

Migration, community context, and child immunization in Ethiopia

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Abstract

This paper examines the relationship between parental migration status and child immunization in Southern Ethiopia, a region characterized by high mortality and morbidity. Using the 1997 Community and Family Survey and a multilevel modeling approach, we find that children born to rural–rural migrant mothers have significantly less chance of receiving full immunization coverage than children born to non-migrant mothers. The social mechanism that explains this huge disparity is that rural–rural migrant women have limited social networks in the host community. In addition, significant variation in receiving complete immunization is found by age of child (a likely period effect), mother's education, and distance to nearest health center. Marked child immunization differentials are also observed by ethnicity. The results from the multilevel analysis confirm the persistence of substantial community effects, even after controlling for a standard array of personal and household characteristics. Given the low levels of vaccination among children born to migrant women, health policy interventions and information campaigns might be effectively augmented to reach such migrant women and their children. Community and ethnic group effects suggest that further targeting of health activities could be efficient and effective.

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Introduction

Infant and child mortality rates in many parts of Africa have been decreasing in recent decades, but still remain among the highest in the world (Hill & Pebley, 1989; Hill, 1992; Delaunay, Etard, Preziosi, Marra, & Simondon, 2001). Numerous studies have demonstrated the considerable importance of preventive health measures such as vaccination in reducing child mortality, morbidity, and disability (Feachem & Jamison, 1991; Kaute Defo, 1994; Foster, 1995; Brockerhoff & DeRose, 1996; Nyarko, Pence, & Debuur, 2001). Indeed, vaccines have significantly reduced or, in some areas, eliminated diseases such as smallpox. The six diseases

(measles, pertussis, diphtheria, tuberculosis, tetanus, poliomyelitis) of the expanded program of immunization (EPI) continue to seriously effect morbidity and mortality in Africa (Feachem & Jamison, 1991), and Ethiopia is no exception. UNICEF estimates that worldwide, these infectious diseases kill 10 children with each passing minute and disable 10 more. In Ethiopia, in the early 1990s, about 300,000 children died per year from immunizable diseases and diarrhea (Lidetu & Okubazgi, 1993). Providing full immunization coverage to substantially reduce infant and child mortality is also a high-priority national public health objective in Ethiopia (Office of the Prime Minister, 1993). In order to most efficiently allocate scarce public health resources, it is crucially important to identify groups with low vaccination coverage and uncover the behavioral process of traits associated with low immunization.

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Migration is likely to be implicated in the coverage and success of immunization. Migration is a salient feature of the social life of developing countries (Zarate, 1983; Evans, 1987), and a variety of political and economic forces have operated to redistribute population in Ethiopia over the last several years (Berhanu & White, 2000). Still, the role of population redistribution in health outcomes is not well understood. On the one hand, migrants are acknowledged to be new—and often less integrated—residents. On the other hand, migrants are generally highly motivated individuals, even innovators. Perhaps this motivation or receptivity to change may counteract the lack of social integration in the new community. We also consider that the migration of women due to marriage may be implicated. It is often the case that neighbors, friends, or relatives exchange information regarding their experiences with health workers and their children's vaccination. In the case of marriage migration, disruption of these social ties may reduce access to such information for women who do not reside in their natal community. This paper investigates the empirical evidence on the nature of the relationship between migration and health.

The investigation of barriers to full immunization has important policy implications. Indeed, examining how migrants adapt in terms of their health seeking behavior as they move among various social settings provides a good opportunity to gain insight into the roles of environment and culture in shaping human behavior. The redistribution of population affects the migrants themselves, their children, and the origin and destination communities, as well. For example, children may be particularly vulnerable to disruptions caused by migration, yet our knowledge in this area is limited. Research assessing the impact of migration on child immunization is woefully inadequate.

In recent studies, researchers have established a link between migration and child survival, and they have documented the health advantage of children living in urban areas compared to rural areas (Brockerhoff, 1990, 1995; Bender, Rivera, & Madonna, 1993). These studies, however, focus on rural–urban migration and have ignored rural–rural migration. In sub-Saharan Africa, rural–rural migration constitutes the largest share of total internal migration (Oucho & Gould, 1993). Further, these studies have not made a link to child immunization. Hence, empirical evidence on the relationship between parental migration status and child immunization is very limited.

This study uses a multilevel framework to examine the effect of a set of individual and community traits on child immunization, with a special focus on the influence of parental migration. We examine this association through the analysis of the 1997 Community and Family Survey (CFS) data collected in the Southern Nations, Nationalities and Peoples Region (SNNPR) of Ethiopia.

This multilevel approach allows us to simultaneously account for individual, household, and community-level influences on the chance that a child is immunized.

Background

Ethiopia, with 65 million people, is the second most populous country in sub-Saharan Africa. Infant and child mortality rates in Ethiopia remain at very high levels, even relative to many other countries in sub-Saharan Africa. According to the recent 2000 Ethiopia Demographic and Health Survey (Central Statistical Authority & Macro International, 2001), infant mortality in 2000 was 97 deaths per 1000 live births, while the child mortality rate was 166 deaths per 1000. By contrast the infant mortality rate in neighboring Kenya was 74, and for all of sub-Saharan Africa (excluding South Africa) the figure was 92. Furthermore, the utilization of preventive health services is very low, and the overall level of immunization in Ethiopia compares unfavorably to many developing countries.

According to the guidelines developed by the World Health Organization (WHO), children are considered fully vaccinated when they have received a vaccination against tuberculosis (BCG), three doses each of the diphtheria–pertussis–tetanus (DPT) and polio vaccines, and a measles vaccination by the age of 12 months. A study sponsored by the government of Ethiopia and the World Bank (PHRD, 1996) reported that the proportion of children receiving immunization for measles is 25.6% (49.4% urban and 22.5% rural), for bacille Calmette-Guerin (BCG) is 25.9 (52.9% urban and 22.5% rural) and for DPT is 26.9%. The study also found that only 21.9% of children are immunized for all three. (The Kenyan immunization rates are often above 65% for these diseases.) Research in Ethiopia also suggests that childhood diseases preventable by immunization are responsible for a considerable proportion of the morbidity, mortality, and disability among Ethiopian children (Lidetu & Okubazgi, 1993; Figueroa, Hawranek, Abraha, & Hay, 1997). Lack of preventive measures was also a major factor for the high prevalence of childhood skin diseases in Ethiopia (Figueroa et al., 1997). Kloos (1990) documented that lack of transportation to health facilities as well as costs associated with transportation are important contributing factors of utilization of health services.

Despite a low level of economic development, population movement in Ethiopia is substantial. Rural–rural as well as rural–urban migration is common. The Central Statistical Authority of Ethiopia has found that the country experiences a relatively high level of internal population redistribution (CSA, 1992). In addition, since 1991, Ethiopian society has been undergoing a radical transformation from a centrally planned

to a market-oriented economy. Under such a transformation, internal migration tends to play an increasing role, demographically and economically, as it serves to keep the supply and demand for labor in equilibrium.

The history of health care in Ethiopia shows a mix of delivery systems and a shift in the mechanisms of government provision. In 1952, the government began to develop a basic health service, emphasizing the establishment of regional and local health centers (Kassie & Kloos, 1993). Health centers were staffed by nurses, sanitarians, laboratory technicians, health assistants, and increasingly, one or two physicians. A national policy and strategy for the development of health services was formulated in 1963. The Ministry of Health (MOH) of Ethiopia is the major provider of modern health services in Ethiopia. Other government organizations such as the Ministry of Education and the Ministry of Defense, private clinics, and non-governmental organizations also provide health care. In several rural areas, religious mission health services provide care. Furthermore, traditional healers also continue serving a large segment of the population in the rural areas.

The EPI began operations in 1980, using the infrastructure and methodology developed for the smallpox eradication program. Among the major constraints in maternal and child health (MCH) care utilization are social barriers to females traveling outside their communities for medical care, access to and affordability of motorized transport, persisting traditional beliefs about illness, lack of effective community health services, lack of education, and the slippage in follow-through (Kassie & Kloos, 1993). At the beginning, the EPI program was integrated into the general health services as an essential component of Primary Health Care. Five vaccines (BCG, measles, DPT, Polio, and TT) were used to immunize children under the age of 1 year and women of childbearing age. Vaccinations were administered in both static outreach and mobile health facilities. Mobile clinics were used mostly in isolated rural settlements and villages where the regular EPI program could not be implemented. The number of static and outreach sites increased from 141 in 1980 to 5995 in 1990. According to Kassie and Kloos (1993) and Kloos (1993), the major reasons for immunization failure were lack of information, lack of motivation, and the civil war. Although the primary goal of the EPI was to increase immunization coverage by 10% each year so as to reach 100% coverage by 1990, the current rate of immunization is only 22%.

There are notable regional imbalances in the quality and quantity of health coverage. The greatest disparities in access to health services are between urban and rural areas. Most health service facilities and personnel are concentrated in the capital, Addis Ababa. Addis Ababa alone accounts for 53.4% of Ethiopia's physicians,

33.2% of the health officers, 67.8% of the pharmacists, and 49.2% of the nurses (Abate, 1995). However, according to the 1994 Ethiopian Census, Addis Ababa's population accounts less than 4.0% of the total Ethiopian population. Thus, a large fraction of Ethiopia's population remains geographically or institutionally out of reach of these health services.

The study area

The Southern Region of Ethiopia has a land area of 117,506 km² and a population of 12 million (CSA, 1998). The region accounts for about 10% of Ethiopia's total land area and approximately 20% of its population. The region has the highest population density in all of Ethiopia with an average of about 95 persons/km², while, at the same time, being one of the least urbanized regions of the country with only 7% of the population living in urban areas (CSA, 1998). The region's peasants rely heavily on ensete (*Ensete ventricosum*), maize, and coffee (Rahmeto, 1992). Although 67% of urban dwellers in the region are literate, the literacy rate in rural areas is only 22%. The 1994 census estimated an infant mortality rate (${}_1q_0$) of 128 per 1000 births and an under-five mortality rate (${}_5q_0$) of 189 per 1000 births, which are substantially higher than the national averages of 116 and 171, respectively (CSA, 1998).

The Southern Region is inhabited by more than 45 indigenous ethnic groups with distinct languages, cultures and forms of socioeconomic organization. The *Sidama*, *Wolaita*, *Kambata*, *Alaba*, *Tembaro*, *Hadiya*, and *Gurage* constitute the major ethnic groups of the region. According to anthropological studies (Shack, 1966; Hamer & Hamer, 1996; Vecchiato, 1997), these indigenous ethnic groups were incorporated into modern Ethiopia in the early 1890s and have largely maintained their traditional social structures. Although Protestantism has been spreading, and both Orthodox Christianity and Islam are now common, until the 1970s the vast majority of the population remained attached to their indigenous religious beliefs and practices (Hamer & Hamer, 1996). In our sample, 36.7% of the household members were Protestants believers followed by Orthodox Christians (25.8%), Muslims (18.0%), traditional believers (11.6%), Roman Catholics (3.3%) and Apostolic (2.2%). Like the rest of Ethiopia, the Southern Region has experienced immense social, economic, and political disruptions.

As previously mentioned, the Southern Region has a peasant economy, with ensete providing the main source of food; indeed, the Gurage people identify themselves as "people of ensete" (Shack, 1966). Food insecurity in the region is high: in our survey 56.6% of the rural households said stocks of food were inadequate to hold until the next harvest (DTRC/PSTC, 1998). Moreover,

children are exposed to a range of potentially lethal diseases, including malaria, parasites, acute respiratory infections, and gastrointestinal infections (Rahmeto, 1992).

Childhood vaccination coverage in the region is extremely low; some 71% of children under age six have not received any vaccination at all (DTRC/PSTC, 1998). The Social Science and Immunization Project (SSIM) carried out in Ethiopia (Streefland, Chowdhury, & Ramos-Jimenez, 1999) in the Gurage zone documented that vaccination service delivery is poor mainly because of the level of poverty, social strife and some legacies from the military regime. According to the region's health bureau, children aged 12 months or less are a priority for vaccination programs in the SNNPR. The vaccination program for these children includes poliomyelitis, DPT, tuberculosis (by BCG), and measles. According to international and Ethiopian standards, a child is considered to be fully vaccinated if he or she has received BCG, measles and three doses each of DPT and polio vaccinations. In our analysis also, this is the level at which we consider a child to be "fully" or "completely" vaccinated.

This portrait of the Southern Region indicates that it is somewhat more disadvantaged than other regions of Ethiopia. At the same time, the Southern Region and other sections of the country share a number of traits: obstacles to health care outreach, rural and urban poverty, economic restructuring, and ethnic and topographic diversity. This suggests that the health care service delivery challenges are broadly representative of other low-income settings within and beyond Ethiopia. We also would suggest that our analysis of behavioral relationships, i.e. the degree to which particular personal or community traits help predict immunization, may be somewhat generalizable beyond the region itself.

Social mechanisms

The influence of women's social networks ties or networks on child health in the developing context has recently gained attention (Castle, 1994; Adams, Madhavan, & Simon, 2002). Collective notions about child vaccinations could emerge when members of social networks, relatives, or neighbors exchange ideas and information about the quality of health services provided in the community, treatment of health workers, side-effects associated with vaccinations, and their experiences related to vaccinating children (Streefland et al., 1999). In Ethiopia, marriage takes place early and is almost universal. Marriage in Ethiopia is fairly stable and it is more stable in rural areas than urban areas. According to the 2000 Ethiopia DHS (CSA Macro, 2001) only 2.5% and 6.2% women aged 15–49 years were divorced and separated, respectively. The National

Family and Fertility Survey (CSA, 1993) also found about two-thirds (61.3%) of the first marriage of women aged 15–49 years were intact. Although marriage is one of the most important life course events, it is also an institution that imposes immense sociocultural constraints, especially for women. Ethiopian society is patrilineally organized, such that Ethiopian brides leave their family and community to join their husbands' families or to live with their husbands. These migrant brides are likely to be disconnected from their social networks, and cultural barriers make them less likely to assimilate within their host community. Their social status may suffer, and their networks of local communication may be weaker. Consequently, children born to these women may be disadvantaged with respect to receiving preventive health measures. In addition, changes associated with the process of migration itself interfere with child immunization. Since most immunization programs in Ethiopia are performed by campaigns at a specific period, it is likely that migrants may miss some of the vaccination installments. We hypothesize, then, that children of migrant women will show lower rates of immunization.

Immunization uptake may also vary by sex of the child. For example, researchers have attributed sex differentials in the use of preventive or curative health services as one factor that accounts for part of the female mortality disadvantage in Asia (D'Souza & Chen, 1980; Chen, Huq, & D'Souza, 1981; Das Gupta, 1990). In these studies, son preference in parental care including utilization of health services is considered the behavioral mechanism by which sex-biased attitudes may have led to the observed mortality pattern. Substantial variations in immunization coverage by sex was also found using data from Demographic and Health Surveys for Africa (Hill & Upchurch, 1995). Since the peoples of the Southern Region are patrilineally organized, we hypothesize that male children are more likely than females to receive full immunization.

Another social mechanism considered is maternal education. Evidence has been provided in several studies suggesting the crucial importance of female education in reducing child mortality (Caldwell, 1979, 1994; Hobcraft, 1993). There are many reasons why educated mothers should make more use of modern health services, both for preventive and curative purposes. For example, Streatfield, Singarimbun, and Diamond (1990) document that female education enhances child survival because of greater knowledge of the protective function of the major childhood immunizations. Education is also likely to impart greater responsiveness to novel ideas and services, greater identification with the outside world, and more social confidence in handling health personnel. In addition, education may enhance the ability and willingness to travel outside the home

community in search of health services. Most studies have shown a positive correlation between maternal education and use of modern preventive services, even when income is controlled. We posit the same.

Ethnicity is also likely to have important influence on the utilization of preventive health services. A recent study of a large set of countries in sub-Saharan Africa (Brockerhoff & Hewett, 1998), for example, found large differentials in child mortality across ethnic groups. They attributed these ethnic differences to variation group economic privilege, demographic behavior, geographical setting, and use of modern health care services. We expect health seeking norms associated with ethnic background to operate in our study population, where the level of literacy is very low.

The environment (ecological zone) in which the family lives may also play an important role. The climatic zones in Ethiopia can be broadly classified into two major zones on the basis of the relation between altitude, temperature, rainfall, and vegetation: highland (dega) and lowland (kolla). The highland (dega zone) consists of areas with high altitude (above 2500 meters) and low or medium temperatures throughout the year. The lowlands (kolla zone), on the other hand, are characterized by very low population density, high temperatures, irregular and limited rainfall, scanty and shrubby vegetation, and the widespread existence of such debilitating hazards as malaria and tsetse fly. Since children living in the lowland areas are exposed to multiple disease environments, the lowland areas have been priority zones for immunization programs. Further, the illness perception of families living in those areas may promote health-enhancing behavior, as in the case of the traditional fear Ethiopians have of the malarial lowlands. We, therefore, hypothesize that child immunization to be higher in the lowland areas than highland areas despite the low population density in the low land areas.

Data

The data used for this analysis come from the 1997 CFS conducted by the Demographic Training and Research Center of Addis Ababa University and the Population Studies and Training Center of Brown University. The sampling design combined stratified sampling with simple random sampling proportional to population size. The CFS was conducted between May and July 1997. Five zones (Gurage, Hadiya, KAT, North Omo, and Sidama) in the Southern Region were covered by the survey. The 1994 Census found that the five selected zones contained eight million people, 78% of the Region's population. The survey covered 30 communities (10 urban and 20 rural), 2317 households, and 2550 women (DTRC/PSTC, 1998). The adminis-

trative structures of the communities in the Region are organized first by zones, then by *weredas*, then by *peasant associations* (PAs) in the rural areas and *kebels* in the urban areas, and at the smallest geographic level, by enumeration areas (EAs). The average number of households was 219 per community (or EA), ranging from 183 to 1304 households. While all the urban communities have mixed ethnic groups, half of the rural communities are inhabited by a single ethnic group. We focus here on all children born between May 1991 and May 1996 (aged 12–59 months) co-resident with currently married parents, providing 1062 families and a sample size of 1614 children. We limit our analysis to children born to currently married parents because we are interested on the effect of migration status of both parents on child vaccination. We also restrict our analysis to children (both alive and dead) aged 1 year and above. The age cutoff corresponding to the first birthday was chosen because WHO recommends that vaccination coverage be assessed for children as of this age. This also allows a 3-month period for children to receive measles immunization, recommended at 9 months of age. Children who have died are included in the analysis if they were aged 12 months or older at the time of death, thereby ensuring that they had survived until the WHO-recommended age by which they should have been fully vaccinated. It should be noted that this is a rich data source, and unusual in being one of very few such surveys to be conducted in Ethiopia in recent decades.

Our analysis focuses on full immunization coverage of children. The WHO-recommended timing of immunization is BCG at birth, three doses each of DPT and oral polio vaccine at 6, 10, and 14 weeks, and a measles immunization at 9 months. To be fully immunized, therefore, a child should have received eight vaccinations in all. During the interview, a mother was able to present a card on which vaccinations had been recorded; information on vaccinations was collected from those cards. If the mother was not able to show a card for the child, this information was collected from mothers' verbal reports. In the 1997 CFS study, only about 10% of mothers were able to show a vaccination card to the interviewer and 12% reported that the child is immunized but failed to provide card to prove it. The main answers given to the question why there was no card include "card is at clinic", "card elsewhere", and "card lost". To check on the implications of card availability, we conducted a simple binary logit analysis of mother's showing a vaccination card versus failure to provide a card. The results do indicate cards were more likely to be available (shown to interviewer) for children who were younger, had more educated mothers, and were urban residents. Differences by ecological zone and ethnicity also emerged. In this analysis, children with a health card who have received all eight vaccinations or whose

mother's reported that they received all the required vaccinations are considered as fully immunized. We elected to proceed with parental reports. These logit results suggest our subsequent results would be somewhat stronger, if those without cards tended to report more immunizations than occurred.

The survey gathered detailed information on immunizations for major childhood diseases for children who were born between May 1991 and May 1997. Focusing on this short time span provides better data quality. An earlier study used various measures of data quality (including comparison of the CFS data to external data sources) to examine the validity of the 1997 CFS data (Kiros, 2001). These results confirmed the claim regarding the data quality of the 1997 CFS.

Table 1
Percentage distribution of migrant parents by main reason for migration

| Reason for migration | Mother | Father |
|-----------------------|--------|--------|
| Join family | 13 | 18 |
| Job transfer + school | 3 | 16 |
| Marriage | 73 | 14 |
| Lack of land | 3 | 19 |
| Looking for job | 4 | 25 |
| Others | 4 | 8 |
| Total | 100 | 100 |
| <i>N</i> | 547 | 468 |

Source: Southern Ethiopia community and health survey, 1997.

Complete immunization according to parental migration

We ascertain migration status of adults by asking adults questions about whether they were born in the community of current residence, and if not, where they were born. Migrants are those residing outside their community of birth. We also ascertain duration of residence in the community in years and months. Of all residents aged 10 years and older living in the study communities, 15.3% of males and 29.8% of females are migrants. In order to get some insight about the motives for migration, Table 1 provides the percentage distribution of migrant parents by reasons of migration. The main reason migrant fathers left their place of birth is predominantly for work and concerns about land. In the case of female migrants, however, it was overwhelmingly for marriage (73%). Table 1 also shows that migration of mothers for schooling or work is very minimal in Southern Ethiopia (only 3%).

Table 2 presents child immunization by type and parents' migration status and type of migration. Our results clearly corroborate previous studies that Ethiopia has a low level of vaccination coverage. While 42.1% of 1–4-year-old children got at least one type of vaccination, only 16% received all the WHO-recommended vaccinations. Overall, 35.2% have received the BCG vaccination, 37.9% have been vaccinated against measles, 21.3% received the third dose of DPT, and 25.1% received the third dose of polio. Since the vaccination coverage with BCG is often higher than other vaccines, we further examined vaccination

Table 2
Proportion of children aged 1 years and above who were vaccinated by the time of the survey, by vaccination type and parental migration status

| Migration type | BCG | Measles | DPT3 | Polio3 | At least one | Full vaccination | <i>N</i> |
|---------------------|--------|---------|--------|--------|--------------|------------------|----------|
| <i>Father</i> | | | | | | | |
| Rural non-migrant | 28.2 | 29.9 | 15.4 | 18.8 | 34.5 | 11.5 | 1181 |
| Urban native | 87.5 | 85.7 | 58.9 | 58.9 | 91.1 | 46.4 | 56 |
| Rural–rural migrant | 16.0 | 28.2 | 8.5 | 17.0 | 31.4 | 3.7 | 188 |
| Rural–urban migrant | 82.5 | 83.6 | 59.8 | 62.4 | 85.2 | 48.1 | 189 |
| <i>F</i> -statistic | 126.9* | 103.8* | 101.6* | 78.4* | 91.7* | 85.3* | |
| <i>Mother</i> | | | | | | | |
| Rural non-migrant | 28.7 | 31.2 | 17.0 | 20.2 | 35.9 | 13.2 | 863 |
| Urban native | 89.8 | 89.8 | 65.8 | 62.0 | 92.4 | 51.9 | 79 |
| Rural–rural migrant | 23.7 | 28.2 | 11.1 | 16.5 | 32.1 | 6.4 | 514 |
| Rural–urban migrant | 80.4 | 80.4 | 55.7 | 61.4 | 82.9 | 45.5 | 158 |
| <i>F</i> -statistic | 117.7* | 97.8* | 96.6* | 75.6* | 86.8* | 83.5* | |
| Total | 35.2 | 37.9 | 21.3 | 25.1 | 42.1 | 16.1 | 1614 |

Source: Southern Ethiopia community and health survey, 1997.

*Significant at the 1% level or less, for *F*-test of null hypothesis of equivalence across migrant categories.

coverage in the study areas by type of vaccination. Indeed, the percentage of children that have been immunized with BCG vaccine is higher than that of other vaccines in four of the five zones covered in our study. However, BCG and measles vaccination coverage in the Gurage zone was only 2.7% and 15.3%, respectively. We speculate this could be due to some problems encountered in particular with the availability or delivery of the BCG vaccine in the Gurage zone or some other aspect of program shortfall. In addition, while the coverage for the first dose of DPT is 40%, only 21.3% received the third dose of DPT, a 47% decline.

As Table 2 shows, differences in vaccination coverage among children significantly varies by their parent's pattern of migration. As expected, coverage is high among children whose parents are urban natives, with about nine of 10 such children having at least one immunization and about half experiencing full coverage. Immunization rates are lowest among children of rural–rural migrant parents. Notably, vaccination coverage of children born to rural–urban migrants is nearly equivalent to the immunization rate of children born to urban natives. Only 3.7% of children born to a rural–rural migrant fathers have received all eight vaccinations compared to 48.1% children born to rural–urban migrant fathers. Likewise, only 6.4% of children born to rural–rural migrant mothers are fully immunized, yet particularly noteworthy for us, 45.5% of children born to rural–urban migrant mothers are fully immunized. The rate of full immunization of children born to rural non-migrant mothers is more than double the rate of children born to rural–rural migrant mothers.

A formal statistical test using Tukey's method of multiple comparison (details not shown) indicates that the pattern is highly differentiated. That is, the proportion of children immunized varies appreciably by parental migration type, and it not simply the case that only one migrant type varies from the others. This differentiation is manifest for both mother's and father's migration type. Only the pairwise comparison between children born to urban natives and rural–urban migrant parents is not statistically significant.

A multilevel analysis

We employ multilevel logistic regression models to examine the effect of parental migration on child immunization, while also identifying factors that influence child immunization at other levels of aggregation. In the 1997 CFS, the data have a three-level structure—children (level 1), within families (level 2), within communities (level 3). The multilevel structure of the data used in this analysis is displayed in Fig. 1.

In addition to the observed covariates considered at each of these three levels, there are likely to be several unobserved or unobservable factors affecting the uptake of immunization, and these may operate at any level in the hierarchy. If we fail to account for the existing hierarchical structure in our data, the estimates of the observed covariates are likely to be biased. The advantage of multilevel modeling is that it explicitly recognizes the existing hierarchical structure of the data and estimates accordingly. The basic idea is that child immunization has family and village determinants, beyond individual traits. Consequently, the multilevel approach enables the researcher to understand where and how effects are occurring. The immunization experiences of children in the same community, and furthermore the experience of children in the same family, are likely to be similar since these children share many characteristics. The multilevel models adjust for this correlation across units of observation. The cost comes at some more difficulty in implementation of the model (including estimation with specialized packages) and some additional work interpreting results, especially those parameter estimates for the hierarchical effects.

The dependent variable in our analysis is whether a child received full immunization or not. Children classified as fully immunized have obtained all eight recommended vaccinations at the time of survey. The model can be described as follows:

Let y_{ijk} be a binary response for the i th child in the j th family and nested within the k th community, where $y_{ijk} = 1$ if the child is fully immunized and $y_{ijk} = 0$ if the child is not. Let π_{ijk} denote the response probability of

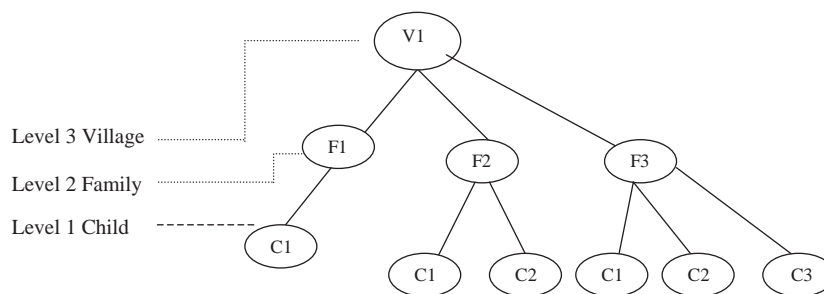


Fig. 1. Multilevel structure of the data.

the *i*th child of the *j*th family in the *k*th community being fully immunized (i.e., $\pi_{ijk} = \text{Prob} \{y_{ijk} = 1\}$). Then the three-level model can be written as follows (Steele, Diamond, & Amin, 1996):

$$y_{ijk} = \pi_{ijk} + e_{ijk}, \tag{1}$$

where

$$\begin{aligned} \log \text{it}(\pi_{ijk}) &= \log\left(\frac{\pi_{ijk}}{1 - \pi_{ijk}}\right) \\ &= x'_{ijk}\beta + f_{jk} + v_k, \end{aligned} \tag{2}$$

where x_{ijk} is a vector of covariates including parental migration status, educational background, and ethnicity; e_{ijk} is a child-level error term distributed as Bernoulli; $u_{jk} \sim N(0, \sigma_f^2)$ is a family level error term, and $v_k \sim N(0, \sigma_v^2)$ is a village-level error term. This model is a three-level hierarchical linear model with a random intercept. The intercept, or average probability of receiving full immunization, is assumed to vary randomly across households and communities. The model includes three child-specific variables: sex of the child, child’s age at interview, and the mother’s age when the child was born. Father’s and mother’s migration statuses and education, and ethnicity of the mother are included as family level variables. Ecological zone and distance to nearest health center are included in the model as community-level variables. We also tested interaction terms between parental migration status and ethnicity, parental migration status and education, parental migration status and ecological zone, mother’s and father’s education, and mother’s education and distance to the nearest health services. None of the interaction terms proved to be statistically significant at the 5% level and were dropped from the final model.

The above model was fitted using the latest version of MLwiN software (Rasbash et al., 2000). We used a second-order “predictive” or “penalized” quasi-likelihood (PQL) approach, which provides least biased results when there are few level-1 (children) units per level-2 (family) unit (Rodriguez and Goldman, 1995; Goldstein & Rasbash, 1996; Goldstein et al., 1998), which is incorporated in the recently developed MLwiN version to obtain more accurate estimates.

The random effects f_{jk} and v_k represent unobserved family and community factors shared between siblings and between children living in the same communities, respectively. Probability of immunization of children living in the same community (but not in the same family) are correlated because they share the random effect v_k . And probability of immunization of children living in the same family are correlated because they share the random effects f_{jk} and v_k .

The degree of resemblance between micro-units belonging to the same macro-unit can be expressed by the intraclass correlation coefficient. Values departing

from zero point to greater similarity among children at that level of aggregation. The correlations between the probability of immunization among children in the same community and the same family are, respectively, given by (Pebley, Goldman, & Rodriguez, 1996; Snijders & Bosker, 1999):

$$\rho_v = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_f^2 + \sigma_i^2} \text{ and } \rho_f = \frac{\sigma_v^2 + \sigma_f^2}{\sigma_v^2 + \sigma_f^2 + \sigma_i^2}. \tag{3}$$

The individual level variance, σ_i^2 is equal to $\pi^2/3$. The total variability in individual probability of immunization can be partitioned into three components: (a) variance among children within families, (b) families within communities, and (c) communities. We expand on this below.

First, we fit an empty model, the simplest case of the hierarchical linear model, of receiving full immunization. It is an empty model because it does not contain a single explanatory variable. Since it is a three-level model indicating there is variability on three levels, the total variance can be partitioned into three variance components. The parameter estimates are presented in Table 3. The total variance in receiving immunization among all children is the sum of the three variance components, which is equal to 7.642. We can see in Table 3 that all three components contribute non-trivially and that the community and individual level effects are particularly noteworthy. Applying Eq. (3), the intrafamily (ρ_f) and intracommunity (ρ_v) correlations are estimated to be 0.46 and 0.57, respectively. These are rather high and indicate that including community and family level random effect variable may improve our estimates in the final model. The intraclass correlations are summarized in Table 4. Since all children of the same family live in the same community, ρ_f is always greater or equal to ρ_v . They suggest that belonging to a particular family and community in Southern Ethiopia has considerable importance in predicting full immunization.

We now turn to the results of the multilevel model and examine the contribution of parental migration status and other explanatory variables. Here, the model includes observed covariates at the individual child,

Table 3
Estimates for empty model without covariates

| Fixed effect | Coefficient | Standard error |
|------------------|--------------------|----------------|
| Intercept | −1.933 | 0.365 |
| Random effect | Variance component | Standard error |
| Community level | 3.541 | 1.021 |
| Household level | 0.812 | 0.277 |
| Individual level | 3.289 | 1.000 |
| −2Log likelihood | −692.02 | |

Table 4
Intraclass correlations based on a model without covariates of receiving immunization

| Correlation type | Value of correlation |
|-----------------------------|----------------------|
| Intracommunity (ρ_v) | 0.46 |
| Intrafamily (ρ_f) | 0.57 |

family, and community levels. The means of all variables included in the analysis are provided in Appendix A. Table 5 presents the results of our final multilevel model for a child receiving full immunization. The deviance is a measure of lack of good-fit and the estimate from our model shows that our model fits the data very well. We will begin discussing the results of child-level explanatory variables. This result contrasts with significant sex differentials in Asia for childhood mortality, traced in turn to variations in health care received by boys and girls. We find no significant difference in immunization between boys and girls. Also, maternal age at birth of the child has no significant effect in receiving full immunization. On the other hand, age of a child has substantial effect, with older children less likely to receive full immunization. This result may not be very surprising given that these older children were born during the country's early transition years from the Derg regime to the new government. During the Derg era Ethiopia was overcome by political turmoil and protracted civil war. Social services—in particular, health services—were non-operational or disrupted. Because it took some time to revive the health sector, children born immediately after the civil war received less immunization coverage relative to those children born in recent years.

Moving on to the effect of family characteristics, we first notice that while father's migration has no significant effect on child immunization, a substantial effect is found for mother's migration status. Interestingly, only when the mother is a rural–rural migrant do we observe a strong and negative impact on child immunization. Since the overwhelming majority (73%) of women migrated for reasons related to marriage, the strong and negative effect of rural–rural migrant mothers suggests that their disconnectedness from their host community adversely affects the immunization of their children, since their social networks in the place of destination are limited. The most surprising finding of this study is that duration of residence has no effect on child immunization at all: the negative impact of the mother's rural–rural migration experience persists even if we control for her time in the destination community.

While other coefficients for migrant status are non-significant, they are tested formally against the rural non-migrant reference category. It is worthwhile to bear in mind the overall pattern of migrant status effects, in

Table 5
Parameter estimates and standard errors for the three-level model for the uptake of full immunization

| Variable | Estimate | Standard error |
|---|----------|----------------|
| Intercept | −1.863* | 0.840 |
| <i>Child-level</i> | | |
| Sex of child is boy | 0.108 | 0.184 |
| Age of child | −0.136* | 0.058 |
| Age of mother at birth of a child | 0.014 | 0.017 |
| <i>Family level</i> | | |
| Father's migration status | | |
| Rural non-migrant (ref.) | 0.000 | |
| Urban native | 0.274 | 0.731 |
| Rural–rural migrant | −0.146 | 0.510 |
| Rural–urban migrant | 0.274 | 0.731 |
| Mother's migration status | | |
| Rural non-migrant (ref.) | 0.000 | |
| Urban native | 0.684 | 0.643 |
| Rural–rural migrant | −0.831* | 0.301 |
| Rural–urban migrant | 0.087 | 0.604 |
| Duration of mother at current residence | 0.005 | 0.018 |
| Mother's education | | |
| No schooling (ref.) | 0.000 | |
| Some schooling | 0.832* | 0.273 |
| Father's education | | |
| No schooling (ref.) | 0.000 | |
| Some schooling | 0.008 | 0.251 |
| Ethnicity | | |
| Sidama (ref.) | 0.000 | |
| Gurage | 0.379 | 0.703 |
| Hadiya | 1.248* | 0.659 |
| KAT | 1.069* | 0.589 |
| Wolaita | 0.922* | 0.568 |
| Others | 0.411 | 0.542 |
| <i>Village-level</i> | | |
| Ecological zone | | |
| Lowland (ref.) | 0.000 | |
| Highland | −0.307 | 0.508 |
| Distance to nearest health center | −0.638* | 0.235 |
| <i>Random effects</i> | | |
| Household level | 1.065* | 0.309 |
| Community level | 1.428* | 0.470 |
| Deviance | −221.23* | |

*Significant at the 5% level or less.

the presence of such extensive personal and community controls. The direction of effect for rural–rural migrant fathers is also negative, suggesting that children with dual migrant parents are probably even more disadvantaged. Children of urban natives are, as expected, especially advantaged (over rural non-migrants). Children of rural–urban migrants are somewhat advantaged over rural stayers and movers, with the net immunization benefit of both rural–urban migrant parents to be about half that of urban natives.

The influence of mother's education on child immunization is as expected: mother's education is significantly and positively associated with child immunization. This is consistent with other prior research on the subject. On the other hand, father's education has no significant effect on child immunization. There is also significant variation in child immunization by ethnic background. Compared to children born to the Sidama ethnic group, children born to the Hadiya, KAT, and Wolaita ethnic groups are more likely to receive full immunization. A cross-tabulation indicates that there is an appreciable—but far from deterministic—association between community and ethnicity, especially in the rural communities, this could be related to variation in economic problems, local health practices, and quantity and quality of health services and vaccination campaigns.

We now turn to community-level covariates. Although we expected higher immunization uptake in the lowland areas, no significant effect of ecological zone on child immunization is found. However, it is important to note that bivariate analysis (results not shown) indicates that while children living in lowland zones have higher immunization coverage for polio, BCG, and measles, they have lower immunization rates for DPT3. This indicated the less effectiveness of the immunization programs in the lowlands compared to the highland areas. Distance to nearest health center is found to be significantly and inversely related with child immunization. This is in line with our hypothesis and it is noteworthy, because we are also controlling for urban–rural residence and ecological characteristics.

Estimates of the random effects at both the family and village level are statistically significant, even in the presence of controls for a number of observed family and village characteristics. Unobserved community and family characteristics remain strong determinants of child immunization in Southern Ethiopia. Quality and quantity of health services in a village, motivation of health workers, extent of government campaigns and family's health beliefs and their previous experience in relation to child immunization and child mortality are possible unobserved factors that might be linked to these effects.

In order to make clear the implications of a multilevel approach, we compare the results to those obtained

from using a conventional logit regression. The results of this regression (using STATA software) are shown in Appendix B. Comparison of these results reveals that key coefficients differ in magnitude and direction across the two estimation specifications. Most importantly, the coefficients for parental migration status, the key variable in our analysis, shift. The direction of the coefficients for some covariates—father urban-native, father rural–urban migrant, and duration of mother at current residence—are reversed. As expected, the standard errors obtained using the standard logit are smaller than the standard errors under the (MLwiN) multilevel specification. This indicates that failure to account for unobserved community and family level variables leads to underestimation of standard errors. For example, while the ethnic difference between the Sidama and Gurage ethnic groups is insignificant in the multilevel model, it appeared to be significant in the logit model.

Although many conclusions derived from this study regarding the statistical significance of effects of explanatory variables based on an ordinary logit model are consistent with the inferences based on multilevel models, our comparison confirms the superiority of using a multilevel approach when data are hierarchically structured.

Conclusion

In this study we have examined the impact of parental migration on immunization of children in a country where war, famine, and economic deterioration have influenced both health resources and population distribution in the last three decades. We used a multilevel approach to examine determinants of immunization among children born between 1991 and 1996 and of ages between 12 and 59 months. There have been repeated international and national exhortations to improve child immunization, yet success has been elusive. When the Ethiopian government established an expanded program of immunization (EPI) in 1980, the goal was to reach 100% coverage by the year 1990 (Lidetu & Okubazgi, 1993). Similarly, the WHO and UNICEF (the Alma Ata Declaration) have called for expanding child immunization in the developing world. Nevertheless, the low level of vaccination coverage among children in Ethiopia persists. In our study area, Southern Ethiopia, only 16% of children between 1 and 5 years old received full immunization. This raises serious concerns about the effectiveness of policies whose major objective is the enhancement of child health.

Parental migration experience does influence child immunization patterns in Southern Ethiopia. In the multivariate analysis, we find that children born to rural–rural migrant women are significantly less likely to

get immunization compared to children born to non-migrant women residing in rural areas, even after adjusting for several child, family and village-level explanatory variables. Given the extremely low immunization rates in Ethiopia, general improvements in vaccination coverage could have considerable impact. Such programs are needed even more so within rural areas. Within this context, our results suggest that programs, policies, and immunization campaigns should give special emphasis to reaching children born to rural–rural migrants.

Unlike father's education, mother's education is found to be an important determinant of child immunization. In this regard, improving female education is an important policy strategy. Distance to the nearest health center also has an important effect on child immunization. Therefore, elimination of unequal access to modern health services by increasing the number of health centers or reducing transportation barriers in those deprived villages is an important policy consideration.

Our results reveal that there is great variability in children's immunization across villages and families. The statistical findings suggest that even in the presence of controls for a number of observed family and village characteristics, unobserved (unmeasured) family and village attributes remain strong determinants of a child's receipt of full immunization. This result suggests the value of further efforts, on the one hand, to discern the ultimate source of this community variation, and on the other hand, to be alert the public health consequences of appreciable variation beyond standard observable family and community traits.

This research extends previous research on the interrelationship of migration and health with both methodological and substantive contributions. First, unlike previous studies, which focus on rural–urban migration, we considered all migration types. Migration between rural communities is the most common type of migration in Africa, and women's rural–rural migration is found to have significantly negative impact on child immunization. Our second contribution lies in illuminating the pathways through which women's rural–rural migration impact child immunization. Limited social networks of migrant women and their disconnectedness from the social fabric of the host community is a likely social mechanism explaining this huge differential in child immunization. We find, moreover, that the effect of, this disconnectedness does not appear to dissipate over time. Our third contribution is methodological. We employed a multilevel approach which is appropriate to the research design of the survey. Comparison of our approach with the commonly used modeling strategies of ordinary logistic regression shows the cost of ignoring the multilevel structure of the data. Results from the ordinary logit model provide biased estimates of

standard errors and different results in magnitude and direction for some key variables.

In summary, we adopted a modeling strategy that aims to disentangle child, family, and community contextual effects on child immunization. We obtain measures of these effects, while preserving substantive estimates of key covariates. Our results point to policies—interventions attentive to the disruptive effects of rural–rural migration and the barriers of transport access and distance—that could improve child immunization coverage.

Table 6
Descriptive statistics of selected variables used in the multilevel analysis ($n = 1614$)

| Variable | Mean |
|--|--------|
| <i>Sex of child</i> | |
| Boy | 0.524 |
| Girl | 0.476 |
| Age of child | 3.200 |
| Age of mother at birth of a child | 29.795 |
| <i>Parental migration status</i> | |
| Father is rural non-migrant | 0.732 |
| Father is urban native | 0.035 |
| Father is rural–rural migrant | 0.116 |
| Father is rural–urban migrant | 0.117 |
| Mother is rural non-migrant | 0.535 |
| Mother is urban native | 0.049 |
| Mother is rural–rural migrant | 0.318 |
| Mother is rural–urban migrant | 0.098 |
| Mother's duration of stay at current residence | 18.928 |
| <i>Parent's education</i> | |
| Mother have no schooling | 0.801 |
| Mother have some schooling | 0.199 |
| Father have no schooling | 0.608 |
| Father have some schooling | 0.392 |
| <i>Ethnicity</i> | |
| Sidama | 0.261 |
| Gurage | 0.051 |
| Hadiya | 0.173 |
| KAT | 0.198 |
| Wolaita | 0.105 |
| Others | 0.209 |
| <i>Place of residence</i> | |
| Rural | 0.892 |
| Urban | 0.108 |
| <i>Ecological zone</i> | |
| Lowland | 0.500 |
| Highland | 0.500 |
| Distance to nearest health center (in hours) | 1.700 |

Source: Southern Ethiopia community and health survey, 1997.

Table 7

Parameter estimates and standard errors from STATA for the uptake of full immunization (comparison analysis with no multilevel modeling)

| Variable | Estimate | Standard error |
|-----------------------------------|----------|----------------|
| Intercept | -1.892* | 0.520 |
| Sex of child is boy | 0.117 | 0.157 |
| Age of child | -0.105* | 0.050 |
| Age of mother at birth of a child | 0.032 | 0.016 |
| <i>Father's migration status</i> | | |
| Rural non-migrant | 0.000 | — |
| Urban native | -0.128 | 0.617 |
| Rural-rural migrant | -0.559 | 0.421 |
| Rural-urban migrant | -0.117 | 0.467 |
| <i>Mother's migration status</i> | | |
| Rural non-migrant | 0.000 | — |
| Urban native | 0.299 | 0.650 |
| Rural-rural migrant | -1.042* | 0.384 |
| Rural-urban migrant | 0.064 | 0.500 |
| Mother's duration of stay | -0.020 | 0.013 |
| <i>Mother's education</i> | | |
| No schooling | 0.000 | — |
| Some schooling | 0.710* | 0.217 |
| <i>Father's education</i> | | |
| No schooling | 0.000 | — |
| Some schooling | 0.192 | 0.199 |
| <i>Ethnicity</i> | | |
| Sidama | 0.000 | — |
| Gurage | 0.837* | 0.405 |
| Hadiya | 0.903* | 0.298 |
| KAT | 1.025* | 0.282 |
| Wolaita | 1.684* | 0.320 |
| Others | 0.546 | 0.284 |
| <i>Ecological zone</i> | | |
| Lowland | 0.000 | — |
| Highland | -0.034 | 0.171 |
| Distance to nearest health center | -0.672* | 0.104 |
| Log Likelihood | -551.26* | |

Source: Southern Ethiopia community and health survey, 1997.

*Significant at the 5% level or less.

Limitations of the current study need to be acknowledged. The first limitation is that our study lacks several important health provision variables such as frequency of immunization sessions, quality of health services provision in the community, etc. Therefore, we are unable to address the contribution of some other factors that affect child immunization. The second limitation is

that our data do not have direct information about the social networks of parents. Hence, it is impossible to accurately measure the extent of father's and mother's connectedness in the community they reside. These considerations, in combination with the substance and methodological advances we offer, suggest routes for improved primary data collection and analysis in the future.

Appendix A

See Table 6 for detail.

Appendix B

See Table 7 for details.

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