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Complete List of Authors:	Anglewicz, Philip; Tulane University School of Public Health and Tropical Medicine, Department of Global Community Health and Behavioral Science; VanLandingham, Mark; Tulane University School of Public Health and Tropical Medicine, Department of Global Community Health and Behavioral Science Manda-Taylor, Lucinda; University of Malawi, College of Medicine Kohler, Hans-Peter; University of Pennsylvania, Population Studies Center
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Cohort Profile: The Migration and Health in Malawi (MHM) Study

Authors:

Philip Anglewicz (corresponding author), Department of Global Community Health and Behavioral Sciences, 1440 Canal Street Suite 2200, Tulane University School of Public Health and Tropical Medicine, New Orleans LA 70112.

Mark VanLandingham, Department of Global Community Health and Behavioral Sciences, 1440 Canal Street Suite 2200, Tulane University School of Public Health and Tropical Medicine, New Orleans LA 70112.

Lucinda Manda-Taylor, Malawi College of Medicine, University of Malawi, 3rd Floor - John Chipangwi Learning Resource Centre, Private Bag 360, Chichiri Blantyre 3, Malawi.

Hans-Peter Kohler, Department of Sociology and Population Studies Center, 3718 Locust Walk, University of Pennsylvania, Philadelphia, PA 19104-6299.

Abstract

Purpose: The Migration and Health in Malawi (MHM) Study focuses on a key challenge in migration research: although it has long been established that migration and health are closely linked, identifying the effect of migration on various health outcomes is complicated by methodological challenges. The MHM Study uses a longitudinal pre- and post-migration study design (with a non-migrant comparison group) to measure and/or control for important characteristics that affect both migration and health outcomes.

Participants: Data are available for two waves. The MHM interviewed 398 of 715 migrants in 2007 (55.7%) and 722 of 1,013 in 2013 (71.3%); as well as 80.4% (604) of a non-migrant reference group in 2013. The total interviewed sample size for the MHM in both waves is 1,809. These data include extensive information on lifetime migration, socioeconomic and demographic characteristics, sexual behaviors, marriage, household/family structure, social networks and social capital, HIV/AIDS biomarkers, and other dimensions of health.

Findings to Date: Differences in health between migrants and non-migrants is primarily due to the selection of individuals with differing health status into migration, instead of the effect of migration on health. Migrants in Malawi have a significantly higher HIV prevalence than non-migrants, which is primarily due to the selection of HIV positive individuals into migration. We also find evidence of health selection in Malawi, where healthier men and women are relatively more likely to move, partly because migration selects younger individuals.

Future Plans: We are preparing for a third round of data collection for these (and any new) migrants, which will take place in 2018. This cohort will be used to examine the effect of migration on various health measures and behaviors, including general mental and physical health, HIV infection, smoking and alcohol use, access to and use of health services, and use of antiretroviral therapy (ART).

Strengths and Limitations of the Study

- This Migration and Health in Malawi (MHM) Study focuses on a key challenge in migration research: although migration and health are closely linked, the exact nature of this relationship is unknown in many settings. Does migration affect health, or are healthier (or less healthy) individuals more likely to migrate, or both? The MHM study uses longitudinal pre- and post-migration data to address this challenge.
- In addition to the longitudinal nature of the data, the MHM data also contain several key aspects of migration and health that have previously been neglected, including (a) spatial direction (rural-urban, rural-rural), (b) reason for migration (e.g. work, marital change, death of family member), (c) duration of migration, (d) gender, (e) and distance from origin (using GPS measures).
- Although several migration “streams” can be identified with MHM data (e.g., rural-rural, rural-town, rural-urban), the MHM study does not include migrants originating from urban areas or towns.

Introduction

It has long been assumed that migration and health are closely linked, but empirical results vary across settings and research designs. Many studies suggest that moving to a new location can improve health and well-being, and research often shows that individuals who previously migrated are in better health than their non-mobile counterparts [1-4]. Other studies have concluded that moving - to cities, for example - can have deleterious effects on health outcomes, e.g., acquisition of HIV and other STIs.

It has been challenging to empirically establish that migration *causes* changes in health, due to the need to address (1) possible selection bias, that healthier (or in some cases, less healthy) individuals are more likely to migrate [5-7]; (2) the “salmon bias” hypothesis, that less healthy individuals are more likely to return to areas of origin, and thus remaining migrants are relatively healthy [8-9], and (3) the possibility that the effect of migration on health status changes over time: some research shows that the better health of migrants declines as they spend more time in their post-migration residence [10-12].

The above hypotheses have seldom been adequately tested with the appropriate methodological approaches, primarily due to data limitations. Examining the extent of selection bias requires data on the health of individuals prior to migration, but research on migration across settings often relies on cross-sectional data to compare non-migrants with migrants *after* migration [13-19]. Identifying the effect of migration on health status, as opposed to merely examining differences in health status for individuals after migration with non-migrant populations, is facilitated by longitudinal data. However, longitudinal data that include health status for individuals before and after migration (in their destination) are very rare in any setting, particularly in sub-Saharan Africa (SSA).

The relatively few existing studies on migration in SSA typically use one of two study designs. The most common are cross-sectional studies with information for migrants after moving. The second type, such as Demographic Surveillance Sites (DSS), are geographically based in one location, with longitudinal measures collected for (1) individuals who migrate and return to the area of origin (“circular” or “temporary” migrants), or (2) “in” migrants, who move into the DSS

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3 site from elsewhere [20-24]. Individuals who move out of the study area (“permanent” migrants)
4 are typically not followed [21, 23-24], an approach that is unbiased only if in-migrants are the
5 same as permanent out-migrants, which is very unlikely to be the case in most settings.
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10 The Migration and Health in Malawi (MHM) Study addresses several key methodological
11 challenges in research on migration and health. Longitudinal data enables the study to (1) use
12 statistical methods that reduce biases which distort the estimation of causal effects of migration
13 on health outcomes, and (2) measure and control for the selection effects that hamper much of
14 the existing research on health and migration: differences in health outcomes between non-
15 migrants and migrants prior to migration. Also, in contrast to much previous migration research
16 that focus only on certain migrant populations (e.g. labor migrants, male migrants, rural-urban
17 migrants, young adults), the MHM uses a population-based approach that better represents the
18 wide range of migration patterns in sub-Saharan Africa (SSA).
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28 The MHM provides one of the first population-based longitudinal datasets on migration and
29 health in SSA. These data are the first to include extensive information on health status, HIV
30 infection, sexual behavior, remittances and transfers, migration history, and social networks for
31 migrants and non-migrants; including measurements on the above characteristics both before and
32 after migration (at post-migration locations). The MHM data include men and women across a
33 broad age range from young adulthood to old age.
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40 Primary research goals of the MHM include: (1) identify the selection effect of individuals with
41 differing health status into migration in Malawi (“migration selection”); (2) estimate the causal
42 effect of migration on mental and physical health status (“migration effect of health”) by using
43 longitudinal data from before and after migration and by employing statistical approaches that
44 control for unobserved determinants of migration and health; and (3) measure several key
45 aspects of migration and health that have previously been neglected in SSA, including (a) spatial
46 direction (rural-urban, rural-rural), (b) reason for migration (e.g. work, marital change, death of
47 family member), (c) duration of migration, (d) gender, (e) and distance from origin.
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56 **Cohort description**

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Setting

The MHM is associated with another study in Malawi, the Malawi Longitudinal Study of Families and Health (MLSFH). The MLSFH is a longitudinal panel survey that examines how families and individuals in rural Malawi cope with the high morbidity and mortality caused by the HIV/AIDS epidemic. The MLSFH began in 1998 in three sites of rural Malawi, Rumphu in the Northern Region, Mchinji in the Central Region and Balaka in the South. The original MLSFH sample included ever-married women and their spouses. The MLSFH study team returned to re-interview the same respondents (along with new spouses for respondents who remarried between the two waves) for five additional waves of survey data collection in 2001, 2004, 2006, 2008 and 2010. More information about the MLSFH study can be found in the MLSFH Cohort Profile [25].

Eligibility Criteria

In all waves of MLSFH, the most common reason for non-interview is migration. Migrants were identified through attempts to interview all respondents in the MLSFH target sample. While visiting the house of a respondent, the MLSFH team was informed of migration activity of previous respondents by friends and family members who remain in the MLSFH pre-migration village of the respondent. To qualify as a “migrant”, friends and family members must report that the individual has definitively moved from the MLSFH village to another location.

Sampling

The MHM sample includes these MLSFH migrants. The MHM has conducted two waves of data collection to date, in 2007 and 2013. Each wave was based on previous MLSFH respondents who were eligible for migration: those eligible for the MHM 1 study were the 4,950 respondents in the 2006 MLSFH target sample, and the 5,914 individuals MLSFH 2010 respondents were eligible for the MHM 2. Among those eligible, the first wave identified 804 individuals who were previously interviewed by MLSFH and were reported to have moved elsewhere during MLSFH data collection in 2006. During 2010 MLSFH data collection, the second wave identified 1,096 individuals who were interviewed at least once since 2001 and had moved elsewhere.

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3 Of those who moved, some migrated to areas outside of Malawi. Specifically, 89 individuals of
4 the MHM 1 target sample and 83 of the MHM 2 target samples were residing outside of Malawi
5 at the time of the respective survey. In both MHM 1 and 2, the most common country of
6 destination was Zambia, followed by Mozambique, reflecting the proximity of these countries to
7 Malawi. The MHM did not seek to trace these international migrants, thus reducing the wave
8 one target sample to 715 and second wave to 1,013.
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15 After removing international migrants, the MHM sought to trace all remaining internal migrants.
16 The first step to do so was to identify their current location. For this purpose, the migration
17 study team first returned to the MLSFH village where the migrant previously resided, and
18 administered a Migration Tracking Survey to friends or family members remaining in the
19 MLSFH sample village. The tracking survey included information on the current location of the
20 migrant (including city, town, or village of residence, phone number), the reason for migration,
21 and other information surrounding the circumstances of the move. This information was used to
22 trace migrants in the second step of the MHM study.
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31 In addition to internal migrants, two other samples are included in the MHM. Following the
32 MLSFH sampling strategy, the MHM interviewed all new spouses for migrants who married
33 since a previous interview (130 in 2007 and 120 in 2013). Second, due to the duration of time
34 since previous interview, the MHM 2 included a “non-migrant” comparison group of 751
35 individuals, randomly selected from the MLSFH roster, who had not moved at the most recent
36 wave (approximately 250 per site).
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44 Despite challenges in finding highly-mobile individuals in a low-income country setting, the
45 MHM traced and re-interviewed the majority of these internal migrants. The MHM interviewed
46 398 of 715 migrants in 2007 (55.7%) and 722 of 1,013 in 2013 (71.3%); the MHM also
47 interviewed 80.4% (604) of the non-migrant reference group in 2013. Overall, the total
48 interviewed sample size for the MHM in both waves is 1,809, which includes 983 migrants, 222
49 new spouses, and 604 non-migrants. Of the migrants and their new spouses, 325 were
50 interviewed at least twice, either in both waves of MHM, or in the first MHM wave and a
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3 subsequent MLSFH wave (i.e., return migration). A flow chart of MLSFH respondents eligible
4 for MHM, and MHM outcomes are shown in Figure 1.
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8 Measures

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10 Measures of health and health-related behaviors are central to the MHM. The MHM has
11 conducted HIV testing and counselling (HTC) at respondents' homes using Determine and
12 Unigold rapid tests. The MHM also collects information on general mental and physical health,
13 using the SF-12 set of questions. The MHM also collects extensive information on health
14 behaviors, such as sexual behavior, smoking and alcohol use, access to and use of health
15 services, and use of antiretroviral therapy (ART). Other measures collected by the MHM are
16 summarized in Table 1.
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24 The MHM also provides detailed measures of migration and the motivation for changing
25 residence. Among the more important measures is a full residence history for MHM respondents
26 in 2013, which includes a list of all locations where they lived for 6 months or more, along with
27 characteristics of the location and reasons for moving there. Given the dearth of migration
28 information in surveys in SSA, the residence histories can provide needed insight into migration
29 patterns of a highly-mobile population.
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36 Study Participant Characteristics

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38 Characteristics of the migrants in 2007 and 2013 (i.e., after migration) and the non-migrant
39 comparison group in 2013 are shown in Table 2. The majority of participants are female, and
40 average age is between 34 and 41 years old in both waves. Unlike many data sources in SSA
41 (such as Demographic and Health Surveys), the MHM has a substantial percentage of
42 participants beyond reproductive ages: over 10% of migrants were 50 years or older in both
43 MHM waves.
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49 Differences between migrants and non-migrants in some measures are evident in Table 2. HIV
50 status is higher among migrants, at 14.1% in wave 1 and 14.3% in wave 2, compared with 6.3%
51 among non-migrants in wave 2. However, mental and physical health, measured by the SF-12
52 summary score, is similar between these groups.
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5 Migration was not uncommon for most respondents: over 46% had lived outside of their district
6 for six months or more since the age of 15. Return migration was also fairly common in MHM2:
7 25.8% of migrants in 2013 were found in MLSFH villages of origin, and over 26% in 2007 and
8 13% in 2013 had lived outside their district for one month or more in the past year. Although
9 rural-to-urban migration has received considerable attention in the literature, intra-rural
10 migration is the most common migration stream: in 2013, 68% of all migrants moved to another
11 rural area. Nearly 25% of migrants moved to a district capital, or “town”. Rural-to-urban
12 migration was relatively rare, as only 8.4% of migrants moved to one of Malawi’s three regional
13 capitals, Lilongwe, Blantyre or Mzuzu.

21 22 Non-Response

23 To assess potential bias due to non-response, we examine the extent to which the sample of
24 migrants found in each wave may be different from those not found. We compare background
25 characteristics at baseline between migrants found and those not found in 2007 and 2013.
26 Results, in Table 3, show few differences: in 2007, MHM was less likely to find migrants from
27 the southern region and more likely northern region migrants, was less likely to find migrants
28 with no schooling, and found relatively wealthier migrants. The 2013 MHM wave was more
29 likely to find female migrants as compared to male migrants, and less likely to find migrants
30 from the southern region as compared to the other two MHM regions.

31 A full tabulation of migration tracking, including outcomes of attempts to interview, is found in
32 Table 4. The most prominent reasons for non-response among migrants were (1) moving again
33 (to an unknown or relatively distant location), and (2) not having sufficient information to trace
34 the migrant at their new location. Refusal rates were less than 3% in both waves of MHM.
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40 **Findings to date**

41 The first wave of MHM was designed to examine the relationship between migration and HIV
42 infection in Malawi. As elsewhere, the MHM 1 found that there is a significant association
43 between migration and HIV infection in Malawi, in which migrants have a significantly higher
44 HIV prevalence than non-migrants [26-27], as shown in Figure 2 for both MHM waves.
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Contrary to a common assumption that migration is an independent risk factor for HIV infection, the MHM instead found that, in Malawi, the higher prevalence of HIV among migrants is due to the selection of HIV positive individuals into migration streams rather than any effect of migration on HIV infection [26-27]. Figure 3 compares HIV prevalence between migrants and non-migrants at baseline, and again shows a significantly higher HIV prevalence among migrants before migration. The selection of HIV positive individuals into migration streams appears due to the connection between marriage, HIV status and migration in Malawi, in which HIV positive individuals are more likely to experience marital dissolution and subsequently move [26-27].

A follow-up of research on the relationship between HIV infection and migration using MHM 2 found similar results: HIV positive individuals are significantly more likely to migrate than the HIV negative [28]. This research also examined this relationship by destination (rural, town, urban), and found that being HIV positive significantly increased the relative risk that respondent will be a rural–urban migrant, rural–town migrant, and a rural–rural migrant, instead of a non-migrant. Being HIV positive also significantly increased the risk that a respondent will move and return to the village of origin and become a permanent migrant instead of not migrating [28].

MHM research has also focused on the relationship between migration and health. The MHM has examined two processes involved in this relationship: migration selection (differences in health status between migrants and non-migrants before migration), and migration effect (differences in health status after migration). Figure 4 shows results for migration selection: logistic regressions in which the dependent variable is future migration and the independent variable is health status prior to migration. Before migration, female MHM migrants have significantly better physical health (measured by SF-12 summary scores) than non-migrants. But after controlling for the fact that migrants are significantly younger than non-migrants, the difference disappears. There is a different story after migration, however. Before controlling for age there is no difference in health status after migration between migrants and non-migrants. After age is added to regression models, however, female migrants are in significantly worse

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3 mental and physical health compared to their non-migrant peers, and there is still no significant
4 difference in health status among men (Figure 5) [29].
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9 Another purpose of the MHM data is to reduce attrition bias in longitudinal analyses of MLSFH
10 data, an important potential bias when migrants are systematically different from non-migrants.
11 For this purpose, several studies have combined the MHM and MLSFH data to (1) examine
12 whether migrants are systematically different in various outcomes, such as HIV testing, marriage
13 and divorce, and education; and (2) reduce bias due to loss-to-follow-up [30-32].
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18 19 **Strengths and limitations**

20 Much migration research in SSA is motivated by a perceived connection between migration and
21 HIV risk and/or status. Empirical investigations of these potential connections have been
22 hampered by a lack of longitudinal data that includes pre- and post-migration observation. Such
23 data are essential for distinguishing between migration selection and the causal effect of
24 migration on HIV and other health outcomes. Building from the MLSFH, the MHM addresses
25 this limitation and is among the first population-based longitudinal datasets on migration and
26 health in SSA.
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35 The MHM is also exceptional with regard to its study population and measures. Much research
36 on migration has focused on male labor migrants. In addition to these male migrants, the MHM
37 also includes female labor migrants, as well as individuals moving for other reasons than work
38 (see table A1 for full list of reasons for migration among MHM respondents). As shown in
39 Table 1, both waves of the MHM capture substantial numbers of individuals over age 50, a
40 population that is increasing in size in SSA, and for which little is known about migration
41 patterns. Regarding measures, the MHM data are the first to include extensive information on
42 health status, HIV infection, sexual behavior, remittances and transfers, migration history, and
43 social networks for migrants and non-migrants, both before and after migration (at post-
44 migration locations).
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54 The MHM also includes measures of migration that are important but rarely included in
55 migration research in SSA. For example, the longitudinal nature of the data allow for the
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MLSFH to measure return migration. Return migrants comprise 25.8% of migrants found in 2013. The comparison of long term migrants, non-migrants, and temporary migrants is useful for analysis of “salmon bias” in migration research. The residence histories included in MHM 2 permit measurement of lifetime migration patterns, which can be linked to other life events, such as marriage, schooling, and employment. Other features of migration are also included in the MHM, such as migration stream (rural-rural, rural-town, rural-urban), migration duration, migration distance (using GPS measurements), and future migration plans.

The MHM has several limitations. The MHM residence histories list only locations where the respondent has lived for six months or more; residences of less than six months are not included. Some of these shorter-term residences could still become permanent (and could contribute meaningfully to health status). In addition, while the MHM is well-suited to measure migration streams originating from rural areas, it is limited in the extent to which it can measure migration from urban areas within Malawi.

Future Plans

The MHM will conduct a third wave of data collection, beginning in 2018. This data collection will follow the same approach as previous waves by interviewing all migrants formerly interviewed by the MHM and any individuals who moved out of the MLSFH sample area to another location within Malawi by 2018 (along with new spouses).

Contributions

HPK and PA initially conceived the manuscript. PA conducted the statistical analysis, and wrote the first draft of the article. HPK, LMT and MV reviewed the paper before submission and provided comments and edits.

Competing Interests

The authors declare no competing interests.

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5 NICHD R21HD071471-01 (Anglewicz & Kohler, PIs). The MLSFH, on which the MHM was
6 built, was funded by NICHD grants R03 HD05 8976, R21 HD050652, R01 HD044228, R01
7 HD053781, as well as funding through R24 HD-044964.
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13 14 **Data Sharing and Collaboration**

15 Information about the MHM is available on the MLSFH project website at
16 <http://malawi.pop.upenn.edu>. Researchers interested in using MHM data that have not yet been
17 made publicly available on the MLSFH website can submit a two-page description of their
18 proposed analysis plan to the MHM principal investigator (mail to: panglewi@tulane.edu). If
19 approved, researchers will then be asked to sign a Data Use Agreement to access and utilize the
20 data. For comparisons of migrants and non-migrants, MHM data can be linked to the public-use
21 MLSFH data that can be requested at <http://malawi.pop.upenn.edu>. All analyses of the restricted
22 MHM data are conducted in collaboration with members of the MHM study team.
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32 **Acknowledgements**

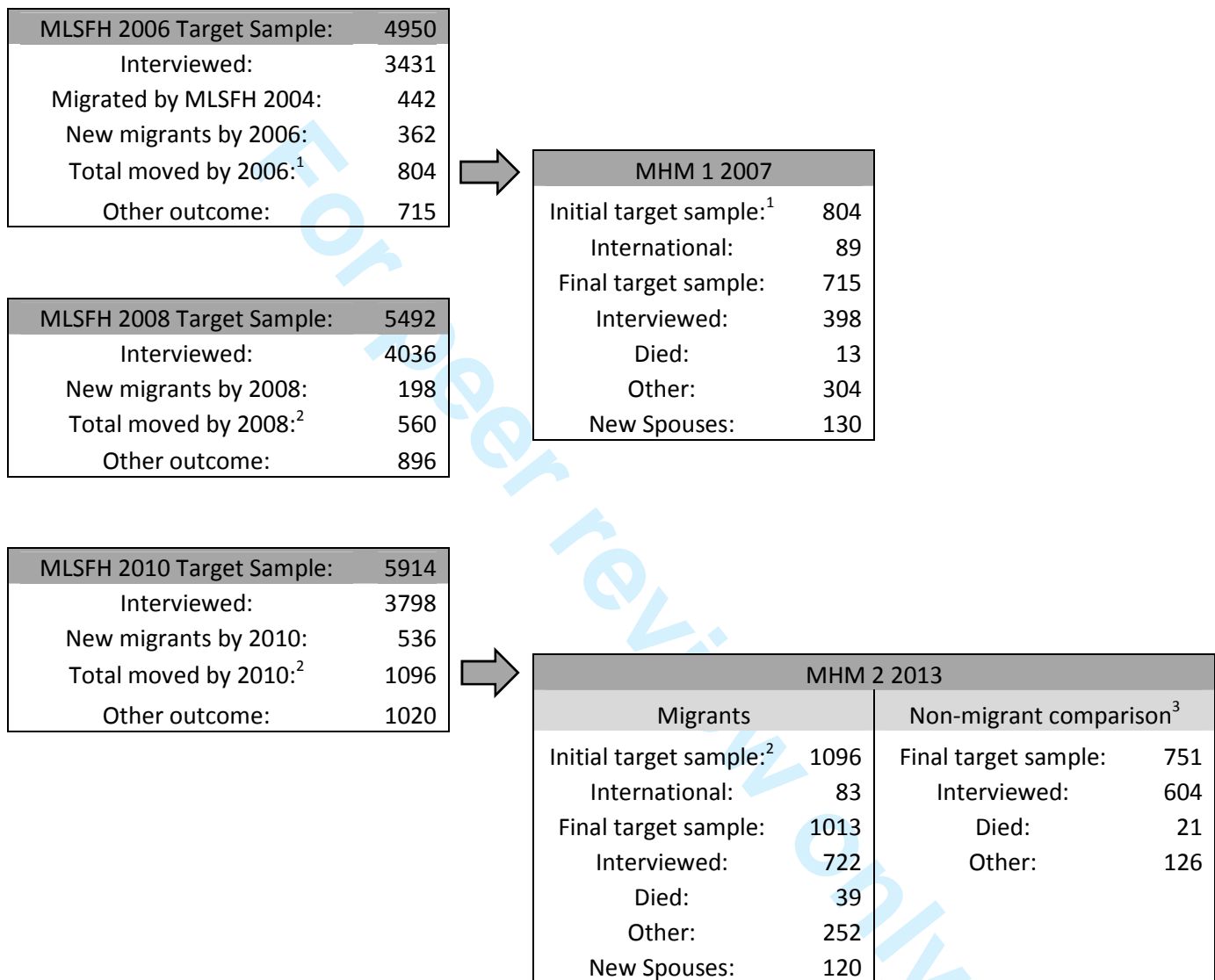
33 The MHM has been conducted in collaboration with the College of Medicine at the University of
34 Malawi and Invest in Knowledge (IKI) in Zomba, Malawi.
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39 **Ethical Approval**

40 The data collection and research conducted by MLSFH and MHM was approved by the
41 Institutional Review Boards at the University of Pennsylvania and Tulane School of Public
42 Health and Tropical Medicine, respectively. Both studies were approved in Malawi by the
43 College of Medicine Research Ethics Committee or the National Health Sciences Research
44 Committee.
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Tables and Figures

Figure 1: MHM Sample Flow Chart



Notes: (1) The sample for MHM 1 was all individuals interviewed in a previous MLSFH wave but moved elsewhere by 2006; (2) total moved by 2008 and 2010 includes only migrants interviewed in 2004 or sooner, as per MHM 2 sampling approach; thus the sample for MHM 2 was all migrants interviewed since 2001 but moved elsewhere by 2010; (3) the non-migrant comparison group in MHM 2 was randomly selected from the MLSFH roster from individuals who were interviewed in 2010.

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Table 1: MHM Data Collection Content

<u>MHM 1, 2007</u>	<u>MHM 1, 2013</u>
GPS coordinates	GPS Coordinates
HIV testing and counseling (Determine and Unigold rapid tests)	HIV testing and counseling (Determine and Unigold rapid tests)
Health measures	Health measures
- Overall self-rated health	- Overall self-rated health
- Self-rated health compared to peers	- Self-rated health compared to peers
	- SF-12 mental and physical health
Family and Household Structure	Family and Household Structure
- Complete listing of household members, some select family members	- Complete listing of household members, some select family members
Financial and Non-Financial Transfers	Financial and Non-Financial Transfers
- Exchanges to and from respondents involving family and household members	- Exchanges to and from respondents involving family and household members
	- Exchanges to and from most important transfers partners
Marriage and Sexual Behavior	Marriage and Sexual Behavior
- Complete Marriage History	- Complete Marriage History
- Sexual behavior and partnerships	- Sexual behavior
- HIV/AIDS-related perceptions and behaviors	- HIV/AIDS-related perceptions and behaviors
- HIV/AIDS social network partners characteristics	
Migration Patterns	Migration Histories
- Ties with previous village of residence	- Complete migration history for respondent
	- Migration patterns of family and household members
	Other Features of Malawi
	- Economic Shocks
	- Diet and Lifestyle
	- Health Care Utilization

Table 2: Background characteristics for MHM 2007 & 2013

	MHM 1, 2007	MHM 2, 2013	MHM 2, 2013
	Migrants	Non-migrants	Migrants
Female	57.3%	59.9%	56.5%
Mean age	34.4	40.9	35.0
Age group			
<20	5.5%	4.8%	6.6%
20-29	34.7%	27.2%	41.4%
30-39	29.9%	21.7%	21.0%
40-49	17.6%	17.4%	14.3%
50-59	8.8%	13.6%	9.2%
60+	3.5%	15.3%	7.5%
Region of residence			
South	29.6%	35.0%	29.1%
Central	36.7%	31.2%	39.9%
North	33.7%	33.8%	31.0%
Marital status			
Married	77.2%	81.1%	79.7%
Divorced/separated	4.8%	7.5%	11.2%
Widowed	8.5%	9.9%	5.1%
Never married	9.5%	1.5%	4.0%
Level of schooling			
None	17.6%	22.8%	13.0%
Primary	59.3%	63.3%	65.6%
Secondary or higher	23.1%	13.9%	21.3%
Mean number of living children	3.6	4.8	4.1
Health measures			
HIV positive	14.1%	6.3%	14.3%
SF-12 physical health score (mean)	----	53.4	53.5
SF-12 mental health score (mean)	----	54.8	53.9
Migration stream			
Rural-rural	----	----	65.2%
Rural-town	----	----	22.5%
Rural-urban	----	----	12.3%
Return migration	----	----	25.7%
Moved to			
Different district	32.3%	----	20.5%
Different region	10.0%	----	7.8%
Ever lived outside district for 6+ months since age 15	51.3%	----	46.9%
Stayed outside district for 1+ month in last year	26.6%	----	13.2%
N=	398	604	722

Table 3: Pre-migration differences between migrants found and those not found

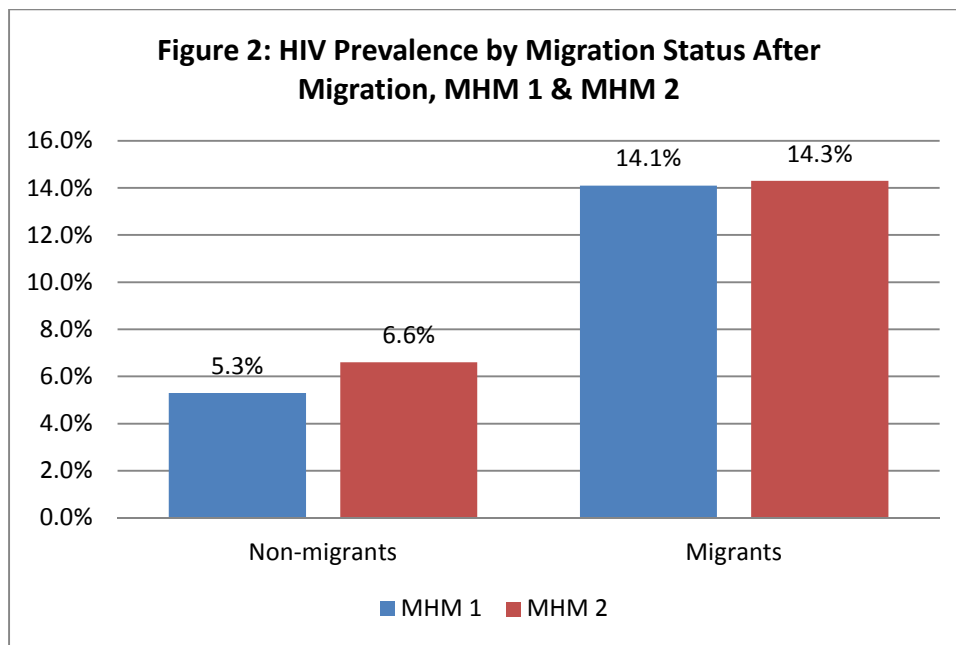
	MHM 1		MHM 2	
	Not Found	Found	Not Found	Found
Female	53.6%	57.2%	44.4%	56.2%***
Mean age	35.0	33.9	36.7	37.0
Age group				
<20	11.2%	11.8%	0.5%	0.4%
20-29	24.1%	29.4%	45.0%	40.5%
30-39	29.4%	29.4%	22.0%	24.4%
40-49	22.8%	18.7%	13.9%	15.8%
50-59	10.5%	7.9%	8.6%	9.6%
60+	2.0%	2.8%	10.0%	9.3%
Region of residence				
South	41.3%	32.5%*	36.5%	29.1%*
Central	28.4%	29.5%	38.3%	39.9%
North	30.3%	38.0%*	25.2%	31.0%
Marital status				
Married	75.8%	72.8%	80.5%	77.0%
Divorced/separated	1.5%	2.2%	2.5%	4.5%
Widowed	0.4%	2.0%	4.4%	5.2%
Never married	22.3%	23.0%	12.6%	13.3%
Level of schooling				
None	21.7%	12.4%**	16.5%	18.4%
Primary	63.3%	68.5%	64.5%	65.2%
Secondary or higher	15.0%	19.1%	19.0%	16.4%
Mean number of living children	3.2	3.4	3.3	3.3
HIV positive	10.1%	12.1%	10.1%	8.3%
N=	317	398	252	722

Notes: Difference between migrants found and not found is significant at * $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$. Pre-migration characteristics measured for found and not-found at 2004 for MHM 1 and 2008 for MHM 2; for time-varying measures, the last available measure is used for migrants not found. Household wealth is measured using principal components analysis of 12 household amenities. MHM 2 not found does not include deceased respondents or those moving internationally.

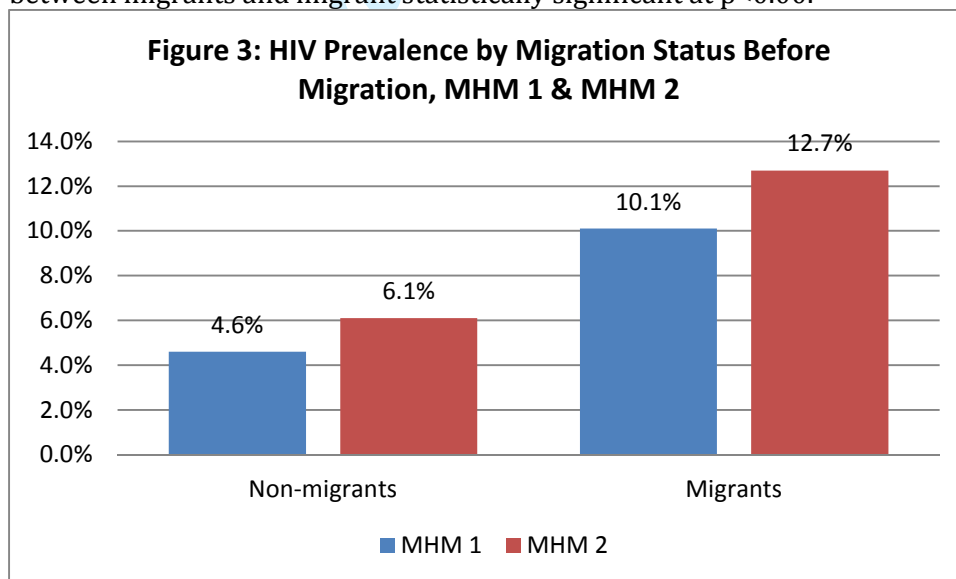
Table 4: Visit Outcomes for Target Samples, MHM 2007 & 2013

Outcome of Visit	MHM 1, 2007		MHM 2, 2013		MHM 2, 2013	
	Migrants		Non-migrants		Migrants	
	N	%	N	%	N	%
Completed	398	55.7%	604	80.4%	722	71.3%
Refused	15	2.1%	2	0.3%	15	1.5%
Dead	13	1.8%	21	2.8%	39	3.8%
Moved	34	4.8%	60	8.0%	37	3.7%
Temporarily away	9	1.3%	29	3.9%	12	1.2%
Sick/hospitalized	3	0.4%	3	0.4%	4	0.4%
Other/not found	243	33.9%	32	4.3%	184	18.2%
Total	715	100.0%	751	100.0%	1013	100.0%

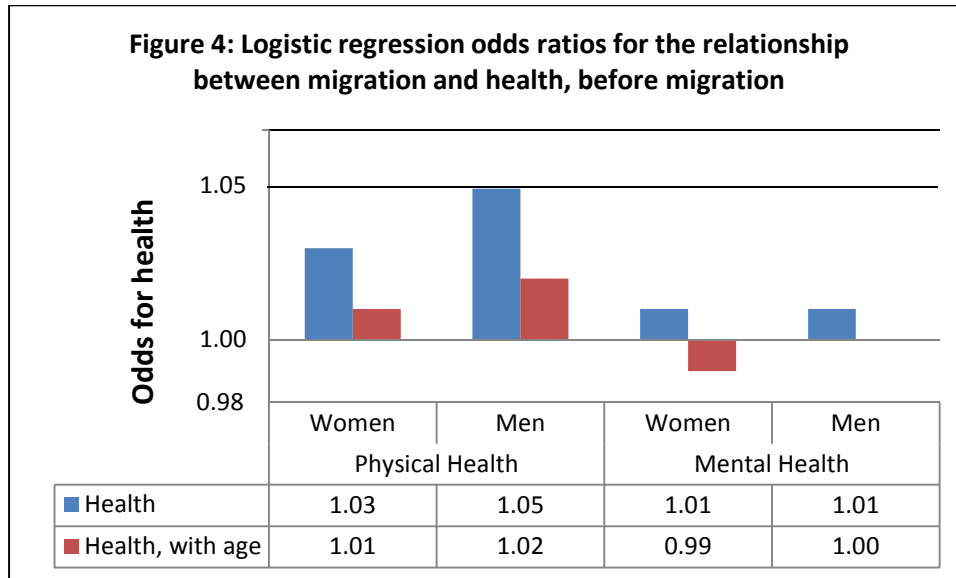
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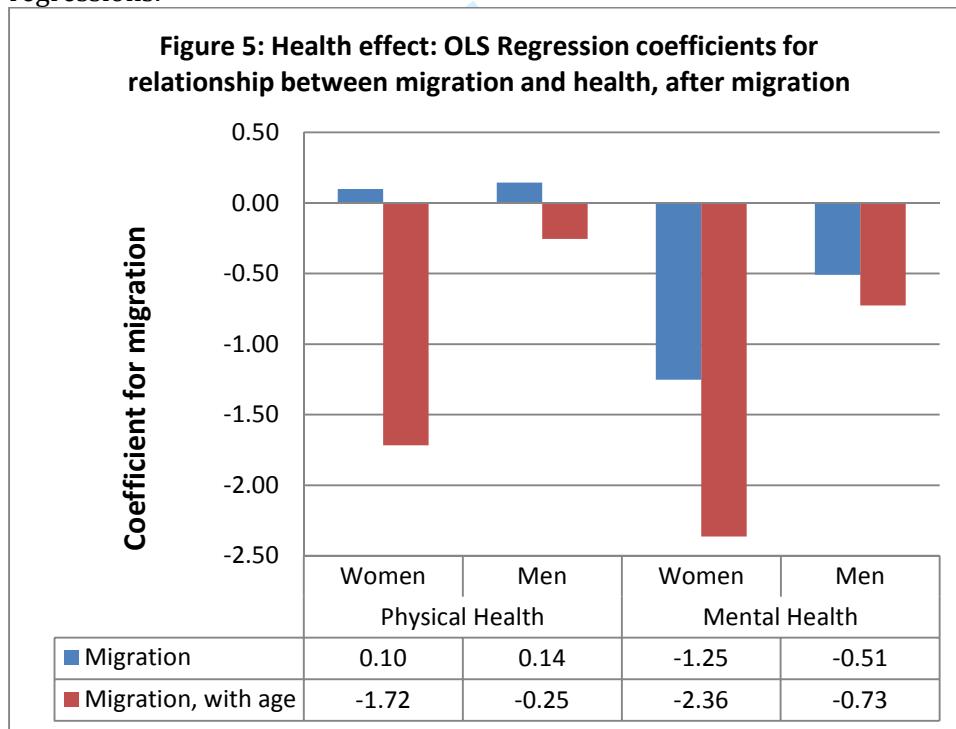
Notes: MHM 1 non-migrants come from the 2006 MLSFH; differences between migrants and migrant statistically significant at $p < 0.00$.



Notes: HIV status is the most recent available for migrants; differences between migrants and migrant statistically significant at $p < 0.00$.



Notes: Health (independent variable) is measured by SF12 summary scores of mental or physical health, migration (dependent variable) is a binary measure of migrant or non-migrant. Before controlling for age, difference in physical health status before migration is statistically significant at $p < 0.05$. Health is not significantly associated with future migration in other regressions.



Notes: Health (dependent variable) is measured by SF12 summary scores of mental or physical health, migration (independent variable) is a binary measure of migrant or non-migrant. Before controlling for age, relationship between migration and health is not statistically significant (at $p < 0.05$). After controlling for age, relationship between migration and health is significant at $p < 0.01$ for women.

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Cohort Profile: Internal Migration in Sub-Saharan Africa- The Migration and Health in Malawi (MHM) Study

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Cohort Profile: Internal Migration in Sub-Saharan Africa- The Migration and Health in Malawi (MHM) Study

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Authors:

31 Philip Anglewicz (corresponding author), Department of Global Community Health and
32 Behavioral Sciences, 1440 Canal Street Suite 2200, Tulane University School of Public Health
33 and Tropical Medicine, New Orleans LA 70112.
34

35
36 Mark VanLandingham, Department of Global Community Health and Behavioral Sciences, 1440
37 Canal Street Suite 2200, Tulane University School of Public Health and Tropical Medicine, New
38 Orleans LA 70112.
39

40
41
42 Lucinda Manda-Taylor, Malawi College of Medicine, University of Malawi, 3rd Floor - John
43 Chipangwi Learning Resource Centre, Private Bag 360, Chichiri Blantyre 3, Malawi.
44

45
46
47 Hans-Peter Kohler, Department of Sociology and Population Studies Center, 3718 Locust Walk,
48 University of Pennsylvania, Philadelphia, PA 19104-6299.
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Abstract

Purpose: The Migration and Health in Malawi (MHM) Study focuses on a key challenge in migration research: although it has long been established that migration and health are closely linked, identifying the effect of migration on various health outcomes is complicated by methodological challenges. The MHM Study uses a longitudinal panel pre- and post-migration study design (with a non-migrant comparison group) to measure and/or control for important characteristics that affect both migration and health outcomes.

Participants: Data are available for two waves. The MHM interviewed 398 of 715 migrants in 2007 (55.7%) and 722 of 1,013 in 2013 (71.3%); as well as 80.4% (604) of a non-migrant reference group in 2013. The total interviewed sample size for the MHM in both waves is 1,809. These data include extensive information on lifetime migration, socioeconomic and demographic characteristics, sexual behaviors, marriage, household/family structure, social networks and social capital, HIV/AIDS biomarkers, and other dimensions of health.

Findings to Date: Our result for the relationship between migration and health differ by health measure and analytic approach. Migrants in Malawi have a significantly higher HIV prevalence than non-migrants, which is primarily due to the selection of HIV positive individuals into migration. We find evidence for health selection; physically healthier men and women are more likely to move, partly because migration selects younger individuals. However, we do not find differences in physical or mental health between migrants and non-migrants after moving.

Future Plans: We are preparing for a third round of data collection for these (and any new) migrants, which will take place in 2018. This cohort will be used to examine the effect of migration on various health measures and behaviors, including general mental and physical health, smoking and alcohol use, access to and use of health services, and use of antiretroviral therapy (ART).

Strengths and Limitations of the Study

- This Migration and Health in Malawi (MHM) Study features longitudinal panel data for migrants (before and after migration), and a comparison group of non-migrants.
- These data are used to examine key issues in migration research, such as migration health selection, the effect of migration on health, and the health status of return migrants.
- Although the MHM study includes migrants to different destinations (rural, town, urban), all originate from rural areas; migrants originating from towns or cities are not included. The MHM also does not include in-migrants to the sample area, only those leaving.

Introduction

It has long been assumed that migration and health are closely linked, but empirical results vary across settings and research designs. Many studies suggest that moving to a new location can improve health and well-being, and research often shows that individuals who previously migrated are in better health than their non-mobile counterparts [1-4]. Other studies have concluded that moving - to cities, for example - can have deleterious effects on health outcomes, e.g., acquisition of human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs) [5-7].

It has been challenging to empirically establish that migration *causes* changes in health, due to the need to address (1) possible selection bias, that healthier (or in some cases, less healthy) individuals are more likely to migrate [8-14]; (2) the “salmon bias” hypothesis, that less healthy individuals are more likely to return to areas of origin, and thus remaining migrants are relatively healthy [9,12,14-19], and (3) the possibility that the effect of migration on health status changes over time: some research shows that the better health of migrants declines as they spend more time in their post-migration residence [14,20-23].

The above hypotheses have seldom been adequately tested with the appropriate methodological approaches, primarily due to data limitations. Examining the extent of selection bias requires data on the health of individuals prior to migration, but research on migration across settings often relies on cross-sectional data to compare non-migrants with migrants *after* migration [24-30]. Identifying the effect of migration on health status, as opposed to merely examining differences in health status for individuals after migration with non-migrant populations, is facilitated by longitudinal data. However, longitudinal data that include health status for individuals before and after migration (in their destination) are very rare in any setting, particularly in sub-Saharan Africa (SSA).

The relatively few existing studies on migration in SSA frequently use one of two study designs. The most common are cross-sectional studies with information for migrants after moving, sometimes including retrospective migration histories. The second type, such as Demographic Surveillance Sites (DSS), are geographically based in one location, with longitudinal measures

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3 collected for (1) individuals who migrate and return to the area of origin (“circular” or
4 “temporary” migrants), or (2) “in” migrants, who move into the DSS site from elsewhere [5,31-
5 33]. Individuals who move out of the study area (“permanent” migrants) are typically not
6 followed [31,33-34], an approach that is unbiased only if in-migrants are the same as permanent
7 out-migrants, which is very unlikely to be the case in most settings.
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14 The Migration and Health in Malawi (MHM) Study addresses several key methodological
15 challenges in research on migration and health. Longitudinal data enables the study to (1) use
16 statistical methods that reduce biases which distort the estimation of causal effects of migration
17 on health outcomes, and (2) measure and control for the selection effects that hamper much of
18 the existing research on health and migration: differences in health outcomes between non-
19 migrants and migrants prior to migration.
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27 The MHM provides one of the first population-based longitudinal datasets on migration and
28 health in SSA, which addresses limitations of previous studies that often focus on migrant
29 subgroups. The focus of migration and health research in SSA has disproportionately been on
30 labor migration [25,35-36], despite the fact that many migrate for marriage-, climate-, and
31 household-related reasons [5,26,37-38]. Due in part to the interest in labor migration, the spatial
32 movement of interest has primarily been rural-urban migration [16,39-40], and the gender focus
33 has often been on male migrants [40-42]. At the same time, rural-to-rural migration is the most
34 common type of movement in many parts of SSA [43-45], emerging research has shown that
35 rates of female migration is increasing in SSA [45], and there are important differences in
36 migrant characteristics by destination [46]. The MHM data also include men and women across
37 a broad age range from young adulthood to old age.
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48 These data also contain a wide range of measures, many of which are rarely collected for
49 migrants. The MHM include extensive information on health status, HIV infection, sexual
50 behavior, remittances and transfers, migration history, and social networks for migrants and non-
51 migrants; including measurements on the above characteristics both before and after migration
52 (at post-migration locations). The range of health measures is a particular asset for the MHM,
53 since it is likely that the relationship between migration and health varies by health measure and
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3 migrant group. For example, research has often found that physically healthier individuals are
4 more likely to migrate, but some studies have found migrants to have worse mental health
5 [14,20], and more likely to be HIV positive or practice risky sexual behavior [6,26-27]. In
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7 addition, research has found that the reason for migration differs between men and women in
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9 SSA (with men moving for work and women moving for marriage-related reasons), and by
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11 destination (urban, town, rural) [43]. We therefore expect to find differences in the relationship
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13 between migration and health by health measure, sex, and migration stream.
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18 Primary research goals of the MHM include: (1) identify the selection effect of individuals with
19 differing health status into migration in Malawi (“migration selection”); (2) estimate the causal
20 effect of migration on mental and physical health status (“migration effect of health”) by using
21 longitudinal data from before and after migration and by employing statistical approaches that
22 control for unobserved determinants of migration and health; and (3) measure several key
23 aspects of migration and health that have previously been neglected in SSA, including (a) spatial
24 direction (rural-urban, rural-rural), (b) reason for migration (e.g. work, marital change, death of
25 family member), (c) duration of migration, (d) gender, (e) and distance from origin.
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33 **Cohort description**

34 Setting

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37 Our study is set in Malawi, a generally very poor setting with a moderate HIV epidemic. Malawi
38 is divided into three regions (Southern, Central, Northern), and 28 districts. The largest cities in
39 Malawi are the three regional capitals, Blantyre (Southern), Lilongwe (Central), and Mzuzu
40 (Northern). Each district has an administrative center, which is a common destination for
41 migrants from rural areas.
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48 The MHM is integrated with another study in Malawi, the Malawi Longitudinal Study of
49 Families and Health (MLSFH). The MLSFH is a longitudinal panel survey that examines how
50 families and individuals in rural Malawi cope with the high morbidity and mortality caused by
51 the HIV/AIDS epidemic. The MLSFH began in 1998 in three sites of rural Malawi, Rumphi in
52 the Northern Region, Mchinji in the Central Region and Balaka in the South. The original
53 MLSFH sample included ever-married women and their spouses. The MLSFH study team
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3 returned to re-interview the same respondents (along with new spouses for respondents who
4 remarried between the two waves) for five additional waves of survey data collection in 2001,
5 2004, 2006, 2008 and 2010. The MLSFH target sample increased from 2,791 in 1998 to 6,306 in
6 2010. The MSLFH sample added to the sample in the following ways: (1) all new spouses for
7 individuals who married in between waves, (2) a sample of young adults aged 15-25 in 2004, and
8 (3) a sample of parents of respondents in 2008. The MLSFH survey has had consistently high
9 participation rates of over 70% (93% in 1998, 77% in 2001, 74% in 2004), and less than 3%
10 refused to be interviewed in every wave. Comparisons of background characteristics between
11 the MLSFH data and the rural sample of the Malawi DHS found relatively few substantive
12 differences [47]. MLSFH data collection in each year took place between May and August.
13 More information about the MLSFH study can be found in the MLSFH Cohort Profile [47].
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24 Eligibility Criteria

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26 In all waves of MLSFH, the most common reason for non-participation is migration. Migrants
27 were identified through attempts to interview all respondents in the MLSFH target sample. While
28 visiting the house of a respondent, the MLSFH team was informed of migration activity of
29 previous respondents by friends and family members who remain in the MLSFH pre-migration
30 village of the respondent. To qualify as a “migrant”, friends and family members must report
31 that the individual has moved from the MLSFH village to another location (as opposed to being
32 temporarily gone with the intention to return).
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40 Sampling

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42 The MHM sample includes these MLSFH migrants. The MHM has conducted two waves of
43 data collection to date, in January-April 2007 and July-November 2013. Each wave was based
44 on previous MLSFH respondents who were eligible for migration: those eligible for the MHM 1
45 study were the 4,950 respondents in the 2006 MLSFH target sample, and the 5,914 individuals
46 MLSFH 2010 respondents were eligible for the MHM 2. Among those eligible, the first wave
47 identified 804 individuals who were previously interviewed by MLSFH and were reported to
48 have moved elsewhere during MLSFH data collection in 2006. During 2010 MLSFH data
49 collection, the second wave identified 1,096 individuals who were interviewed at least once since
50 2001 and had moved elsewhere.
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5 Of those who moved, some migrated to areas outside of Malawi. Specifically, 89 individuals of
6 the MHM 1 target sample and 83 of the MHM 2 target samples were residing outside of Malawi
7 at the time of the respective survey. In both MHM 1 and 2, the most common country of
8 destination was Zambia, followed by Mozambique, reflecting the proximity of these countries to
9 Malawi. The MHM did not seek to trace these international migrants, thus reducing the wave
10 one target sample to 715 and second wave to 1,013.
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17 After removing international migrants, the MHM sought to trace all remaining internal migrants.
18 The first step to do so was to identify their current location. For this purpose, the migration
19 study team first returned to the MLSFH village where the migrant previously resided, and
20 administered a Migration Tracking Survey to friends or family members remaining in the
21 MLSFH sample village. The tracking survey included information on the current location of the
22 migrant (including city, town, or village of residence, phone number), the reason for migration,
23 and other information surrounding the circumstances of the move. This information was used to
24 trace migrants in the second step of the MHM study.
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33 In addition to internal migrants, two other samples are included in the MHM. Following the
34 MLSFH sampling strategy, the MHM interviewed all new spouses for migrants who married
35 since a previous interview (130 in 2007 and 120 in 2013). Second, due to the duration of time
36 since previous interview, the MHM 2 included a “non-migrant” comparison group of 751
37 individuals, randomly selected from the MLSFH roster, who had not moved at the most recent
38 wave (approximately 250 per site).
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46 Despite challenges in finding mobile individuals in a low-income country setting, the MHM
47 traced and re-interviewed the majority of these internal migrants. The MHM interviewed 398 of
48 715 migrants in 2007 (55.7%) and 722 of 1,013 in 2013 (71.3%); the MHM also interviewed
49 80.4% (604) of the non-migrant reference group in 2013. Overall, the total interviewed sample
50 size for the MHM in both waves is 1,809, which includes 983 migrants, 222 new spouses, and
51 604 non-migrants. Of the migrants and their new spouses, 325 were interviewed at least twice,
52 either in both waves of MHM, or in the first MHM wave and a subsequent MLSFH wave (i.e.,
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3 return migration). A flow chart of MLSFH respondents eligible for MHM, and MHM outcomes
4 are shown in Figure 1.
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8 Measures

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10 Measures of health and health-related behaviors are central to the MHM. The MHM has
11 conducted HIV testing and counselling (HTC) at respondents' homes using Determine and
12 Unigold rapid tests. The MHM also collects extensive information on health behaviors, such as
13 sexual behavior, smoking and alcohol use, access to and use of health services, and use of
14 antiretroviral therapy (ART). Other measures collected by the MHM are summarized in Table 1.
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21 The MHM also collects information on general mental and physical health, using the SF-12 set
22 of questions. The SF-12 has been shown to accurately capture physical and mental health status
23 in a wide range of settings [48-50], including sub-Saharan Africa [51-52]. SF-12 scores are
24 shown to be more robust measures of health than the single five point scale of health that is
25 commonly used in migration research [10]. SF-12 summary measures range from 0 to 100, with
26 higher scores indicating better health. Two summary measures, a mental health component
27 summary (MCS) score and a physical health component summary (PCS) score, are calculated by
28 aggregating data from the eight subscales [49]. The MHM/MLSFH-SF12 mental health score is
29 strongly correlated with more detailed measures of depression and anxiety that are available for
30 some non-MHM respondents [53].
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41 The MHM also provides detailed measures of migration and the motivation for changing
42 residence. Among the more important measures is a full residence history for MHM respondents
43 in 2013, which includes a list of all locations where they lived for 6 months or more, along with
44 characteristics of the location and reasons for moving there. Given the dearth of migration
45 information in surveys in SSA, the residence histories can provide needed insight into migration
46 patterns of a highly-mobile population.
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51 Study Participant Characteristics

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53 Characteristics of the migrants in 2007 and 2013 (i.e., after migration) and the non-migrant
54 comparison group in 2013 are shown in Table 2. Like the MLSFH, the majority of participants
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3 are female, and average age is between 34 and 41 years old in both waves. Unlike many data
4 sources in SSA (such as Demographic and Health Surveys), the MHM has a substantial
5 percentage of participants beyond reproductive ages: over 10% of migrants were 50 years or
6 older in both MHM waves.
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12 Differences between migrants and non-migrants in some measures are evident in Table 2. HIV
13 status is higher among migrants, at 14.1% in wave 1 and 14.3% in wave 2, compared with 6.3%
14 among non-migrants in wave 2. However, mental and physical health, measured by the SF-12
15 summary score, is similar between these groups.
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21 We measure different patterns of movement for MHM migrants. Over 46% of migrants had
22 lived outside of their district for six months or more since the age of 15 in MHM 2, compared
23 with 51% in MHM 1. Return migration was not uncommon in MHM 2: 25.8% of migrants in
24 2013 were found in MLSFH villages of origin, and over 26% in 2007 and 13% in 2013 had lived
25 outside their district for one month or more in the past year. Although rural-to-urban migration
26 has received considerable attention in the literature, intra-rural migration is the most common
27 migration stream: in 2013, 65.2% of all migrants moved to another rural area, and 22.5% of
28 migrants moved to a district capital, or “town”. Rural-to-urban migration was less common, as
29 only 12.3% of migrants moved to one of Malawi’s three regional capitals, Lilongwe, Blantyre or
30 Mzuzu.
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40 Non-Response

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42 To assess potential bias due to non-response, we examine the extent to which the sample of
43 migrants found in each wave may be different from those not found. We compare background
44 characteristics at baseline between migrants found and those not found in 2007 and 2013.
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46 Results, in Table 3, show few differences: in 2007, MHM was less likely to find migrants from
47 the southern region and more likely northern region migrants, was less likely to find migrants
48 with no schooling, and found relatively wealthier migrants. The 2013 MHM wave was more
49 likely to find female migrants as compared to male migrants, and less likely to find migrants
50 from the southern region as compared to the other two MHM regions.
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3 A full tabulation of migration tracking, including outcomes of attempts to interview, is found in
4 Table 4. The most prominent reasons for non-response among migrants were (1) moving again
5 (to an unknown or relatively distant location), and (2) not having sufficient information to trace
6 the migrant at their new location. Since our approach to finding these migrants relied on
7 gathering information on their location from friends and family members remaining in MLSFH
8 sample villages, we expect that migrants not found left fewer friends or family behind to report
9 on their location, and/or had fewer or weaker ties with MLSFH village residents after moving.
10 We also expect that information on current location is less accurate for less recent migrants.
11 Refusal rates were less than 3% in both waves of MHM. There were very few instances of
12 missing items, observations in these cases were dropped from the analysis.
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23 Findings to date

24 The first wave of MHM was designed to examine the relationship between migration and HIV
25 infection in Malawi. As elsewhere, the MHM 1 found that there is a significant association
26 between migration and HIV infection in Malawi, in which, according to chi squared tests,
27 migrants have a significantly higher HIV prevalence than non-migrants [43,54], as shown in
28 Figure 2 for both MHM waves (with results from chi squared tests).
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35 Contrary to a common assumption that migration is an independent risk factor for HIV infection,
36 the MHM instead found that, in Malawi, the higher prevalence of HIV among migrants is due to
37 the selection of HIV positive individuals into migration streams rather than any effect of
38 migration on HIV infection [43,54]. The higher HIV prevalence among migrants before moving
39 was established by multiple logistic regressions in which the dependent variable was migrating
40 in a future wave, and the key independent variable was HIV status before migration (also
41 controlling for multiple confounders, such as age). Results for the selection of HIV positive
42 individuals into migration were statistically significant and consistent by sex [43,54]. Similarly,
43 Figure 3 compares HIV prevalence between migrants and non-migrants at baseline using chi
44 squared tests, and again shows a significantly higher HIV prevalence among migrants before
45 migration. The selection of HIV positive individuals into migration streams appears due to the
46 connection between marriage, HIV status and migration in Malawi, in which HIV positive
47 individuals are more likely to experience marital dissolution and subsequently move [43,54],
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3 either returning to rural homes for care, or potentially to gain better access to antiretroviral
4 therapy (ART).
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9 Follow-up research on the relationship between HIV infection and migration using MHM 2
10 found similar results. Using several waves of data and random effects logistic regressions where
11 the dependent variable was migration in the future, and the independent variable of interest was
12 HIV status from a prior wave (controlling for data collection wave, sex, age and previous
13 migration), results were consistent: HIV positive individuals are significantly more likely to
14 migrate than the HIV negative (unadjusted odds ratio 2.26, adjusted 2.71 95% CI 1.62–4.54)
15 [55]. Next, classifying migrants by destination (rural, town, urban), MHM research also found
16 that being HIV positive significantly increased the relative risk that respondent will be a rural–
17 urban migrant (unadjusted relative risk ratio 2.41, adjusted 4.09 95% CI 1.68–9.97), a rural–
18 town migrant (unadjusted relative risk ratio 2.03, adjusted 3.62 95% CI 1.24–10.54), and a rural–
19 rural migrant (unadjusted relative risk ratio 2.48, adjusted 6.28 95% CI 1.77–22.26), instead of a
20 non-migrant. Being HIV positive also significantly increased the risk that a respondent will (1)
21 return migrate, and (2) permanently migrate instead of not migrating [55].
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34 MHM research has also focused on the relationship between migration and health. The MHM
35 has examined two processes involved in this relationship: migration selection (differences in
36 health status between migrants and non-migrants before migration), and migration effect
37 (differences in health status after migration). To examine migration selection, logistic
38 regressions were estimated for a dependent variable indicating future migration, using the SF-12
39 score of mental or physical health prior to migration as the main independent variable. Figure 4
40 shows results for migration selection: before migration, male and female MHM migrants have
41 significantly better physical health (measured by SF-12 summary scores) than non-migrants
42 (unadjusted odds ratio 1.04 for women, 1.05 for men). But after controlling for age (accounting
43 for the fact that migrants are significantly younger than non-migrants), the difference disappears
44 [56]. We also find differences in health selection by destination: classifying migrants by
45 destination (rural-rural, rural-town, rural-urban, all compared to non-migrants) finds that
46 selection of healthier individuals into migration is strongest for rural-rural and rural-urban
47 migrants, and is not evident for rural-town migrants.
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5 There is a different story after migration, however. To examine health differences between non-
6 migrants and migrants (after migration), we ran OLS regressions where the dependent variable is
7 the SF-12 score of mental or physical health after migration, and the independent variable of
8 interest is a binary indicator of migration status. Before controlling for age there is no difference
9 in health status after migration between migrants and non-migrants (Figure 5). After age is
10 added to regression models, however, female migrants are in significantly worse mental and
11 physical health compared to their non-migrant peers, and there is still no significant difference in
12 health status among men. As with migration health selection, we find differences in the effect of
13 migration on health by destination, with significant improvements in mental health for male
14 rural-urban migrants [56].
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25 Another purpose of the MHM data is to reduce attrition bias in longitudinal analyses of MLSFH
26 data, an important potential bias when migrants are systematically different from non-migrants.
27 For this purpose, several studies have combined the MHM and MLSFH data to (1) examine
28 whether migrants are systematically different in various outcomes, such as HIV testing, marriage
29 and divorce, and education; and (2) reduce bias due to loss-to-follow-up [57-59].
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35 Discussion

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37 Overall, results to date for the MHM study shows that the relationship between internal
38 migration and health in Malawi varies by health measure. For HIV infection, we find strong
39 evidence that those who are HIV positive are more likely to move in the future than those who
40 are HIV negative. The reason appears to be due to marital dissolution, which HIV positive
41 individuals are more likely to experience and is often followed by migration. This result is
42 consistent across destinations, with HIV positive individuals more likely to move to other rural
43 areas, towns and cities.
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51 At the same time, we find that physically healthier men and women are more likely to move.
52 Results from the MHM 2 study show that men and women with better physical health are
53 selected into migration. Unlike HIV status, the relationship between physical health and
54 migration varies by destination, with the healthier individuals moving to other rural areas and
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3 cities, but not towns. There is no statistically significant relationship between migration and
4 mental health, however; and there are no statistically significant differences in health status after
5 migration among men and women.
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10 Our findings to date have several implications for public health programs. The fact that HIV
11 positive individuals are more likely to move means that their behavior after migration will likely
12 affect the future course of the epidemic: are they more likely to remarry after they move? If so,
13 do they seek others who are HIV positive as potential spouses, or do they marry HIV negative
14 individuals? In addition, since some have called for specifically targeting migrants in HIV
15 prevention campaigns, our results suggest that this approach may not be effective in reducing
16 incidence if many migrants are already HIV positive. This research also has implication for
17 health systems: are HIV positive individuals moving to better access antiretroviral therapy
18 (ART)? Such a pattern should inform the supply of ART at various locations. At the same time,
19 it is important to note that migrants are in better physical health before moving, and there are no
20 significant differences in health status after moving (not controlling for age). Although migrants
21 may use HIV-related services more than non-migrants, use of health services may not differ for
22 other health conditions by migration status.
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35 **Strengths and limitations**

36 Much migration research in SSA is motivated by a perceived connection between migration and
37 HIV risk and/or status. Critical empirical investigations of these potential connections have been
38 hampered by a lack of longitudinal data that includes pre- and post-migration observation. Such
39 data are essential for distinguishing between migration selection and the causal effect of
40 migration on HIV and other health outcomes. Building from the MLSFH, the MHM addresses
41 this limitation and is among the first population-based longitudinal datasets on migration and
42 health in SSA.
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51 The MHM is also exceptional with regard to its study population and measures. Much research
52 on migration has focused on male labor migrants. In addition to these male migrants, the MHM
53 also includes female labor migrants, as well as individuals moving for other reasons than work
54 (see table A1 for full list of reasons for migration among MHM respondents). As shown in
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3 Table 1, both waves of the MHM capture substantial numbers of individuals over age 50, a
4 population that is increasing in size in SSA, and for which little is known about migration
5 patterns. Regarding measures, the MHM data are the first to include extensive information on a
6 wide array of measures (Table 1) both before and after migration (at post-migration locations).
7 The MHM also measures features of migration that are often not included in migration data, such
8 as return migration, full residence histories, different migration destinations (rural-rural, rural-
9 town, rural-urban), duration at residence, GPS measures before and after migration, and future
10 migration plans. Finally, given that MLSFH participants generally reflect characteristics of the
11 rural population of Malawi [47], and the relatively few differences in characteristics between
12 migrants found and not found, our results likely reflect the populations of interest in Malawi.
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23 The MHM has several limitations. The MHM residence histories list only locations where the
24 respondent has lived for six months or more; residences of less than six months are not included.
25 Some of these shorter-term residences could still become permanent (and could contribute
26 meaningfully to health status). In addition, while the MHM is well-suited to measure migration
27 streams originating from rural areas, it is limited in the extent to which it can measure migration
28 from urban areas within Malawi. The MLSFH does not systematically include individuals
29 moving into sample areas, so the MHM is only able to measure out-migration for this population.
30 Although we find few statistically significant differences in characteristics between migrants
31 found and those not found (Table 3), it is possible that these groups differ in other characteristics,
32 some of which may be related to individual health; and they may also differ in health after
33 migration (and they may have died at a higher rate than those found). These possible biases
34 would affect our analysis of migration health selection, and the impact of migration on health.
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46 **Future Plans**

47 The MHM will conduct a third wave of data collection, beginning in 2018. This data collection
48 will follow the same approach as previous waves by interviewing all migrants formerly
49 interviewed by the MHM and any individuals who moved out of the MLSFH sample area to
50 another location within Malawi by 2018 (along with new spouses). In addition to this new data
51 collection, we also intend to examine other research topics related to migration and health,
52 including differences by age (specifically focusing on older respondents), for reproductive health
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measures and other health measures, distance of migration, and the relationship between migration and transfers.

Contributions

HPK and PA initially conceived the manuscript. PA conducted the statistical analysis, and wrote the first draft of the article. HPK, LMT and MV reviewed the paper before submission and provided comments and edits.

Competing Interests

The authors declare no competing interests.

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Data Sharing and Collaboration

Information about the MHM is available on the MLSFH project website at <http://malawi.pop.upenn.edu>. Researchers interested in using MHM data that have not yet been made publicly available on the MLSFH website can submit a two-page description of their proposed analysis plan to the MHM principal investigator (mail to: panglewi@tulane.edu). If approved, researchers will then be asked to sign a Data Use Agreement to access and utilize the data. For comparisons of migrants and non-migrants, MHM data can be linked to the public-use MLSFH data that can be requested at <http://malawi.pop.upenn.edu>. All analyses of the restricted MHM data are conducted in collaboration with members of the MHM study team.

Acknowledgements

The MHM has been conducted in collaboration with the College of Medicine at the University of Malawi and Invest in Knowledge (IKI) in Zomba, Malawi.

Ethical Approval

The data collection and research conducted by MLSFH and MHM was approved by the Institutional Review Boards at the University of Pennsylvania and Tulane School of Public Health and Tropical Medicine, respectively. Both studies were approved in Malawi by the College of Medicine Research Ethics Committee or the National Health Sciences Research Committee.

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Tables and Figures

Figure 1: MHM Sample Flow Chart

Notes: the MHM studies also interviewed new spouses of migrants, 130 in 2007 and 120 in 2013; (1) the "other" outcome includes such reasons as temporarily away, sick/hospitalized, refused. A full tabulation of other outcomes for the MHM is shown in Table 4; (2) the sample for MHM 1 was all individuals interviewed in a previous MLSFH wave but moved elsewhere by 2006; (3) the sample for MHM 2 was all individuals interviewed since 2001 but moved elsewhere by 2010; (4) the non-migrant comparison group in MHM 2 was randomly selected from the MLSFH roster from individuals who were interviewed in 2010.

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Table 1: MHM Data Collection Content

<u>MHM 1, 2007</u>	<u>MHM 1, 2013</u>
GPS coordinates	GPS Coordinates
HIV testing and counseling (Determine and Unigold rapid tests)	HIV testing and counseling (Determine and Unigold rapid tests)
Health measures	Health measures
- Overall self-rated health	- Overall self-rated health
- Self-rated health compared to peers	- Self-rated health compared to peers
	- SF-12 mental and physical health
Family and Household Structure	Family and Household Structure
- Complete listing of household members, some select family members	- Complete listing of household members, some select family members
Financial and Non-Financial Transfers	Financial and Non-Financial Transfers
- Exchanges to and from respondents involving family and household members	- Exchanges to and from respondents involving family and household members
	- Exchanges to and from most important transfers partners
Marriage and Sexual Behavior	Marriage and Sexual Behavior
- Complete Marriage History	- Complete Marriage History
- Sexual behavior and partnerships	- Sexual behavior
- HIV/AIDS-related perceptions and behaviors	- HIV/AIDS-related perceptions and behaviors
- HIV/AIDS social network partners characteristics	
Migration Patterns	Migration Histories
- Ties with previous village of residence	- Complete migration history for respondent
	- Migration patterns of family and household members
	Other Features of Malawi
	- Economic Shocks
	- Diet and Lifestyle
	- Health Care Utilization

Table 2: Background characteristics for MHM 2007 & 2013

	MHM 1, 2007	MHM 2, 2013	MHM 2, 2013
	Migrants	Non-migrants	Migrants
Female	57.3%	59.9%	56.5%
Mean age	34.4	40.9	35.0
Age group			
<20	5.5%	4.8%	6.6%
20-29	34.7%	27.2%	41.4%
30-39	29.9%	21.7%	21.0%
40-49	17.6%	17.4%	14.3%
50-59	8.8%	13.6%	9.2%
60+	3.5%	15.3%	7.5%
Region of residence			
South	29.6%	35.0%	29.1%
Central	36.7%	31.2%	39.9%
North	33.7%	33.8%	31.0%
Marital status			
Married	77.2%	81.1%	79.7%
Divorced/separated	4.8%	7.5%	11.2%
Widowed	8.5%	9.9%	5.1%
Never married	9.5%	1.5%	4.0%
Level of schooling			
None	17.6%	22.8%	13.0%
Primary	59.3%	63.3%	65.6%
Secondary or higher	23.1%	13.9%	21.3%
Mean number of living children	3.6	4.8	4.1
Health measures			
HIV positive	14.1%	6.3%	14.3%
SF-12 physical health score (mean)	----	53.4	53.5
SF-12 mental health score (mean)	----	54.8	53.9
Diet & lifestyle			
Ever drink alcoholic beverages	----	22.2%	24.7%
Ever smoke tobacco or use smokeless tobacco	----	18.3%	15.4%
Have spending money for self	----	57.5%	45.7%
Average number of days per week eat outside house	----	0.56	0.67
Migration stream			
Rural-rural	----	----	65.2%
Rural-town	----	----	22.5%
Rural-urban	----	----	12.3%
Return migration	----	----	25.7%
Moved to			
Different district	32.3%	----	20.5%
Different region	10.0%	----	7.8%

Ever lived outside district for 6+ months since age 15	51.3%	----	46.9%
Stayed outside district for 1+ month in last year	26.6%	----	13.2%
N=	398	604	722

Notes: percentages of those accepting HIV testing were 90.5% in MHM 1, 94.8% of MHM 2 non-migrants, and 94.2% of MHM 2 migrants. Other than HIV positive, there were fewer than 1% missing values for all measures.

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Table 3: Pre-migration differences between migrants found and those not found

	MHM 1		MHM 2	
	Not Found	Found	Not Found	Found
Female	53.6%	57.2%	44.4%	56.2%***
Mean age	35.0	33.9	36.7	37.0
Age group				
<20	11.2%	11.8%	0.5%	0.4%
20-29	24.1%	29.4%	45.0%	40.5%
30-39	29.4%	29.4%	22.0%	24.4%
40-49	22.8%	18.7%	13.9%	15.8%
50-59	10.5%	7.9%	8.6%	9.6%
60+	2.0%	2.8%	10.0%	9.3%
Region of residence				
South	41.3%	32.5%*	36.5%	29.1%*
Central	28.4%	29.5%	38.3%	39.9%
North	30.3%	38.0%*	25.2%	31.0%
Marital status				
Married	75.8%	72.8%	80.5%	77.0%
Divorced/separated	1.5%	2.2%	2.5%	4.5%
Widowed	0.4%	2.0%	4.4%	5.2%
Never married	22.3%	23.0%	12.6%	13.3%
Level of schooling				
None	21.7%	12.4%**	16.5%	18.4%
Primary	63.3%	68.5%	64.5%	65.2%
Secondary or higher	15.0%	19.1%	19.0%	16.4%
Mean number of living children	3.2	3.4	3.3	3.3
HIV positive	10.1%	12.1%	10.1%	8.3%
N=	317	398	252	722

Notes: Difference between migrants found and not found is significant at * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$. Pre-migration characteristics measured for found and not-found at 2004 for MHM 1 and 2008 for MHM 2; for time-varying measures, the last available measure is used for migrants not found. Household wealth is measured using principal components analysis of 12 household amenities. MHM 2 not found does not include deceased respondents or those moving internationally.

Table 4: Visit Outcomes for Final Target Samples, MHM 2007 & 2013

Outcome of Visit	MHM 1, 2007		MHM 2, 2013		MHM 2, 2013	
	Migrants		Non-migrants		Migrants	
	N	%	N	%	N	%
Completed	398	55.7%	604	80.4%	722	71.3%
Refused	15	2.1%	2	0.3%	15	1.5%
Dead	13	1.8%	21	2.8%	39	3.8%
Moved	34	4.8%	60	8.0%	37	3.7%
Temporarily away	9	1.3%	29	3.9%	12	1.2%
Sick/hospitalized	3	0.4%	3	0.4%	4	0.4%
Other/not found	243	33.9%	32	4.3%	184	18.2%
Total	715	100.0%	751	100.0%	1013	100.0%

Notes: the "other" category includes several other reasons for non-interview, none of which individually represents a substantial proportion of the overall category, such as imprisonment, identity unknown, and incapable of interview. This table does not include international migrants (89 in 2007 and 83 in 2013), for whom visits were not attempted.

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Figure 2: HIV Prevalence by Migration Status After Migration, MHM 1 & MHM 2

Notes: MHM 1 non-migrants come from the 2006 MLSFH; differences between migrants and non-migrants chi squared tests statistically significant at $p < 0.00$.

Figure 3: HIV Prevalence by Migration Status Before Migration, MHM 1 & MHM 2

Notes: HIV status is the most recent available for migrants; differences between migrants and non-migrants chi squared tests statistically significant at $p < 0.00$.

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Figure 4: Logistic regression odds ratios for the relationship between migration and health, before migration

Notes: Health (independent variable) is measured by SF12 summary scores of mental or physical health, migration (dependent variable) is a binary measure of migrant or non-migrant. Difference in physical health status before migration is statistically significant at $p < 0.05$ for both men and women.

Figure 5: Health effect: OLS Regression coefficients for relationship between migration and health, after migration

Notes: Health (dependent variable) is measured by SF12 summary scores of mental or physical health, migration (independent variable) is a binary measure of migrant or non-migrant. The relationship between migration and health is not statistically significant (at $p < 0.05$).

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

Pg.	Item No	Recommendation
2	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
2		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
3-5	2	Explain the scientific background and rationale for the investigation being reported
5	3	State specific objectives, including any prespecified hypotheses
Methods		
5-10	4	Present key elements of study design early in the paper
5-6	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
6-8, F1	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed
7-8, T1	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
7-8, T1	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
4-6, 9-10	9	Describe any efforts to address potential sources of bias
6-7, F1	10	Explain how the study size was arrived at
10-12	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
10-12	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses
11-12, 10		
9-10, T3		
11		
Results		
6-8, F1	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
10-11, T3, T4		
F1		
T2	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)
T2		

1	T2,	Outcome data	15*	Report numbers of outcome events or summary measures over time
2	F2			
3	11-12	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
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7	N/A			(b) Report category boundaries when continuous variables were categorized
8	N/A			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
9				
10	10-12	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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14		Discussion		
15	11-13	Key results	18	Summarise key results with reference to study objectives
16	14-15	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
17				
18	12-13	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
19				
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21				
22	14	Generalisability	21	Discuss the generalisability (external validity) of the study results
23				
24		Other information		
25	15-16	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
26				
27				

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

Table A1: Reasons for migration, MHM migrants 2007 & 2013

	MHM 1, 2007						MHM 2, 2013					
	Female Migrants		Male Migrants		All Migrants		Female Migrants		Male Migrants		All Migrants	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
To look for work / offered job	44	19.4%	65	38.0%	109	27.4%	60	16.0%	83	29.9%	143	21.9%
Attending school	8	3.5%	9	5.3%	17	4.3%	5	1.3%	7	2.5%	12	1.8%
Divorce/separation or widowhood	37	16.3%	9	5.3%	46	11.6%	50	13.3%	15	5.4%	65	10.0%
New marriage	56	24.7%	16	9.4%	72	18.1%	132	35.2%	44	19.4%	186	28.5%
Illness	20	8.8%	3	1.8%	23	5.8%	8	2.1%	1	0.4%	9	1.4%
Staying with relative	9	4.0%	13	7.6%	22	5.5%	9	2.4%	5	1.8%	14	2.1%
New land for farming	24	10.6%	35	20.5%	59	14.8%	48	12.8%	4	1.9%	102	15.6%
Conflict with others in village	7	3.1%	1	0.6%	8	2.0%	31	8.3%	11	7.6%	52	8.0%
Other reason	22	9.7%	20	11.7%	42	10.6%	32	8.5%	8	13.7%	70	10.7%
Total	227	100.0%	171	100.0%	398	100.0%	375	100.0%	78	100.0%	653	100.0%

Notes: Limited to categories that are consistent across waves; in 2013 reason for migration was asked only for those who lived elsewhere for 6 months or more

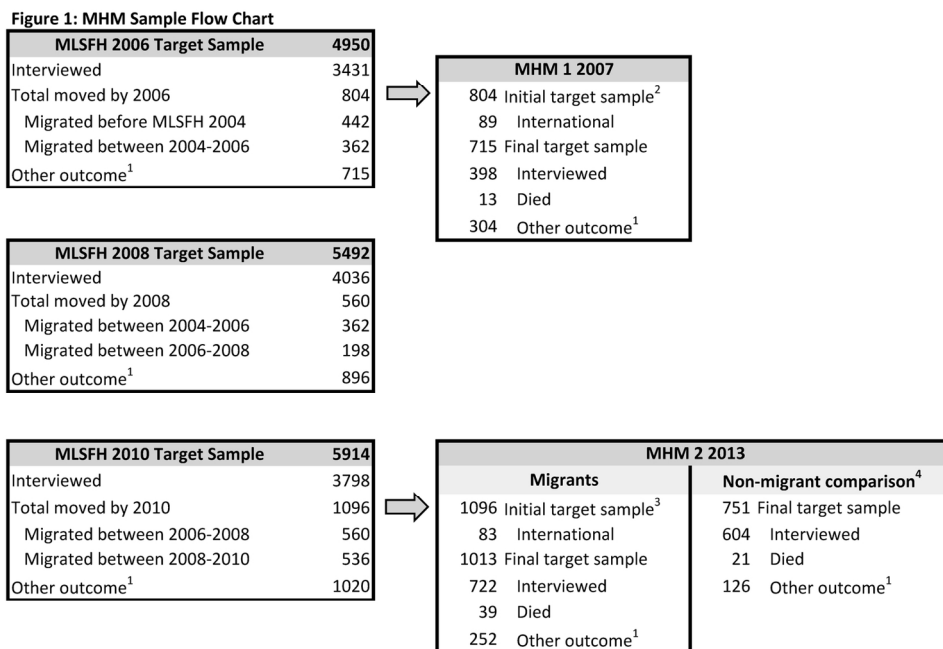


Figure 1: MHM Sample Flow Chart

151x108mm (300 x 300 DPI)

Review only

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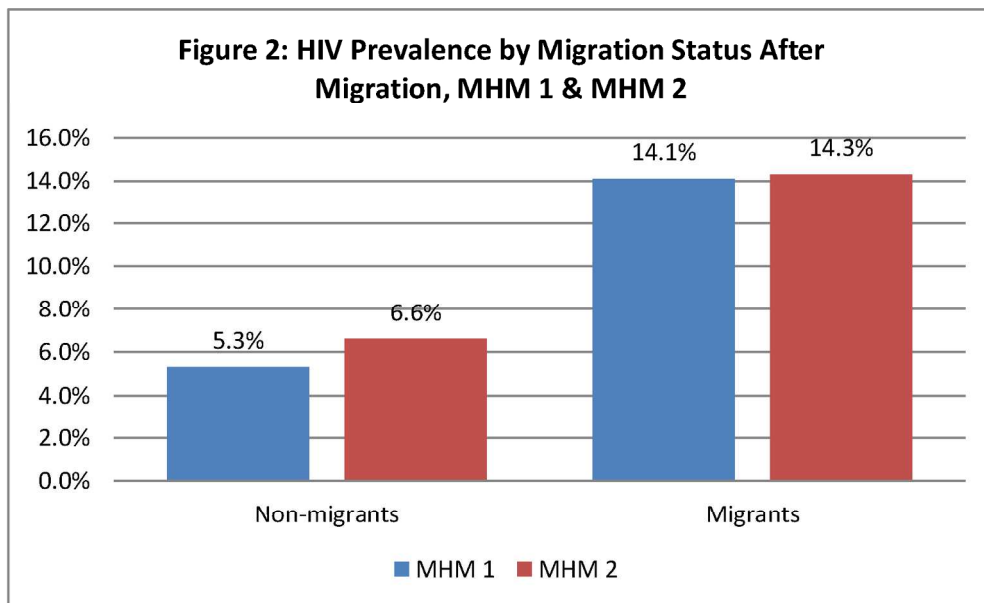


Figure 2: HIV Prevalence by Migration Status After Migration, MHM 1 & MHM 2

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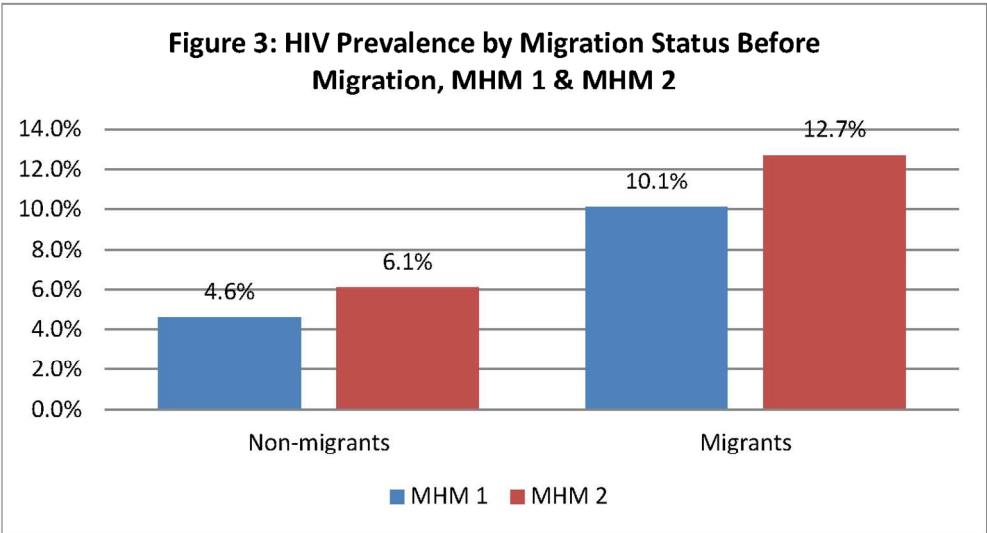


Figure 3: HIV Prevalence by Migration Status Before Migration, MHM 1 & MHM 2

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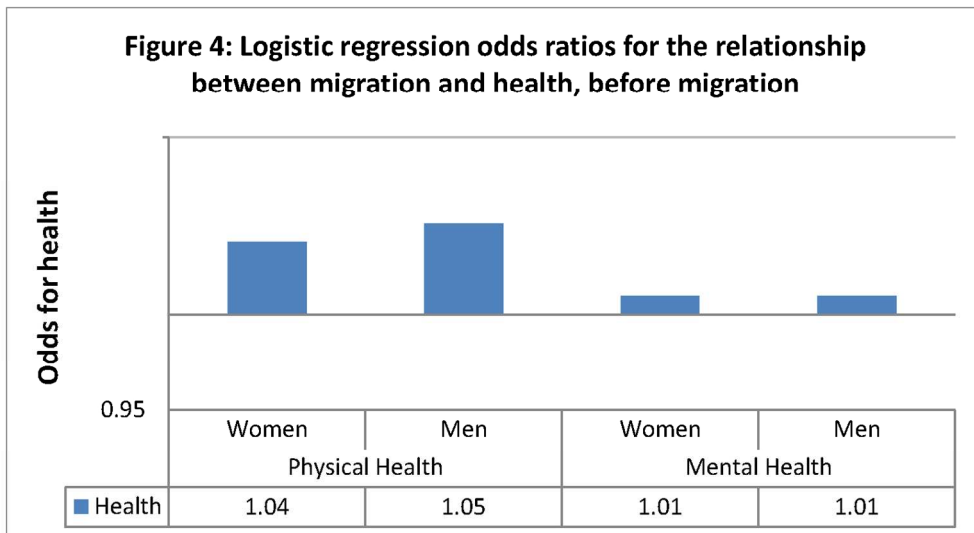


Figure 4: Logistic regression odds ratios for the relationship between migration and health, before migration

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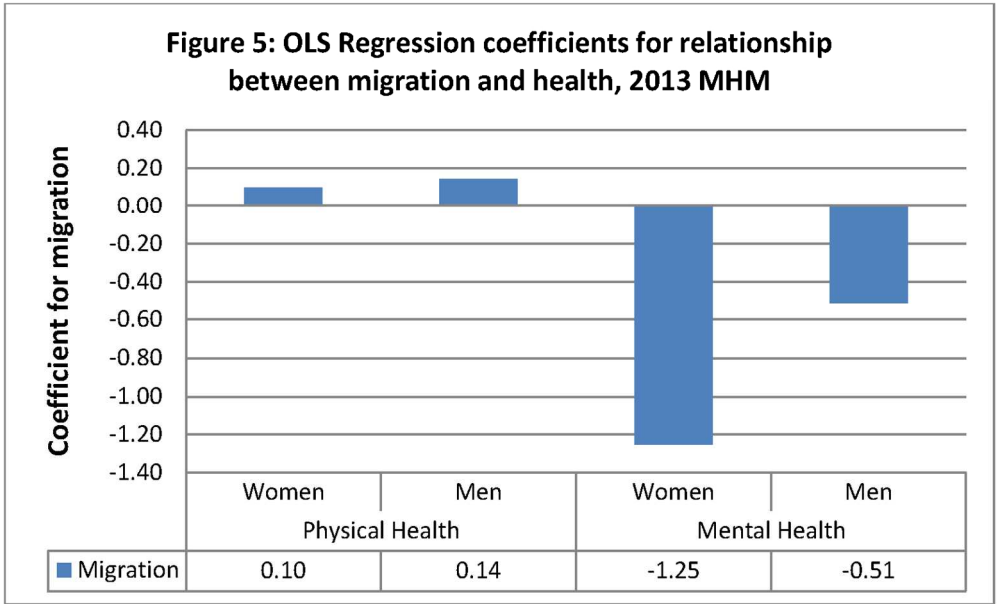


Figure 5: Health effect: OLS Regression coefficients for relationship between migration and health, after migration

138x84mm (300 x 300 DPI)

Review only

BMJ Open

Cohort Profile: Internal Migration in Sub-Saharan Africa- The Migration and Health in Malawi (MHM) Study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-014799.R2
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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	HIV/AIDS, Mental health, Public health, Sociology
Keywords:	EPIDEMIOLGY, HIV & AIDS < INFECTIOUS DISEASES, PUBLIC HEALTH

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Cohort Profile: Internal Migration in Sub-Saharan Africa- The Migration and Health in Malawi (MHM) Study

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Authors:

31 Philip Anglewicz (corresponding author), Department of Global Community Health and
32 Behavioral Sciences, 1440 Canal Street Suite 2200, Tulane University School of Public Health
33 and Tropical Medicine, New Orleans LA 70112.
34

35
36 Mark VanLandingham, Department of Global Community Health and Behavioral Sciences, 1440
37 Canal Street Suite 2200, Tulane University School of Public Health and Tropical Medicine, New
38 Orleans LA 70112.
39

40
41
42 Lucinda Manda-Taylor, Malawi College of Medicine, University of Malawi, 3rd Floor - John
43 Chipangwi Learning Resource Centre, Private Bag 360, Chichiri Blantyre 3, Malawi.
44

45
46
47 Hans-Peter Kohler, Department of Sociology and Population Studies Center, 3718 Locust Walk,
48 University of Pennsylvania, Philadelphia, PA 19104-6299.
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Abstract

Purpose: The Migration and Health in Malawi (MHM) Study focuses on a key challenge in migration research: although it has long been established that migration and health are closely linked, identifying the effect of migration on various health outcomes is complicated by methodological challenges. The MHM Study uses a longitudinal panel pre- and post-migration study design (with a non-migrant comparison group) to measure and/or control for important characteristics that affect both migration and health outcomes.

Participants: Data are available for two waves. The MHM interviewed 398 of 715 migrants in 2007 (55.7%) and 722 of 1,013 in 2013 (71.3%); as well as 604 of 751 (80.4%) for a non-migrant reference group in 2013. The total interviewed sample size for the MHM in both waves is 1,809. These data include extensive information on lifetime migration, socioeconomic and demographic characteristics, sexual behaviors, marriage, household/family structure, social networks and social capital, HIV/AIDS biomarkers, and other dimensions of health.

Findings to Date: Our result for the relationship between migration and health differ by health measure and analytic approach. Migrants in Malawi have a significantly higher HIV prevalence than non-migrants, which is primarily due to the selection of HIV positive individuals into migration. We find evidence for health selection; physically healthier men and women are more likely to move, partly because migration selects younger individuals. However, we do not find differences in physical or mental health between migrants and non-migrants after moving.

Future Plans: We are preparing a third round of data collection for these (and any new) migrants, which will take place in 2018. This cohort will be used to examine the effect of migration on various health measures and behaviors, including general mental and physical health, smoking and alcohol use, access to and use of health services, and use of antiretroviral therapy (ART).

Strengths and Limitations of the Study

- This Migration and Health in Malawi (MHM) Study features longitudinal panel data for migrants (before and after migration), and a comparison group of non-migrants.
- These data are used to examine key issues in migration research, such as migration health selection, the effect of migration on health, and the health status of return migrants.
- Although the MHM study includes migrants to different destinations (rural, town, urban), all originate from rural areas; migrants originating from towns or cities are not included. The MHM also does not include in-migrants to the sample area, only those leaving.

Introduction

It has long been assumed that migration and health are closely linked, but empirical results vary across settings and health measures. Many studies suggest that moving to a new location can improve health and well-being, and research often shows that individuals who previously migrated are in better health than their non-mobile counterparts [1-4]. Other studies have concluded that moving - to cities, for example - can have deleterious effects on health outcomes, e.g., acquisition of human immunodeficiency virus (HIV) and other sexually transmitted infections (STIs) [5-7].

It has been challenging to empirically establish that migration *causes* changes in health, due to the need to address (1) possible selection bias, that healthier (or in some cases, less healthy) individuals are more likely to migrate [8-14]; (2) the “salmon bias” hypothesis, that less healthy individuals are more likely to return to areas of origin, and thus remaining migrants are relatively healthy [9,12,14-19], and (3) the possibility that the effect of migration on health status changes over time: some research shows that the better health of migrants declines as they spend more time in their post-migration residence [14,20-23].

The above hypotheses have seldom been adequately tested with the appropriate methodological approaches, primarily due to data limitations. Examining the extent of selection bias requires data on the health of individuals prior to migration, but research on migration across settings often relies on cross-sectional data to compare non-migrants with migrants *after* migration [24-30]. Identifying the effect of migration on health status, as opposed to merely examining differences in health status for individuals after migration with non-migrant populations, is facilitated by longitudinal data. However, longitudinal data that include health status for individuals before and after migration (in their destination) are very rare in any setting, particularly in sub-Saharan Africa (SSA).

The relatively few existing studies on migration in SSA frequently use one of two study designs. The most common are cross-sectional studies with information for migrants after moving, sometimes including retrospective migration histories. The second type, such as Demographic Surveillance Sites (DSS), are geographically based in one location, with longitudinal measures

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3 collected for (1) individuals who migrate and return to the area of origin (“circular” or
4 “temporary” migrants), or (2) “in” migrants, who move into the DSS site from elsewhere [5,31-
5 33]. Individuals who move out of the study area (“permanent” migrants) are typically not
6 followed [31,33-34], an approach that is unbiased only if in-migrants are the same as permanent
7 out-migrants, which is very unlikely to be the case in most settings.
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14 The Migration and Health in Malawi (MHM) Study addresses several key methodological
15 challenges in research on migration and health. Longitudinal data enables the study to (1) use
16 statistical methods that reduce biases which distort the estimation of causal effects of migration
17 on health outcomes, and (2) measure and control for the selection effects that are missing from
18 much of the existing research on health and migration: differences in health outcomes between
19 non-migrants and migrants prior to migration.
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27 The MHM provides one of the first population-based longitudinal datasets on migration and
28 health in SSA, which addresses several limitations of previous studies. A common limitation is
29 the focus on migrant subgroups, rather than all migrants. Research on migration and health in
30 SSA has disproportionately been on labor migration [25,35-36], despite the fact that many
31 migrate for marriage-, climate-, and household-related reasons [5,26,37-38]. Due in part to the
32 interest in labor migration, the spatial movement of interest has primarily been rural-urban
33 migration [16,39-40], and the gender focus has often been on male migrants [40-42]. At the
34 same time, rural-to-rural migration is the most common type of movement in many parts of SSA
35 [43-45], emerging research has shown that rates of female migration is increasing in SSA [45],
36 and there are important differences in migrant characteristics by destination [46]. The MHM
37 data also include men and women across a broad age range from young adulthood (age 15) to old
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50 These data also contain a wide range of measures, many of which are rarely collected for
51 migrants. Health measures used in previous research have been limited, with predominant focus
52 on outcomes like fertility, child health and mortality, and HIV infection (SSA) [5-7,11,27,47-51],
53 and very little research on the relationship between migration and general health (mental and
54 physical). The MHM include extensive information on health status, HIV infection, sexual
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3 behavior, remittances and transfers, migration history, and social networks for migrants and non-
4 migrants; including measurements on the above characteristics both before and after migration
5 (at post-migration locations). The range of health measures is a particular asset for the MHM,
6 since it is likely that the relationship between migration and health varies by health measure and
7 migrant group. For example, research has often found that physically healthier individuals are
8 more likely to migrate, but some studies have found migrants to have worse mental health
9 [14,20], and more likely to be HIV positive or practice risky sexual behavior [6,26-27]. In
10 addition, research has found that the reason for migration differs between men and women in
11 SSA (with men moving for work and women moving for marriage-related reasons), and by
12 destination (urban, town, rural) [43]. We therefore expect to find differences in the relationship
13 between migration and health by health measure, sex, and migration stream.
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25 Primary research goals of the MHM are to (1) identify the selection effect of individuals with
26 differing health status into migration in Malawi (“migration selection”); (2) estimate the causal
27 effect of migration on mental and physical health status (“migration effect of health”) by using
28 longitudinal data from before and after migration and by employing statistical approaches that
29 control for unobserved determinants of migration and health; and (3) measure several key
30 aspects of migration and health that have previously been neglected in SSA, including (a) spatial
31 direction (rural-urban, rural-rural), (b) reason for migration (e.g. work, marital change, death of
32 family member), (c) duration of migration, (d) gender, (e) and distance from origin.
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41 **Cohort description**

42 Setting

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44 Our study is set in Malawi, a low income setting with a moderate HIV epidemic. Malawi is
45 divided into three regions (Southern, Central, Northern), and 28 districts. The largest cities in
46 Malawi are the three regional capitals, Blantyre (Southern), Lilongwe (Central), and Mzuzu
47 (Northern). Each district has an administrative center, which is a common destination for
48 migrants from rural areas.
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55 The MHM is integrated with another study in Malawi, the Malawi Longitudinal Study of
56 Families and Health (MLSFH). The MLSFH is a longitudinal panel survey that examines how
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3 families and individuals in rural Malawi cope with the high morbidity and mortality caused by
4 the HIV/AIDS epidemic. The MLSFH began in 1998 in three sites of rural Malawi, Rumphu in
5 the Northern Region, Mchinji in the Central Region and Balaka in the South. The original
6 MLSFH sample included ever-married women and their spouses. The MLSFH study team
7 returned to re-interview the same respondents (along with new spouses for respondents who
8 remarried between the two waves) for five additional waves of survey data collection in 2001,
9 2004, 2006, 2008 and 2010. The MLSFH target sample increased from 2,791 in 1998 to 6,306 in
10 2010. The MSLFH sample added to the sample in the following ways: (1) all new spouses for
11 individuals who married in between waves, (2) a sample of young adults aged 15-25 in 2004, and
12 (3) a sample of parents of respondents in 2008. The MLSFH survey has had consistently high
13 participation rates of over 70% (93% in 1998, 77% in 2001, 74% in 2004), and less than 3%
14 refused to be interviewed in every wave. Comparisons of background characteristics between
15 the MLSFH data and the rural sample of the Malawi DHS found relatively few substantive
16 differences [52]. The MSLFH offered HIV testing and test results to participants in 2004, 2006
17 and 2008. The MLSFH conducted extensive pre- and post-HIV test counseling for all
18 participants, and all those who tested positive for HIV were referred to health facilities for
19 confirmatory testing and determining of eligibility for ART. MLSFH data collection in each
20 year took place between May and August. More information about the MLSFH study can be
21 found in the MLSFH Cohort Profile [52].
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39 Eligibility Criteria

40 In all waves of MLSFH, the most common reason for non-participation is migration. Migrants
41 were identified through attempts to interview all respondents in the MLSFH target sample. While
42 visiting the house of a respondent, the MLSFH team was informed of migration activity of
43 previous respondents by friends and family members who remain in the MLSFH pre-migration
44 village of the respondent. To qualify as a “migrant”, friends and family members must report
45 that the individual has moved from the MLSFH village to another location (as opposed to being
46 temporarily gone with the intention to return).
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55 Sampling

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3 The MHM sample includes these MLSFH migrants. The MHM has conducted two waves of
4 data collection to date, in January-April 2007 and July-November 2013. Each wave was based
5 on previous MLSFH respondents who were eligible for migration: those eligible for the MHM 1
6 study were the 4,950 respondents in the 2006 MLSFH target sample, and the 5,914 individuals
7 MLSFH 2010 respondents were eligible for the MHM 2. Among those eligible, the first wave
8 identified 804 individuals who were previously interviewed by MLSFH and were reported to
9 have moved elsewhere during MLSFH data collection in 2006. During 2010 MLSFH data
10 collection, the second wave identified 1,096 individuals who were interviewed at least once since
11 2001 and had moved elsewhere.
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21 Of those who moved, some migrated to areas outside of Malawi. Specifically, 89 individuals of
22 the MHM 1 target sample and 83 of the MHM 2 target samples were residing outside of Malawi
23 at the time of the respective survey. In both MHM 1 and 2, the most common country of
24 destination was Zambia, followed by Mozambique, reflecting the proximity of these countries to
25 Malawi. The MHM did not seek to trace these international migrants, thus reducing the wave
26 one target sample to 715 and second wave to 1,013.
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33 After removing international migrants, the MHM sought to trace all remaining internal migrants.
34 The first step to do so was to identify their current location. For this purpose, the migration
35 study team first returned to the MLSFH village where the migrant previously resided, and
36 administered a Migration Tracking Survey to friends or family members remaining in the
37 MLSFH sample village. The tracking survey included information on the current location of the
38 migrant (including city, town, or village of residence, phone number), the reason for migration,
39 and other information surrounding the circumstances of the move. This information was used to
40 trace migrants in the second step of the MHM study.
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49 In addition to internal migrants, two other samples are included in the MHM. Following the
50 MLSFH sampling strategy, the MHM interviewed all new spouses for migrants who married
51 since a previous interview (130 in 2007 and 120 in 2013). Second, due to the duration of time
52 since previous interview, the MHM 2 included a “non-migrant” comparison group of 751
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3 individuals, randomly selected from the MLSFH roster, who had not moved at the most recent
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5 wave (approximately 250 per site).
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9 Despite challenges in finding mobile individuals in a low-income country setting, the MHM
10 traced and re-interviewed the majority of these internal migrants. The MHM interviewed 398 of
11 715 migrants in 2007 (55.7%) and 722 of 1,013 in 2013 (71.3%); the MHM also interviewed
12 80.4% (604) of the non-migrant reference group in 2013. Overall, the total interviewed sample
13 size for the MHM in both waves is 1,809, which includes 983 migrants, 222 new spouses, and
14 604 non-migrants. Of the migrants and their new spouses, 325 were interviewed at least twice,
15 either in both waves of MHM, or in the first MHM wave and a subsequent MLSFH wave (i.e.,
16 return migration). A flow chart of MLSFH respondents eligible for MHM, and MHM outcomes
17 are shown in Figure 1.
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25 26 Measures

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28 Measures of health and health-related behaviors are central to the MHM. The MHM has
29 conducted HIV testing and counselling (HTC) at respondents' homes using Determine and
30 Unigold rapid tests, following the same procedures as the MLSFH. The MHM also collects
31 extensive information on health behaviors, such as sexual behavior, smoking and alcohol use,
32 access to and use of health services, and use of antiretroviral therapy (ART). Other measures
33 collected by the MHM are summarized in Table 1.
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41 The MHM also collects information on general mental and physical health, using the SF-12 set
42 of questions. The SF-12 has been shown to accurately capture physical and mental health status
43 in a wide range of settings [53-55], including sub-Saharan Africa [56-57]. SF-12 scores are
44 shown to be more robust measures of health than the single five point scale of health that is
45 commonly used in migration research [10]. SF-12 summary measures range from 0 to 100, with
46 higher scores indicating better health. Two summary measures, a mental health component
47 summary (MCS) score and a physical health component summary (PCS) score, are calculated by
48 aggregating data from the eight subscales [54]. The MHM/MLSFH-SF12 mental health score is
49 strongly correlated with more detailed measures of depression and anxiety that are available for
50 some non-MHM respondents [58].
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5 The MHM also provides detailed measures of migration and the motivation for changing
6 residence. Among the more important measures is a full residence history for MHM respondents
7 in 2013, which includes a list of all locations where they lived for 6 months or more, along with
8 characteristics of the location and reasons for moving there. Given the dearth of migration
9 information in surveys in SSA, the residence histories can provide needed insight into migration
10 patterns of a highly-mobile population.
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16 17 18 Study Participant Characteristics

19 Characteristics of the migrants in 2007 and 2013 (i.e., after migration) and the non-migrant
20 comparison group in 2013 are shown in Table 2. Like the MLSFH, the majority of participants
21 are female, and average age is between 34 and 41 years old in both waves. Unlike many data
22 sources in SSA (such as Demographic and Health Surveys), the MHM has a substantial
23 percentage of participants beyond reproductive ages: over 10% of migrants were 50 years or
24 older in both MHM waves.
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31 Differences between migrants and non-migrants in some measures are evident in Table 2. HIV
32 status is higher among migrants, at 14.1% in wave 1 and 14.3% in wave 2, compared with 6.3%
33 among non-migrants in wave 2. However, mental and physical health, measured by the SF-12
34 summary score, is similar between these groups.
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40 We measure different patterns of movement for MHM migrants. Over 46% of migrants had
41 lived outside of their district for six months or more since the age of 15 in MHM 2, compared
42 with 51% in MHM 1. Return migration was not uncommon in MHM 2: 25.8% of migrants in
43 2013 were found in MLSFH villages of origin, and over 26% in 2007 and 13% in 2013 had lived
44 outside their district for one month or more in the past year. Although rural-to-urban migration
45 has received considerable attention in the literature, intra-rural migration is the most common
46 migration stream: in 2013, 65.2% of all migrants moved to another rural area, and 22.5% of
47 migrants moved to a district capital, or “town”. Rural-to-urban migration was less common, as
48 only 12.3% of migrants moved to one of Malawi’s three regional capitals, Lilongwe, Blantyre or
49 Mzuzu.
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Non-Response

To assess potential bias due to non-response, we examine the extent to which the sample of migrants found in each wave may be different from those not found. We compare background characteristics at baseline between migrants found and those not found in 2007 and 2013.

Results, in Table 3, show few differences: in 2007, MHM was less likely to find migrants from the southern region and more likely northern region migrants, was less likely to find migrants with no schooling, and found relatively wealthier migrants. The 2013 MHM wave was more likely to find female migrants as compared to male migrants, and less likely to find migrants from the southern region as compared to the other two MHM regions.

A full tabulation of migration tracking, including outcomes of attempts to interview, is found in Table 4. The most prominent reasons for non-response among migrants were (1) moving again (to an unknown or relatively distant location), and (2) not having sufficient information to trace the migrant at their new location. Since our approach to finding these migrants relied on gathering information on their location from friends and family members remaining in MLSFH sample villages, we expect that migrants not found left fewer friends or family behind to report on their location, and/or had fewer or weaker ties with MLSFH village residents after moving. We also expect that information on current location is less accurate for less recent migrants. Refusal rates were less than 3% in both waves of MHM. There were very few instances of missing items, observations in these cases were dropped from the analysis.

Findings to date

The first wave of MHM was designed to examine the relationship between migration and HIV infection in Malawi. As elsewhere, the MHM 1 found that there is a significant association between migration and HIV infection in Malawi, in which, according to chi squared tests, migrants have a significantly higher HIV prevalence than non-migrants [43,59], as shown in Figure 2 for both MHM waves (with results from chi squared tests).

Contrary to a common assumption that migration is an independent risk factor for HIV infection, the MHM instead found that, in Malawi, the higher prevalence of HIV among migrants is due to

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3 the selection of HIV positive individuals into migration streams rather than any effect of
4 migration on HIV infection [43,59]. The higher HIV prevalence among migrants before moving
5 was established by multiple logistic regressions in which the dependent variable was migrating
6 in a future wave, and the key independent variable was HIV status before migration (also
7 controlling for multiple confounders, such as age). Results for the selection of HIV positive
8 individuals into migration were statistically significant and consistent by sex [43,59]. Similarly,
9 Figure 3 compares HIV prevalence between migrants and non-migrants at baseline using chi
10 squared tests, and again shows a significantly higher HIV prevalence among migrants before
11 migration. The selection of HIV positive individuals into migration streams appears due to the
12 connection between marriage, HIV status and migration in Malawi, in which HIV positive
13 individuals are more likely to experience marital dissolution and subsequently move [43,59],
14 either returning to rural homes for care, or potentially to gain better access to antiretroviral
15 therapy (ART).
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28 Follow-up research on the relationship between HIV infection and migration using MHM 2
29 found similar results. Using several waves of data and random effects logistic regressions where
30 the dependent variable was migration in the future, and the independent variable of interest was
31 HIV status from a prior wave (controlling for data collection wave, sex, age and previous
32 migration), results were consistent: HIV positive individuals are significantly more likely to
33 migrate than the HIV negative (unadjusted odds ratio 2.26, adjusted 2.71 95% CI 1.62–4.54)
34 [60]. Next, classifying migrants by destination (rural, town, urban), MHM research also found
35 that being HIV positive significantly increased the relative risk that respondent will be a rural–
36 urban migrant (unadjusted relative risk ratio 2.41, adjusted 4.09 95% CI 1.68–9.97), a rural–
37 town migrant (unadjusted relative risk ratio 2.03, adjusted 3.62 95% CI 1.24–10.54), and a rural–
38 rural migrant (unadjusted relative risk ratio 2.48, adjusted 6.28 95% CI 1.77–22.26), instead of a
39 non-migrant. Being HIV positive also significantly increased the risk that a respondent will (1)
40 return migrate, and (2) permanently migrate instead of not migrating [60].
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53 MHM research has also focused on the relationship between migration and health. The MHM
54 has examined two processes involved in this relationship: migration selection (differences in
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(differences in health status after migration). To examine migration selection, logistic regressions were estimated for a dependent variable indicating future migration, using the SF-12 score of mental or physical health prior to migration as the main independent variable. Figure 4 shows results for migration selection: before migration, male and female MHM migrants have significantly better physical health (measured by SF-12 summary scores) than non-migrants (unadjusted odds ratio 1.04 for women, 1.05 for men). But after controlling for age (accounting for the fact that migrants are significantly younger than non-migrants), the difference disappears [61]. We also find differences in health selection by destination: classifying migrants by destination (rural-rural, rural-town, rural-urban, all compared to non-migrants) finds that selection of healthier individuals into migration is strongest for rural-rural and rural-urban migrants, and is not evident for rural-town migrants.

There is a different story after migration, however. To examine health differences between non-migrants and migrants (after migration), we ran OLS regressions where the dependent variable is the SF-12 score of mental or physical health after migration, and the independent variable of interest is a binary indicator of migration status. Before controlling for age there is no difference in health status after migration between migrants and non-migrants (Figure 5). After age is added to regression models, however, female migrants are in significantly worse mental and physical health compared to their non-migrant peers, and there is still no significant difference in health status among men. As with migration health selection, we find differences in the effect of migration on health by destination, with significant improvements in mental health for male rural-urban migrants [61].

Another purpose of the MHM data is to reduce attrition bias in longitudinal analyses of MLSFH data, an important potential bias when migrants are systematically different from non-migrants. For this purpose, several studies have combined the MHM and MLSFH data to (1) examine whether migrants are systematically different in various outcomes, such as HIV testing, marriage and divorce, and education; and (2) reduce bias due to loss-to-follow-up [62-64].

Discussion

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3 Overall, results to date for the MHM study shows that the relationship between internal
4 migration and health in Malawi varies by health measure. For HIV infection, we find strong
5 evidence that those who are HIV positive are more likely to move in the future than those who
6 are HIV negative. The reason appears to be due to marital dissolution, which HIV positive
7 individuals are more likely to experience and is often followed by migration. This result is
8 consistent across destinations, with HIV positive individuals more likely to move to other rural
9 areas, towns and cities.
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17 At the same time, we find that physically healthier men and women are more likely to move.
18 Results from the MHM 2 study show that men and women with better physical health are
19 selected into migration. Unlike HIV status, the relationship between physical health and
20 migration varies by destination, with the healthier individuals moving to other rural areas and
21 cities, but not towns. There is no statistically significant relationship between migration and
22 mental health, however; and there are no statistically significant differences in health status after
23 migration among men and women.
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32 Our findings to date have several implications for public health programs. The fact that HIV
33 positive individuals are more likely to move means that their behavior after migration will likely
34 affect the future course of the epidemic: are they more likely to remarry after they move? If so,
35 do they seek others who are HIV positive as potential spouses, or do they marry HIV negative
36 individuals? In addition, since some have called for specifically targeting migrants in HIV
37 prevention campaigns, our results suggest that this approach may not be effective in reducing
38 incidence if many migrants are already HIV positive. This research also has implication for
39 health systems: are HIV positive individuals moving to better access antiretroviral therapy
40 (ART)? Such a pattern should inform the supply of ART at various locations. At the same time,
41 it is important to note that migrants are in better physical health before moving, and there are no
42 significant differences in health status after moving (not controlling for age). Although migrants
43 may use HIV-related services more than non-migrants, use of health services may not differ for
44 other health conditions by migration status.
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55 56 57 **Strengths and limitations** 58 59 60

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Much migration research in SSA is motivated by a perceived connection between migration and HIV risk and/or status. Critical empirical investigations of these potential connections have been hampered by a lack of longitudinal data that includes pre- and post-migration observation. Such data are essential for distinguishing between migration selection and the causal effect of migration on HIV and other health outcomes. Building from the MLSFH, the MHM addresses this limitation and is among the first population-based longitudinal datasets on migration and health in SSA.

The MHM is also exceptional with regard to its study population and measures. Much research on migration has focused on male labor migrants. In addition to these male migrants, the MHM also includes female labor migrants, as well as individuals moving for other reasons than work (see table A1 for full list of reasons for migration among MHM respondents). As shown in Table 1, both waves of the MHM capture substantial numbers of individuals over age 50, a population that is increasing in size in SSA, and for which little is known about migration patterns. The MHM data are the first to include extensive information on a wide array of measures (Table 1) both before and after migration (at post-migration locations). The MHM also measures features of migration that are often not included in migration data, such as return migration, full residence histories, different migration destinations (rural-rural, rural-town, rural-urban), duration at residence, GPS measures before and after migration, and future migration plans. Finally, given that MLSFH participants generally reflect characteristics of the rural population of Malawi [52], and the relatively few differences in characteristics between migrants found and not found, our results likely reflect the populations of interest in Malawi.

The MHM has several limitations. The MHM residence histories list only locations where the respondent has lived for six months or more; residences of less than six months are not included. Some of these shorter-term residences could still become permanent (and could contribute meaningfully to health status). In addition, while the MHM is well-suited to measure migration streams originating from rural areas, it is limited in the extent to which it can measure migration from urban areas within Malawi. The MLSFH does not systematically include individuals moving into sample areas, so the MHM is only able to measure out-migration for this population. Although we find few statistically significant differences in characteristics between migrants

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3 found and those not found (Table 3), it is possible that these groups differ in other characteristics,
4 some of which may be related to individual health; and they may also differ in health after
5 migration (and they may have died at a higher rate than those found). These possible biases
6 would affect our analysis of migration health selection, and the impact of migration on health.
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10 11 12 **Future Plans**

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14 The MHM will conduct a third wave of data collection, beginning in 2018. This data collection
15 will follow the same approach as previous waves by interviewing all migrants formerly
16 interviewed by the MHM and any individuals who moved out of the MLSFH sample area to
17 another location within Malawi by 2018 (along with new spouses). In addition to this new data
18 collection, we also intend to examine other research topics related to migration and health,
19 including differences by age (specifically focusing on older respondents), for reproductive health
20 measures and other health measures, distance of migration, and the relationship between
21 migration and transfers.
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30 31 **Contributions**

32 HPK and PA initially conceived the manuscript. PA conducted the statistical analysis, and wrote
33 the first draft of the article. HPK, LMT and MV reviewed the paper before submission and
34 provided comments and edits.
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39 40 **Competing Interests**

41 The authors declare no competing interests.
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50 HD053781, as well as funding through R24 HD-044964.
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56 57 **Data Sharing and Collaboration**

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3 Information about the MHM is available on the MLSFH project website at
4 <http://malawi.pop.upenn.edu>. Researchers interested in using MHM data that have not yet been
5 made publicly available on the MLSFH website can submit a two-page description of their
6 proposed analysis plan to the MHM principal investigator (mail to: panglewi@tulane.edu). If
7 approved, researchers will then be asked to sign a Data Use Agreement to access and utilize the
8 data. For comparisons of migrants and non-migrants, MHM data can be linked to the public-use
9 MLSFH data that can be requested at <http://malawi.pop.upenn.edu>. All analyses of the restricted
10 MHM data are conducted in collaboration with members of the MHM study team.
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19 **Acknowledgements**

20 The MHM has been conducted in collaboration with the College of Medicine at the University of
21 Malawi and Invest in Knowledge (IKI) in Zomba, Malawi.
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25 **Ethical Approval**

26 The data collection and research conducted by MLSFH and MHM was approved by the
27 Institutional Review Boards at the University of Pennsylvania and Tulane School of Public
28 Health and Tropical Medicine, respectively. Both studies were approved in Malawi by the
29 College of Medicine Research Ethics Committee or the National Health Sciences Research
30 Committee.
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Tables and Figures

Figure 1: MHM Sample Flow Chart

Notes: the MHM studies also interviewed new spouses of migrants, 130 in 2007 and 120 in 2013; (1) the "other" outcome includes such reasons as temporarily away, sick/hospitalized, refused. A full tabulation of other outcomes for the MHM is shown in Table 4; (2) the sample for MHM 1 was all individuals interviewed in a previous MLSFH wave but moved elsewhere by 2006; (3) the sample for MHM 2 was all individuals interviewed since 2001 but moved elsewhere by 2010; (4) the non-migrant comparison group in MHM 2 was randomly selected from the MLSFH roster from individuals who were interviewed in 2010.

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Table 1: MHM Data Collection Content

<u>MHM 1, 2007</u>	<u>MHM 1, 2013</u>
GPS coordinates	GPS Coordinates
HIV testing and counseling (Determine and Unigold rapid tests)	HIV testing and counseling (Determine and Unigold rapid tests)
Health measures	Health measures
- Overall self-rated health	- Overall self-rated health
- Self-rated health compared to peers	- Self-rated health compared to peers
	- SF-12 mental and physical health
Family and Household Structure	Family and Household Structure
- Complete listing of household members, some select family members	- Complete listing of household members, some select family members
Financial and Non-Financial Transfers	Financial and Non-Financial Transfers
- Exchanges to and from respondents involving family and household members	- Exchanges to and from respondents involving family and household members
	- Exchanges to and from most important transfers partners
Marriage and Sexual Behavior	Marriage and Sexual Behavior
- Complete Marriage History	- Complete Marriage History
- Sexual behavior and partnerships	- Sexual behavior
- HIV/AIDS-related perceptions and behaviors	- HIV/AIDS-related perceptions and behaviors
- HIV/AIDS social network partners characteristics	
Migration Patterns	Migration Histories
- Ties with previous village of residence	- Complete migration history for respondent
	- Migration patterns of family and household members
	Other Features of Malawi
	- Economic Shocks
	- Diet and Lifestyle
	- Health Care Utilization

Table 2: Background characteristics for MHM 2007 & 2013

	MHM 1, 2007	MHM 2, 2013	MHM 2, 2013
	Migrants	Non-migrants	Migrants
Female	57.3%	59.9%	56.5%
Mean age	34.4	40.9	35.0
Age group			
<20	5.5%	4.8%	6.6%
20-29	34.7%	27.2%	41.4%
30-39	29.9%	21.7%	21.0%
40-49	17.6%	17.4%	14.3%
50-59	8.8%	13.6%	9.2%
60+	3.5%	15.3%	7.5%
Region of residence			
South	29.6%	35.0%	29.1%
Central	36.7%	31.2%	39.9%
North	33.7%	33.8%	31.0%
Marital status			
Married	77.2%	81.1%	79.7%
Divorced/separated	4.8%	7.5%	11.2%
Widowed	8.5%	9.9%	5.1%
Never married	9.5%	1.5%	4.0%
Level of schooling			
None	17.6%	22.8%	13.0%
Primary	59.3%	63.3%	65.6%
Secondary or higher	23.1%	13.9%	21.3%
Mean number of living children	3.6	4.8	4.1
Health measures			
HIV positive	14.1%	6.3%	14.3%
SF-12 physical health score (mean)	----	53.4	53.5
SF-12 mental health score (mean)	----	54.8	53.9
Diet & lifestyle			
Ever drink alcoholic beverages	----	22.2%	24.7%
Ever smoke tobacco or use smokeless tobacco	----	18.3%	15.4%
Have spending money for self	----	57.5%	45.7%
Average number of days per week eat outside house	----	0.56	0.67
Migration stream			
Rural-rural	----	----	65.2%
Rural-town	----	----	22.5%
Rural-urban	----	----	12.3%
Return migration	----	----	25.7%
Moved to			
Different district	32.3%	----	20.5%
Different region	10.0%	----	7.8%

Ever lived outside district for 6+ months since age 15	51.3%	----	46.9%
Stayed outside district for 1+ month in last year	26.6%	----	13.2%
N=	398	604	722

Notes: percentages of those accepting HIV testing were 90.5% in MHM 1, 94.8% of MHM 2 non-migrants, and 94.2% of MHM 2 migrants. Other than HIV positive, there were fewer than 1% missing values for all measures.

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Table 3: Pre-migration differences between migrants found and those not found

	MHM 1		MHM 2	
	Not Found	Found	Not Found	Found
Female	53.6%	57.2%	44.4%	56.2%***
Mean age	35.0	33.9	36.7	37.0
Age group				
<20	11.2%	11.8%	0.5%	0.4%
20-29	24.1%	29.4%	45.0%	40.5%
30-39	29.4%	29.4%	22.0%	24.4%
40-49	22.8%	18.7%	13.9%	15.8%
50-59	10.5%	7.9%	8.6%	9.6%
60+	2.0%	2.8%	10.0%	9.3%
Region of residence				
South	41.3%	32.5%*	36.5%	29.1%*
Central	28.4%	29.5%	38.3%	39.9%
North	30.3%	38.0%*	25.2%	31.0%
Marital status				
Married	75.8%	72.8%	80.5%	77.0%
Divorced/separated	1.5%	2.2%	2.5%	4.5%
Widowed	0.4%	2.0%	4.4%	5.2%
Never married	22.3%	23.0%	12.6%	13.3%
Level of schooling				
None	21.7%	12.4%**	16.5%	18.4%
Primary	63.3%	68.5%	64.5%	65.2%
Secondary or higher	15.0%	19.1%	19.0%	16.4%
Mean number of living children	3.2	3.4	3.3	3.3
HIV positive	10.1%	12.1%	10.1%	8.3%
N=	317	398	252	722

Notes: Difference between migrants found and not found is significant at * $p \leq 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$. Pre-migration characteristics measured for found and not-found at 2004 for MHM 1 and 2008 for MHM 2; for time-varying measures, the last available measure is used for migrants not found. Household wealth is measured using principal components analysis of 12 household amenities. MHM 2 not found does not include deceased respondents or those moving internationally.

Table 4: Visit Outcomes for Final Target Samples, MHM 2007 & 2013

Outcome of Visit	MHM 1, 2007		MHM 2, 2013		MHM 2, 2013	
	Migrants		Non-migrants		Migrants	
	N	%	N	%	N	%
Completed	398	55.7%	604	80.4%	722	71.3%
Refused	15	2.1%	2	0.3%	15	1.5%
Dead	13	1.8%	21	2.8%	39	3.8%
Moved	34	4.8%	60	8.0%	37	3.7%
Temporarily away	9	1.3%	29	3.9%	12	1.2%
Sick/hospitalized	3	0.4%	3	0.4%	4	0.4%
Other/not found	243	33.9%	32	4.3%	184	18.2%
Total	715	100.0%	751	100.0%	1013	100.0%

Notes: the "other" category includes several other reasons for non-interview, none of which individually represents a substantial proportion of the overall category, such as imprisonment, identity unknown, and incapable of interview. This table does not include international migrants (89 in 2007 and 83 in 2013), for whom visits were not attempted.

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Figure 2: HIV Prevalence by Migration Status After Migration, MHM 1 & MHM 2

Notes: MHM 1 non-migrants come from the 2006 MLSFH; differences between migrants and non-migrants chi squared tests statistically significant at $p < 0.00$.

Figure 3: HIV Prevalence by Migration Status Before Migration, MHM 1 & MHM 2

Notes: HIV status is the most recent available for migrants; differences between migrants and non-migrants chi squared tests statistically significant at $p < 0.00$.

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Figure 4: Logistic regression odds ratios for the relationship between migration and health, before migration

Notes: Health (independent variable) is measured by SF12 summary scores of mental or physical health, migration (dependent variable) is a binary measure of migrant or non-migrant. Difference in physical health status before migration is statistically significant at $p < 0.05$ for both men and women.

Figure 5: Health effect: OLS Regression coefficients for relationship between migration and health, after migration

Notes: Health (dependent variable) is measured by SF12 summary scores of mental or physical health, migration (independent variable) is a binary measure of migrant or non-migrant. The relationship between migration and health is not statistically significant (at $p < 0.05$).

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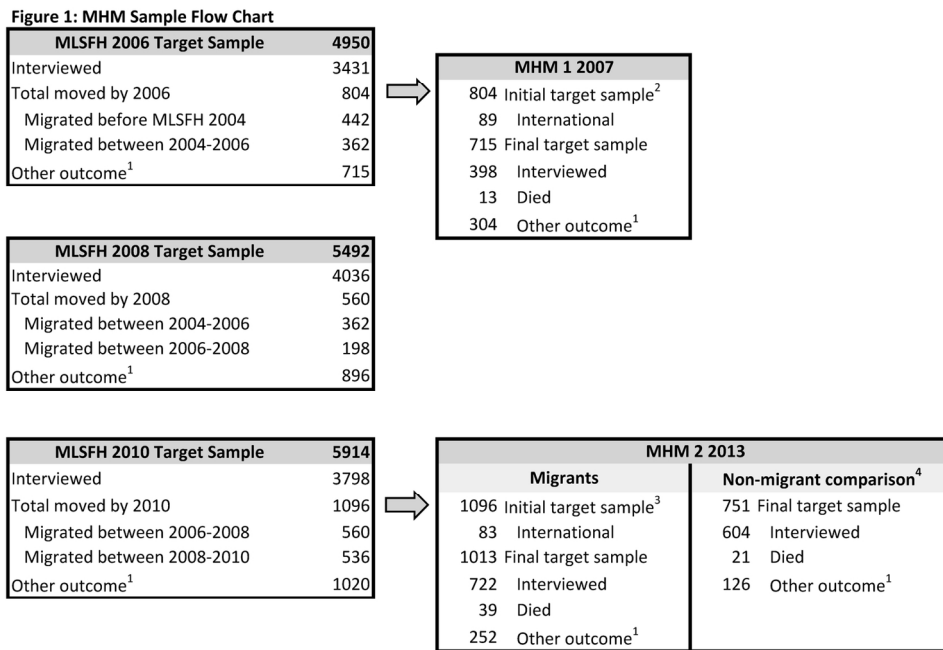


Figure 1: MHM Sample Flow Chart

151x108mm (300 x 300 DPI)

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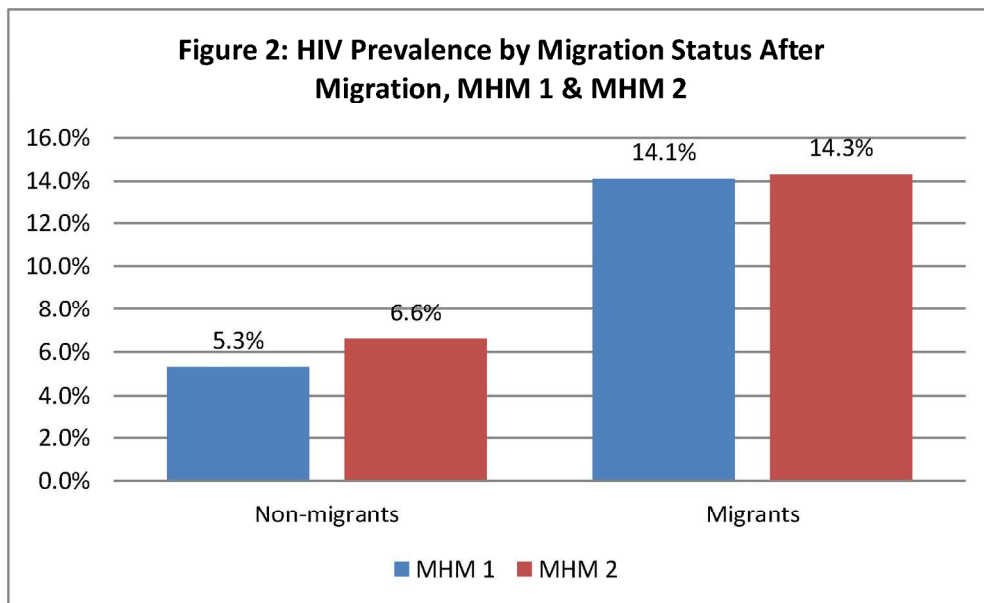


Figure 2: HIV Prevalence by Migration Status After Migration, MHM 1 & MHM 2

176x108mm (300 x 300 DPI)

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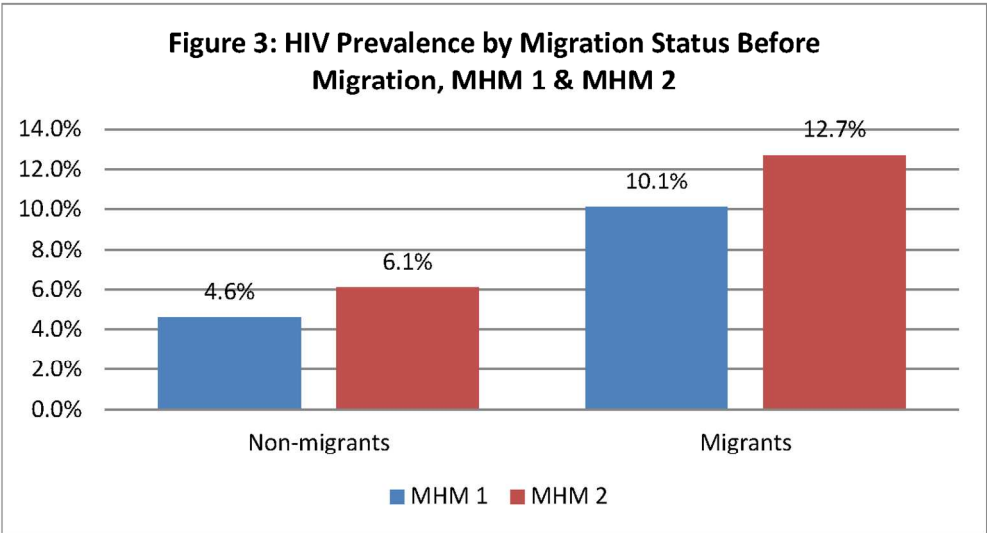


Figure 3: HIV Prevalence by Migration Status Before Migration, MHM 1 & MHM 2

138x76mm (300 x 300 DPI)

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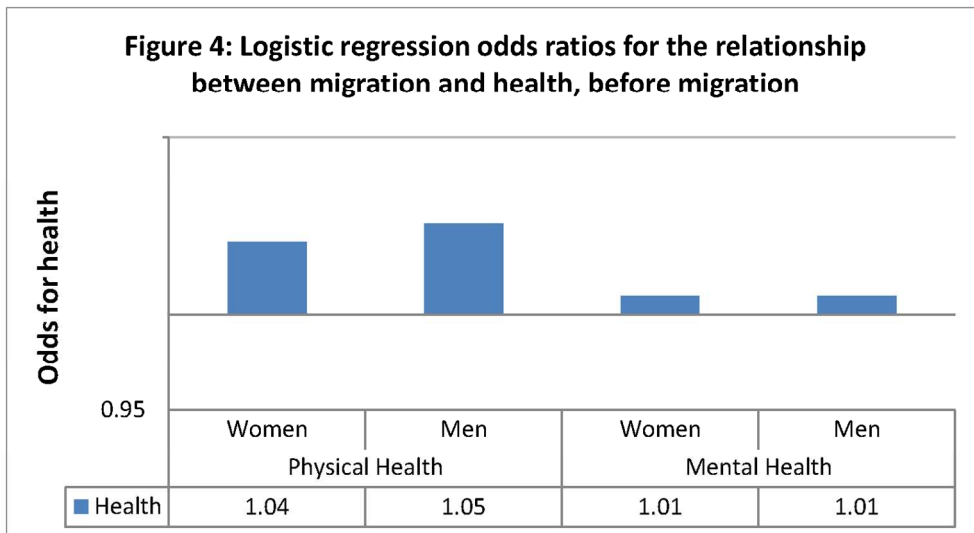


Figure 4: Logistic regression odds ratios for the relationship between migration and health, before migration

139x75mm (300 x 300 DPI)

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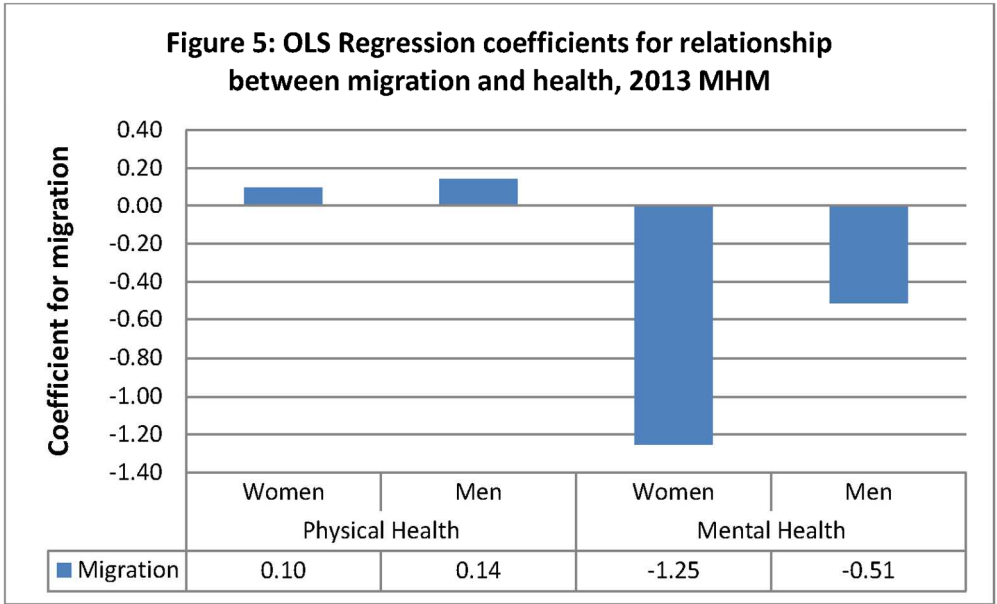


Figure 5: Health effect: OLS Regression coefficients for relationship between migration and health, after migration

138x84mm (300 x 300 DPI)

Review only

Table A1: Reasons for migration, MHM migrants 2007 & 2013

	MHM 1, 2007						MHM 2, 2013					
	Female Migrants		Male Migrants		All Migrants		Female Migrants		Male Migrants		All Migrants	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
To look for work / offered job	44	19.4%	65	38.0%	109	27.4%	60	16.0%	83	29.9%	143	21.9%
Attending school	8	3.5%	9	5.3%	17	4.3%	5	1.3%	7	2.5%	12	1.8%
Divorce/separation or widowhood	37	16.3%	9	5.3%	46	11.6%	50	13.3%	15	5.4%	65	10.0%
New marriage	56	24.7%	16	9.4%	72	18.1%	132	35.2%	4	19.4%	186	28.5%
Illness	20	8.8%	3	1.8%	23	5.8%	8	2.1%	1	0.4%	9	1.4%
Staying with relative	9	4.0%	13	7.6%	22	5.5%	9	2.4%	5	1.8%	14	2.1%
New land for farming	24	10.6%	35	20.5%	59	14.8%	48	12.8%	4	19.4%	102	15.6%
Conflict with others in village	7	3.1%	1	0.6%	8	2.0%	31	8.3%	11	7.6%	52	8.0%
Other reason	22	9.7%	20	11.7%	42	10.6%	32	8.5%	8	13.7%	70	10.7%
Total	227	100.0%	171	100.0%	398	100.0%	375	100.0%	78	100.0%	653	100.0%

Notes: Limited to categories that are consistent across waves; in 2013 reason for migration was asked only for those who lived elsewhere for 6 months or more

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

Pg.	Item No	Recommendation
2	1	(a) Indicate the study's design with a commonly used term in the title or the abstract
2		(b) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
3-5	2	Explain the scientific background and rationale for the investigation being reported
5	3	State specific objectives, including any prespecified hypotheses
Methods		
5-10	4	Present key elements of study design early in the paper
5-6	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
6-8, F1	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (b) For matched studies, give matching criteria and number of exposed and unexposed
7-8, T1	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
7-8, T1	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
4-6, 9-10	9	Describe any efforts to address potential sources of bias
6-7, F1	10	Explain how the study size was arrived at
10-12	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
10-12	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) If applicable, explain how loss to follow-up was addressed (e) Describe any sensitivity analyses
Results		
6-8, F1	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram
10-11, T3, T4, F1		
T2	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)
T2		

1	T2, F2	Outcome data	15*	Report numbers of outcome events or summary measures over time
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3	11-12	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
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7	N/A			(b) Report category boundaries when continuous variables were categorized
8	N/A			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
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10	10-12	Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
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14		Discussion		
15	11-13	Key results	18	Summarise key results with reference to study objectives
16	14-15	Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
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18	12-13	Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
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22	14	Generalisability	21	Discuss the generalisability (external validity) of the study results
23				
24		Other information		
25	15-16	Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
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*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.