation years per country is five, however, any one country might be observed across as few as two years (e.g., Gabon 2000, 2012), with the greatest number being 12 in Peru, where DHS conducted surveys across a series of continuous years. The Supporting Information includes a table that lists countries in this study, number of years observed, and observation years.

TABLE 1 Data characteristics

		Dataset		
		All households	Children under 15	Adults aged 60+
Number of countries	49			
Observation years	243			
Average number of observation years per country	5			
Earliest observation year for any country	1990			
Latest observation year for any country	2017			
Average years between first to last observation	16			
Observations in the total pooled sample		2,976,793	5,421,038	1,083,681
Observations in the analytical subsample[a]		147,000	147,000	147,000
Proportion skip-generation households pooled sample		0.0190	0.0186	0.0488
Proportion in skip-generation households analytical subsample[a]		0.0247	0.0211	0.0775

[a]Used for the multilevel modeling and made available on the lead author's institutional website at: https://globalagingandcommunity.com/publications/

Data pooled across the 49 countries, 167 survey rounds, and 243 observation years contain 2,976,793 households. A pooled dataset of children under 15 from these households contains 5,421,038 individual observations. A pooled dataset of adults aged 60 and older from these households contains 1,083,681 individual observations. We restrict our analyses to de jure household members.

We measure a skip-generation household as follows: in the household dataset, it is a household that includes one or more child under 15 living with one or more grandparent of any age, with nobody else in the household. For the dataset containing children under 15, a child is considered to reside in a skip-generation household if s/he lives with one or more grandparent of any age with nobody else in the household except other grandchildren under 15. For those 60 and older, it is living with one or more grandchild under 15 without other household members except for a spouse. While in the household dataset and the child dataset the grandparent can be any age, the child is always restricted to being under 15. Although it is the case that there are additional skip-generation households containing adult grandchildren (aged 15+) living with grandparents, due to the nature of the DHS household survey it is not possible to reliably categorize the living situation of the parents of these adult children. Therefore, the term skip-generation for our study denotes a grandchild under 15 living with a grandparent, with parents of the grandchild not present, and no other adult household member present. Notably, given the cross-sectional nature of the data, we do not know the length of time that each household has

been classified as, or length of time that each individual has been living in, a skip-generation configuration.

Note that we conducted supplementary analyses with broader definitions of skip-generation; in particular, situations whereby parents of children under 15 were absent but other relatives or co-residents were present. If defined in this more generous way, a much larger proportion would be classified as skip-generation households (about 6 percent of all households, about 9 percent of children under 15, and about 13 percent of adults 60 and older).

Analytical strategy

The analysis examines the extent to which the proportion of all households, children under age 15 or adults aged 60+ are classified as being or as living in skip-generation households, varies across countries and time. The analyses include both descriptive and explanatory stages. First we examine the proportion skip-generation in the earliest available versus the most recent *round* of the DHS separately for each one of the 49 countries. The number of years that passed between the earliest and more recent rounds differs for each country and therefore this analysis only provides an overview of direction of the trend. Next we adjust for the different number of years that passed between surveys by pooling data for each country across rounds and introducing a *time* variable that depends on the year in which the observation occurred. The specific coding for time counts the midpoint of the total observation period as year zero and then codes a particular observation year according to number of years prior to or since the midpoint. The earliest observation in our data was taken in 1990 and the latest in 2017, so the midpoint is 2003.5. Therefore, an observation in 2003 is 0.5 years before the midpoint, and is coded as –0.5. Similarly, an observation taken in 2004 is 0.5 years after the midpoint and is therefore coded as +0.5. Other years are coded similarly as number of years before or after 2003.5. This time variable is then used in logistic regressions with the coefficient for time interpreted as the effect of each year on the log-odds of skip-generation. If the time coefficient is positive and significant, it indicates a statistically relevant annual increase in skip-generation households in that country. For all regressions in this study, a quadratic term for time was tested; however, in no case was it significant, indicating that the influence of time is linear.

We then move into a more explanatory stage by pooling data across all countries, adding variables to the pooled data, and employing multilevel logistic regressions with individual- and country-level predictors. This pooling results in a massive dataset with observations numbering in the millions. Running multilevel models on such large datasets results in two challenges. The first is computation time. Statistical software currently available cannot easily handle datasets of this size for multilevel models.

Second, even when the computational power to handle these datasets exists, any coefficient will be statistically significant even if effect size is small. To address these challenges, we adopt a strategy of randomly selecting *analytical samples* consisting of 3,000 observations per country for each dataset, resulting in three datasets with $N = 147{,}000$, and running multilevel models on the subsets. This number of cases was selected for several reasons, chief among them being statistical power. With this number of observations, a trend equaling a 1 percent average annual change in the odds of skip-generation is statistically significant, but much smaller changes are not. A second reason for this sample size is reliability. We conducted multiple runs using both larger and smaller sample sizes and found that this number produces stable estimates such that just about any random subset of the data of 3,000 cases per country results in similar findings as reported below. (For replication purposes, we made the analytical subsamples available for download in an excel file on the lead author's institutional website. This file can be obtained by following this address: https://globalagingandcommunity.com/publications/.) As noted in Table 1, the proportion of households classified as skip-generation in the analytical subsample is 0.0247 (or 2.47 percent), the proportion of children under 15 living in skip-generation households across this sample is 0.0211 (or 2.11 percent), and for adults 60 and older it is 0.0775 (or 7.75 percent). As the analytical sample contains an equal number of observations per country, these percentages can be interpreted as a cross-country average. These percentages differ from what is observed in the full pooled sample because number of observations per country differs across samples. We use Stata version 15.1 for analysis.

The multilevel models include random intercepts for countries and random slopes for time. The country-level random intercepts account for variation in the idiosyncratic tendency of the formation of skip-generation household across countries. The random slope accounts for variation in the idiosyncratic influence of the passage of time or the variation in the timing of secular trends across countries. Statistically significant random effects indicate that the proportion or probability of skip-generation household, and the effect of time on that proportion, varies across countries.

Models adjust the effect of time for age, sex, and rural/urban residence. In the household dataset, age is age of household head and sex is sex of household head. In the child or adult dataset, it is age and sex of the child or adult in question. Age is mean centered. Sex is coded as 1 for male; residence is coded as 1 for rural; then both sex and residence are mean centered.

To assess how the concentration of key macrofactors influences the changing probability of living in a skip-generation household, we include a series of country-level indicators. Data for these come from a variety of statistical databases, all of which are downloaded from publicly available websites such as those maintained by the United Nations and the World

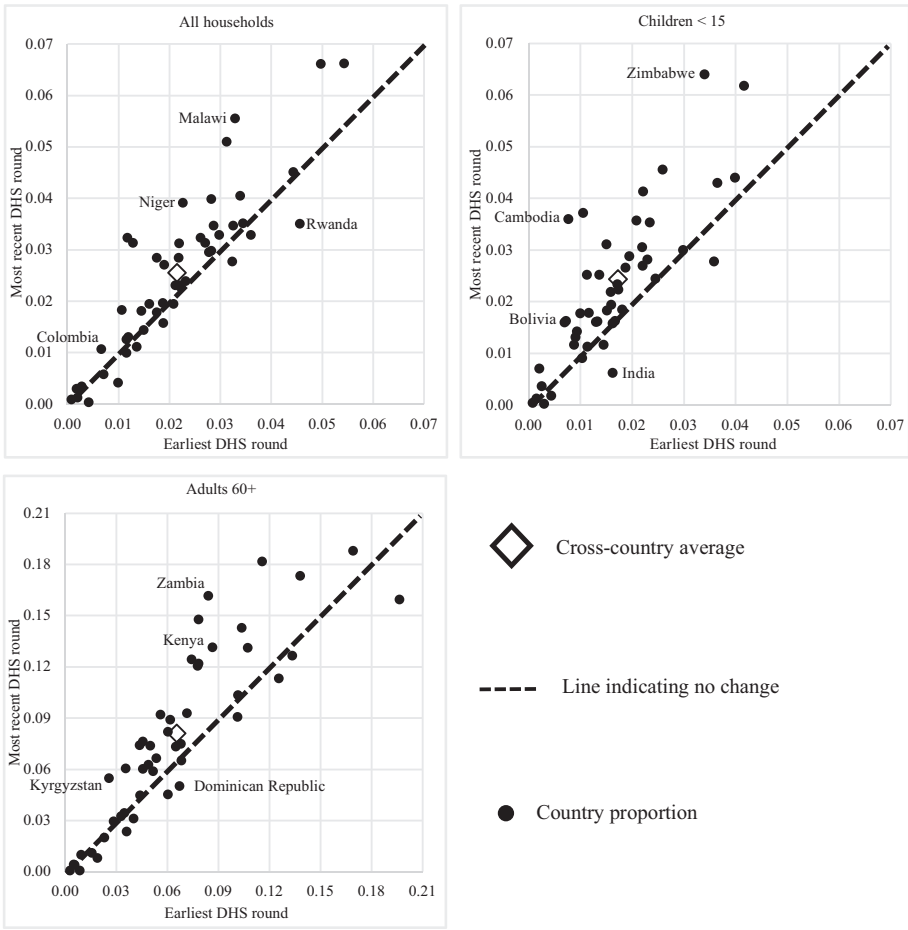
Bank (UNAIDS 2017, United Nations 2018, World Bank 2018, Migration Policy Institute 2018, CIA 2016, International Labour Organization 2018). We considered a number of possible country-level variables, and found many of interest were too highly correlated with each other to be simultaneously considered in a single model, meaning a number of the country-level variables of interest represent similar constructs. For instance, if we include gross national income per capita (GNI) as a measure of economic development we cannot also include percent urban, total fertility rate (TFR), or the Human Development Index (HDI), all variables we considered, since GNI correlates very highly with these other desirable indicators. After testing many combinations of these types of predictors, we found a model that includes six country-level variables is most efficacious for representing four constructs which, based on the theoretical discussion above, we are interested in controlling for in our models. The constructs are *mortality*, *economic development*, *migration*, and *age structure*. The variables we use to represent these constructs are as follows: for mortality, crude AIDS death rate (CADR) aged 15 to 59 and crude non-AIDS death rate (CDR) aged 15 to 59; for economic development, Female Labor Force Participation (FLFP) rate and GNI per capita (GNI); for migration, international migration rate (MIG); for age structure, total dependency ratio (DEP). Average values by year are provided in the Supporting Information, and these indicate that over the course of the study period there was dramatic change in these measures.

So coefficients for country-level variables are both meaningful and comparable, these measures are normalized such that each has a mean of 0 and standard deviation of 1. Because age, sex, and residence are mean-centered, the intercept for any equation can be interpreted as the log of the odds of being skip-generation at the middle of the observation period (year 2003.5), for an average person living in a country, or a household, at a time where country-level variables are equal to the dataset average.

Country-specific trends in skip-generation households

Figure 1 shows the proportion of households classified as, and proportion of children under 15 and adults 60 and older who live in, skip-generation households in 49 countries at the time of the earliest and most recent DHS round in our data. A dashed line is drawn such that points above the line indicate countries where the proportion increased over time, and points below the line indicate a decreasing trend. The preponderance of the change in all three cases is an increase in the proportion skip-generation, with the net change being extremely large in some instances. Specific values for all data points are provided in Supporting Information along with an indicator of whether the change is statistically significant. For each graph we show the names of four specific countries for

FIGURE 1 The proportion of households that are, and persons under 15 or 60 and older who live in, skip-generation households, across 49 countries, comparing the earliest and most recent DHS round, and showing cross-country average



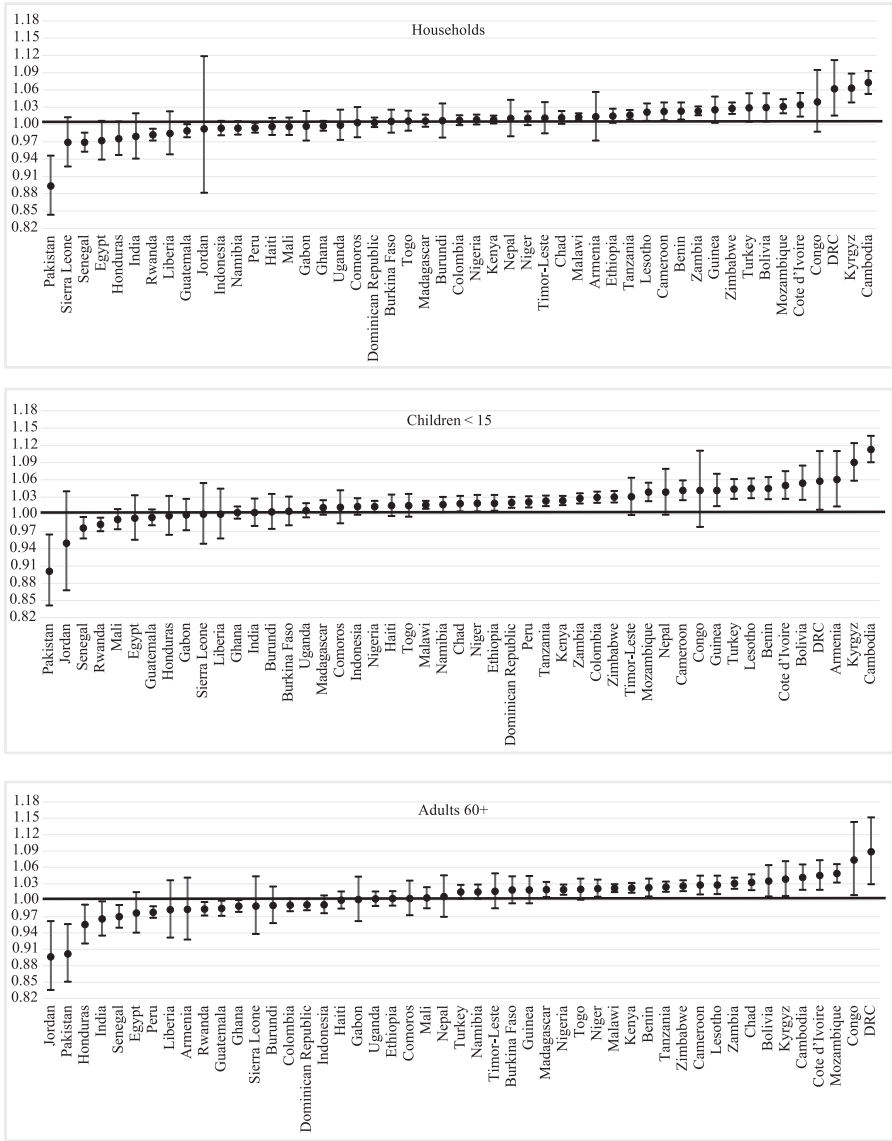
heuristic purposes. For households, the proportion that are skip generation increased from 0.050 to 0.066 in Malawi from earliest to most recent DHS round; from 0.034 to 0.041 in Niger; and from 0.007 to 0.011 in Colombia. The proportion dropped from 0.046 to 0.035 in Rwanda. The proportion of children under 15 living in a skip-generation household rose in Zimbabwe from 0.034 to 0.064; in Cambodia from 0.008 to 0.036; and in Bolivia from 0.012 to 0.025. The proportion in India dropped from 0.016 to 0.006. Finally, when it comes to those aged 60+, we observe an increase from 0.084 to 0.160 in Zambia; from 0.104 to 0.143 in Kenya and from 0.035 to 0.061 in Kyrgyzstan. We observe a decline from 0.067 to 0.050 in Dominican Republic.

These examples, as well as the placement of the other points on these graphs, highlight that the prevalence increased quite substantially in many countries, but there is also variation. It also indicates that increases occurred across countries in various regions of the world. The cross-country averages (sum of the 49 proportions divided by 49) are indicated as a larger diamond-shaped point. For each graph, these averages are clearly above the dashed line, indicating that the average trend was an increase in the prevalence of skip-generation households.

In Figure 2, we present the trends adjusted for the length of time between DHS survey years. Here, we show how each year of time associates with the odds of a household being, or an individual residing in, a skip-generation household. Confidence intervals are plotted with point estimates and countries are labeled. The graphs are organized such that the countries are ordered from the lowest odds on the left-hand side to the highest odds on the right-hand side. So, looking, for example, at the first graph, Pakistan experienced the greatest decline, with each year resulting in a relatively large decline in the odds that a household is classified as skip-generation. On the other end, each year results in a relatively large increase in the odds of a household being skip-generation in Cambodia. Looking across the three graphs, although there is variation, the point estimates are above the 1.00 odds line for the majority of the countries. Countries that experienced substantial increases in the odds of skip-generation across all three indicators (households, children under 15, adults 60+) include Bolivia, Cambodia, DRC, Kyrgyzstan, Lesotho, Mozambique, Tanzania, Togo, Turkey, Zambia, Zimbabwe, among others. Only Pakistan and Senegal experienced substantial declines across all three.

Table 2 provides a summary of the descriptive analysis. The cross-country average proportion in skip-generation households increased from 0.0215 to 0.0256 for households; from 0.0173 to 0.0243 for children under 15; and from 0.0541 to 0.0669 for adults 60 and older from earliest to most recent DHS round. The average effect of one year on the odds of residing in a skip-generation household is 1.007 for households; 1.019 for children; and 1.006 for adults 60 and older. The most revealing result is found in the number of countries that experienced a significant increase in effect of time on the odds of skip-generation versus the number that experienced a significant decrease. Seventeen countries experienced a significant increase in the odds of a household being skip-generation; 24 experienced a significant increase in the odds of children living in skip-generation households; and 20 experienced a significant increase in the odds of adults 60 and older living in skip-generation households. In contrast, the number experiencing a significant decrease is 3, 3, and 8, respectively. Thus, an increasing trend in skip-generation households is relatively common while a decreasing trend is much less so.

FIGURE 2 The association of one year of time on the odds that households are, and persons under 15 or 60 and older who live in, skip-generation households, showing effects country-by-country, with point estimates and 95% confidence intervals



Can the trends in skip-generation households be explained by country-level factors?

Table 3 provides results of multilevel regression equations that introduce individual unit- and country-level covariates, the latter of which adjust for mortality, economic development, migration, and age structure indicators. For each dataset, three models are presented. The first examines

TABLE 2 Summarizing changes in skip-generation households across 49 countries

	Dataset		
	All households	Children under 15	Adults aged 60+
Cross-country average proportion in the earliest DHS wave[a]	0.0215	0.0173	0.0541
Cross-country average proportion in most recent DHS wave[a]	0.0256	0.0243	0.0669
Average effect of one year on odds[b]	1.007	1.019	1.006
Number of countries where time associates with a statistically significant increase in the odds of skip-generation[c]	17	24	20
Number countries where time associates with a statistically significant decrease in the odds of skip-generation[c]	3	3	8
Number countries where one year associates with no significant change[c]	29	22	21

[a] Calculating by summing the proportions across countries and dividing by 49.
[b] Calculating by summing the odds across countries and dividing by 49.
[c] At $p < 0.05$.

the unadjusted average effect of time across countries. The second include unit-level covariates age, sex, and rural versus urban residence. The third adds country-level covariates. Results are shown as log-odds. Random effects for the intercept and the association of time and odds of skip-generation are added to account for variation across countries.

The effect of time, measured as single years, is significant and consistent across all nine models, confirming that on average, across these countries, there have been significant increases in skip-generation households and in the proportion of children under 15 and adults aged 60+ living in skip-generation households. There is also variation, as indicated by significant random effects. The addition of country-level factors in Model 3, while having their own effect on skip-generation households, does little to explain the trend or why the effect of time varies across countries. Coefficients for time in Model 3, across all three datasets, are robust such that regardless of which skip-generation measure is examined, there is about a 2.5 percent annual increase in the odds.

Some of the covariates turn out to be robust predictors of whether an individual is in a skip-generation household. With respect to unit-level measures, for households, older age of household head, household head being male, and being a rural household, relates to higher chances of skip-generation. For children under age 15, being older and living in a rural area increase the odds. For persons 60 and older, women are more likely to be in skip-generation households than men, and skip-generation households are more common in rural areas than urban. The effect of sex for persons 60 and older may imply grandmothers as opposed to grandfathers are the ones most likely to take on a caretaker role. That skip-generation

TABLE 3 Multilevel logistic regressions showing the effect of time on the log-odds of skip-generation household in 49 countries, controlling for unit- and country-level variables

	All households			Households with children under age 15			Households with adults aged 60+		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Time	0.014**	0.013**	0.026**	0.017**	0.019**	0.024**	0.016**	0.016**	0.025**
Unit level									
Age[a]		0.011**	0.011**		0.098**	0.098**		0.003	0.003
Male[b]		–1.436**	–1.435**		–0.060	–0.061		–0.560*	–0.561**
Rural		0.851**	0.838**		0.558**	0.552**		0.476**	0.475**
Country level									
CDR			0.019			–0.011			–0.031
CADR			0.036			0.090#			0.042***
FLFP			0.312**			0.371**			0.423**
GNI			–0.134***			–0.088			–0.104*
MIG			0.065			–0.015			0.002
DEP			0.184**			0.028			0.200**
Intercept	–4.007	–3.718	–3.751	–4.198	–4.310	–4.327	–2.895	–2.941	–2.967
Random components									
Intercept (SE)	0.827**	0.616**	0.259**	0.807**	0.747**	0.397**	1.104**	1.017**	0.379**
Time slope (SE)	0.00038*	0.00030***	0.0037	0.00106*	0.00111*	0.00121*	0.00020*	0.00019*	0.00040**
ICC	0.201	0.158	0.073	0.197	0.185	0.108	0.251	0.236	0.103
LPL	–16,440.2	–15,267.3	–15,247.7	–14,350.1	–14,026.4	–14,013.2	–36,954.6	–36,404.9	–36,384.6

**$p < 0.01$, *$0.01 < p < 0.05$, #$0.05 < p < 0.10$.

[a]For all households, age of household head; for households with children under age 15, age of child; for households with adults aged 60+, age of adult.

[b]For all households, sex of the household head; for households with children under 15, sex of child; for households with adults aged 60+, sex of adult.

CDR, crude death rate (non-AIDS); CADR, crude AIDS death rate; FLFP, female labor force participation; GNI, gross national income per capita; MIG, international net migration rate; DEP, total dependency ratio; LPL, log-psuedo-likelihood; ICC, intraclass correlation.

households are more common in rural areas may be a sign of rural/urban labor-related migration resulting in children left behind with grandparents.

Overall mortality is not significantly associated with the odds of skip-generation, but AIDS-related mortality has some impact on increasing the odds, approaching significance among children under 15 and adults 60 and older. This is undoubtedly the impact of the loss of the middle generation in high-burden HIV/AIDS countries. Higher FLFP rates associates with higher odds of skip-generation, while higher gross national income associates with lower odds. International migration rates are not significant. Higher dependency ratios, meaning a larger population under 15 and 60+ relative to those 15–59, increase the odds of a household being skip-generation and of an adult 60 and older living in a skip-generation situation.

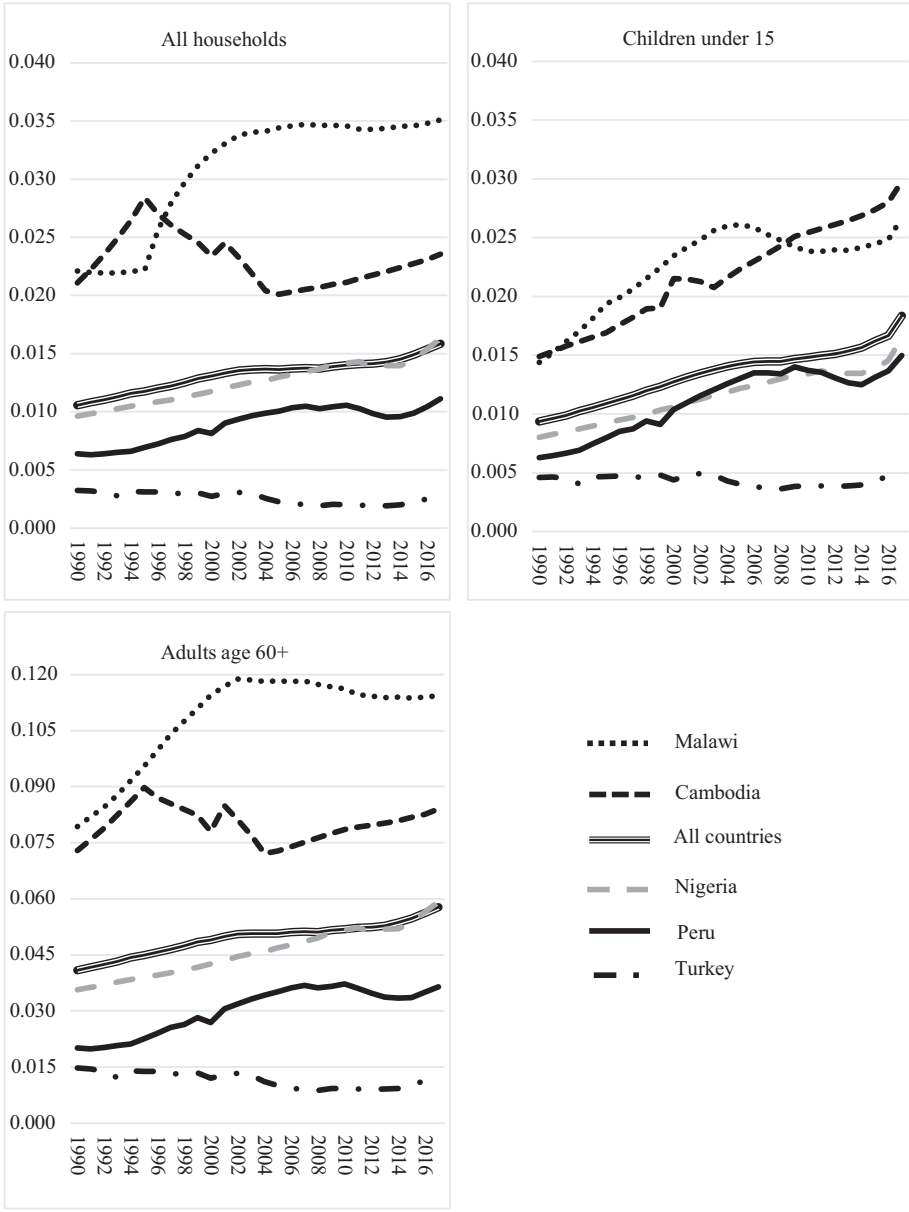
We conducted a series of sensitivity analyses to determine whether results hold in different scenarios. We included different country-level variables, such as percent urban; allowed for a nonlinear time variable; considered broader definitions of skip-generation; and looked at skip-generation separately among female versus male headed households. None of these tests substantially altered the conclusions. It is particularly noteworthy that although there has generally been an increase in the proportion of households that are female-headed across countries, having a female head of household does not alter the effect of time on the change in the odds of skip-generation households. Therefore, while there has been an increase in female-headed skip-generation households relative to male, this is a function of the overall change in proportion of household headed by females.

Predicted probabilities

Predicted probabilities provide a more intuitive understanding of how country-level factors impact upon trends. Figure 3 presents predicted probabilities, from 1990 and 2016, in five countries (Cambodia, Malawi, Nigeria, Peru, Turkey) chosen for illustrative reasons. It also shows the overall average predicted probability for all countries in this study. Because they are predicted, these statistics are reflective of how the probability of living in a skip-generation household is *expected* to change (not how it actually did change), based on coefficients from Model 3 in Table 3, given specific country-level dynamics taking place in these countries. Those dynamics are the values of the country-level measures in particular years. Values used to calculate the predicted probabilities are provided for select years (in five-year increments) in the Supporting Information. Unit-level variables age, sex, and rural/urban residence are held constant at the country average.

The overall probability for all countries indicates that the magnitude of the rise in the chances of skip-generation household across LMICs is

FIGURE 3 Predicted probability that households are, and persons under 15 or 60 and older live in, skip-generation households, for select exemplary countries over time



NOTE: [1]These probabilities are calculated using Model 3 in Table 3. Unit-level variables are held constant at country means. Country-level variables use values for the specific country in a specifie year as shown in online Supplementary materials.

considerable. For all households, the probability rises from about 0.011 to 0.016 between 1990 and 2016. Put another way, the percent of all households that are skip-generation as defined in this analysis rose from about 1.1 percent to 1.6 percent in these LMICs. Given different dynamics in country-level factors, there are, however, substantial variations. For example, given the realities in Malawi, there is a predicted increase in the probability from about 0.022 to about 0.035 from 1990 to 2006, followed by a leveling off at that level.

For children under 15, the overall rise in the probability of skip-generation is from about 0.010 to about 0.018, indicating close to a doubling of the prevalence. There are sharp increases in the predicted probabilities in Malawi, Cambodia, Nigeria, and Peru. For adults aged 60 and older, the proportions across all countries increased from about 0.04 to about 0.06. In Malawi, the model predicts that the probability that an older person lives in a skip-generation situation reaches almost 0.120, meaning about 12 percent of persons 60+ in Malawi live in a skip-generation situation. In Nigeria, the change over time is from about 0.035 to 0.060, while in Peru it goes from about 0.020 to about 0.035. The exception to rising probabilities is seen in Turkey where the chances of skip-generation remain flat over time across all three measures.

These predicted probabilities reflect country-level changes captured by Models presented in Table 3. To provide one example, AIDS mortality vacillated dramatically in some countries between 1990 and 2016 (see the Supporting Information). In Malawi, the AIDS mortality rate was 1.54 deaths per 1,000 in 1990, reached 8.95 in 2005, and declined back to 2.34 by 2015. Increasing AIDS mortality in the model associates with increasing probabilities of being in a skip-generation household. The upshot can be seen clearly in the predicted probabilities for Malawi. For adults aged 60+, for instance, we notice a sharp increase from 1990 to 2005, followed by a leveling. In contrast, in Turkey, the level of AIDS mortality remained zero over time. However, GNI in Turkey increased more than fivefold over the study period, and dependency ratios dropped. Higher GNI and lower dependency is associated with a lower probability of skip-generation. Therefore, in Turkey we might expect declines in the probabilities of skip-generation households. However, we see little change. This is because there is an underlying time effect acting upon each country. As such, even though country-level indicators mostly change in ways that do not promote skip-generation households, for instance, GNI is generally increasing and AIDS mortality is generally decreasing, the main trend for almost every country is still an increase in the probability of skip-generation.

Discussion

Our analysis of the probability that households in LMIC are, and that children under 15 and adults aged 60 and older reside in, skip-generation households concludes that, on average, the chances are increasing, and in some countries, at a rapid pace. Trends of living in a skip-generation household do vary from country to country. Descriptive analyses indicate that, in some countries, there has been relative stability over time and, in other countries such as Pakistan there have been sharp declines. But, a majority of countries experienced an increase in skip-generation households. The effect of one year of time on the unadjusted odds of skip-generation households, regardless of whether one is looking at all households, children or older adults, are relatively large in a number of countries including Cambodia, Kyrgyzstan, Mozambique, DRC, Lesotho, and Bolivia. Multilevel models that account for country-level variation in the level of skip-generation and the effect of time on skip-generation by using random effects confirm that the average trend is toward more skip-generation households. This trend appears to indicate an underlying phenomenon encouraging this type of household formation, unaccounted for by the individual- and country-level factors. It is quite possible, therefore, that our results reflect cultural and normative changes in values related to household formation across LMICs.

The phenomenon is important for a number of reasons. Skip-generation households are not predicted to be a dominant form of household formation within the standard demographic and sociological theories of family in the context of social and economic development. There clearly needs to be further work around understanding the cause and nature of this household type if we will be able to project upon patterns and future developments. However, of greater concern may be the implications of living in this household type. Some emergent literature suggests disadvantages to grandparents and grandchildren who live in skip-generation households. For example, literature points to grandparents who care for grandchildren having lower wealth and worse physical and mental health due to the physical, social, and emotional demands of caring for young children (Chen and Liu 2011, Hayslip and Kaminski 2005, Zimmer and Van Natta 2018). In skip-generation households, grandparents are usually the primary caregivers of their grandchildren. Day-to-day care of young children is physically taxing and may involve sleep loss and increased exposure to infections (Hughes et al. 2007). It is also associated with chronic stress, which creates a role strain, or overload (Jendrek 1993, Pearlin 1989). Evidence from the United States, where skip-generation households are sometimes formed when parents are absent due to incarceration or drug use, suggests that children in these types of households face worse health outcomes, have less access to quality healthcare, and experience socioeconomic disadvantage (Baker and Mutchler 2010, Minkler and Fuller-Thomson 1999). Limited but

recent evidence from LMICs suggests children in skip-generation households face financial, social, and structural barriers to accessing health services (Treleaven and Ngin 2017). In migrant-sending areas of rural China, where skip-generation households are common, time living apart from migrant parents has been correlated with poorer health and educational outcomes among children (Meng and Yamauchi 2017). Notably, in many skip-generation households, grandparents live with multiple grandchildren. In some situations, grandparents may be caring for grandchildren from more than one adult child, a further burden on grandparents.

We also recognize some direct or associated benefits of residing in a skip-generation household. Evidence from China suggests grandparents in skip-generation households benefit psychologically through a greater sense of purpose by occupying a culturally sanctioned role, and thus have better mental health and experience a slower health decline as they age (Silverstein, Cong, and Li 2006). In the case of labor migration, left-behind families have been found to benefit from remittance support, leading to an improved economic situation (Adams and Page 2005, Zimmer and Knodel 2013). Evidence from Cambodia suggests that children who reside in skip-generation households due to parental migration may benefit from improved food security and lower rates of malnutrition than children in other living arrangements, given their parents' increased economic support (Treleaven 2018). Where the skip-generation or other migration-related living arrangement results in improved financial well-being for the entire family, children may be more likely to remain in school (Nobles 2011).

Given the diversity of situations that lead to the formation of skip-generation households and the likelihood that such household formations will continue to increase in number, assessing the balance of factors and the underlying causes of positive and negative effects is critical for identifying the social, demographic, and health implications of this living arrangement. In particular, understanding the prevalence, geographic distribution, and consequences of skip-generation households formed due to migration can inform national policy efforts to address the well-being of the left behind. For example, because child health programs primarily target mothers, children in skip-generation households may be less likely to benefit from such programs (MacDonald et al. 2020). Grandchildren may face barriers to school enrolment or continuation where these households are financially vulnerable. Institutionalizing support services and schemes for grandparent caregivers may also improve well-being for both generations (Lam et al. 2013). Implications of skip-generation households on the loss of rural labor, poverty and increased financial vulnerabilities, particularly in the poorest parts of the world, must also be better understood so adequate policies and social schemes can successfully address these susceptibilities (Piotrowski 2007, Gupta, Pattillo, and Wagh 2009, Adams and Page 2005, Zimmer and Das 2014).

Our multilevel models suggested some additional associations worth highlighting. First, the influence of AIDS mortality on increasing the probability of living in a skip-generation situation supports earlier research, some of which is based on survey methods and some of which is qualitative or anecdotal (Kuo and Operario 2011, Ardington et al. 2010, Hosegood 2009, Richter et al. 2009, Schatz and Ogunmefun 2007, Knodel et al. 2006, Ntozi and Zirimenya 1999). While AIDS mortality is on the decline in many countries around the world, these findings do indicate the potential importance of support structures in place for older persons who often serve as caregivers in times of crisis.

Second, demographic change can influence persons in different age groups in different ways. We found dependency ratios, for instance, to affect the probability that older persons live in skip-generation households while not influencing the probability that children do (see Table 3). One explanation for this is how availability affects opportunities differently across generations. Take the example of a family where a single grandchild among many lives with his/her surviving grandparent. In this family, the proportion of grandparents versus grandchildren in a skip-generation household differs. Advance this example to a societal level where dependency ratios are changing and it is possible to see significant influences for older persons and not children.

Third, the impact of economic development on household formation may not be unidirectional. Our data indicate that, while increases in GNI per capita relate to fewer skip-generation households, higher FLFP, a potential consequence of economic development, can result in more children being left behind to be cared for by grandparents. This result suggests the need to rethink conceptual frameworks around economic development and household change.

Finally, our results may speak to the notion of translocality. In the current age of economic and demographic change, with older persons living longer and individuals more likely to be on the move in the search of labor opportunities, it is likely that the context of family is changing. It is critical that demographic perspectives expand upon the notion and consider the implications of families working together as units even when living apart.

The results presented here represent a fraction of the analyses that were completed in preparing this manuscript. What is presented is what was determined to be effectual while parsimonious. We tested a large number of models, some of which included regional effects, other predictor variables, and nonlinear effects. Results were examined using broader definitions of skip-generation, allowing individuals to be living with others besides the grandparents and grandchildren as long as there were no parents of the children present. None of the additional results offered any challenge to the overall findings presented here.

To sum, while trends in skip-generation households across LMICs are heterogeneous, most LMICs have seen a rise. This cannot be explained by changes in a series of social, demographic and economic country-level characteristics. The increase in proportion living in skip-generation households is extremely large in some countries, like Cambodia and the DRC. The overall positive trend is linear from 1990 onward and therefore there is no reason to believe that it will be curtailed in the near future. Thus, our findings underscore the need to consider skip-generation households in policies and future research across LMICs.

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