Rural-to-urban migration and changes in health status among young adults in Thailand: Distinguishing selection effects from migration effects using a longitudinal framework

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Introduction

The transition from a predominantly rural to a predominantly urban global population is well underway. About half of the world's population now lives in urban areas, and the United Nations (2010) projects that this proportion will reach 68.7% urban by the year 2050. The world's more developed regions are further along in this urban transition than are less developed countries, where the pace of urbanization is now most rapid. While the urban population of more developed regions is projected to increase slightly, the vast majority of population growth in the coming decades will be absorbed by urban areas in the developing world. Meanwhile, the size of rural populations in all regions of the world will decline by 2050 (United Nations, 2010).

Urbanization occurs through three interacting processes: 1) natural increase, 2) rural-to-urban migration and 3) reclassification. Natural increase is the population growth that occurs as a result of fertility rates exceeding mortality rates. It is a direct and indirect cause of urbanization. Natural increase in the rural population contributes to urban growth indirectly by driving rural-to-urban migration to alleviate overpopulation relative to the availability of opportunities in rural areas. Meanwhile, natural increase in the urban population directly impacts urban growth. Internal migration from rural to urban areas also directly contributes to a country's urban transition. Reclassification occurs when urban status is conferred upon a formerly rural or peri-urban territory, often because the absolute population size or the population density exceeds a certain threshold. Both migration and natural increase can contribute to changes in population density that lead to reclassification.

Asia and Africa are currently experiencing the most rapid urbanization in the world, while urbanization rates have slowed in other regions that are further along in the urban transition, including North America, Europe and Latin America. In Asia, about 2 in 5 people currently live in urban areas, and projections put the Asian population at 2/3 urban by 2050 (United Nations, 2010). The urban transition in Asia is particularly consequential because it is the most populous region in the world. Asia is already home to about half of the world's total urban population, and the United Nations (2010) projects that 54% of the world's urban population will be concentrated in Asia by 2050.

Much attention has been paid to the macro-economic and environmental effects of urbanization on communities and countries. However, the demographic processes underlying urbanization also carry important implications for the well-being of the individuals engaged in these processes. Rural-to-urban migration, in particular, affects migrants' economic burdens and

opportunities, presents new environmental risks and benefits, leads to changes in the cultural and social context in which migrants function, and provides access to resources that were unavailable at their place of origin. Clearly, the migration process and its consequences can impact migrants' well-being both positively and negatively.

The potential health consequences of rural-to-urban migration constitute the substantive focus of this study. A substantial body of literature assesses health outcomes among immigrants to the developed world, although much less attention has been paid to the health impacts of internal migration. With rapid urbanization underway in many developing countries, internal migration, especially rural-to-urban movement, is occurring on an even larger scale than international migration (IOM, 2005).

The geographical focus of this study is Thailand, where 31% of the population currently resides in urban areas (Population Reference Bureau, 2010). The United Nations (2010) projects that this figure will reach 60% by 2050, an increase that is commensurate with the projected urbanization trend of the developing world. At 0.6%, the rate of natural increase in Thailand is low relative to most countries in the developing world, giving rural-to-urban migration a particularly significant role in Thailand's urban transition. Thailand represents not only urbanization and migration patterns typical of the developing world, but it also exemplifies the demographic context that other developing countries will face as they complete their own demographic transitions.

Systematic research on the health effects of migration presents formidable challenges. Many studies face methodological limitations, such as selection bias and a lack of optimal comparison groups. Certain demographic characteristics and socioeconomic status render some people more likely to migrate than others. Likewise, health status may also vary systematically between those who subsequently migrate and those who stay at origin. The "healthy migrant hypothesis" predicts that migrants are typically a healthier subset of the population, compared to the average health status of their peers at origin and destination. These selection factors impede the attribution of post-migration differences in health status – when compared with non-migrant counterparts – to the effects of migration. To mitigate selection bias, health status would ideally be measured before and after migration by implementing a longitudinal study design. Differences in *a priori* health status must be established and controlled for in statistical analyses in order to conclude that observed differences in post-migration health status between those who moved and those who stayed at origin are in fact due to the migration process *per se*.

Because longitudinal data are difficult and expensive to collect, most migration studies compare migrants with the receiving or sending populations using cross-sectional data collected post-migration. However, this approach does not account for potential differences between the migrant and non-migrant samples that may result from sampling them independently, such as pre-migration health status, demographic characteristics and socioeconomic status. Such differences are likely to confound the effects of migration on health. In longitudinal studies, a natural comparison group can be established by recruiting one sample of residents at origin prior to the migration of a subset who subsequently decide to move. Those who remain at origin during the timeframe of the study constitute an appropriate comparison group since the potentially confounding effects of *a priori* health status can be assessed and taken into account.

This study addresses the potential threats to validity discussed above in two ways: 1) by employing a longitudinal design, with data collected pre- and post-migration, and 2) by employing a natural comparison group of rural residents who remained there. The follow-up survey included an additional comparison group of longer-term urban residents in the destination areas. This sample could only be selected after migration, because it was drawn from migrants' chosen destinations in order to maximize comparability with the rural-to-urban migrants.

Research Objectives

The study's main objective is to ascertain the impact of rural-to-urban moves upon the health of young adult migrants, compared to those who stayed behind. It will also determine the effects of *a priori* health status on subsequent migration in order to distinguish selection factors from the direct effects of migration on health outcomes. Finally, the health status of migrants will be compared to that of longer-term urban residents to determine whether migrants, upon arrival, are healthier or less healthy than their counterparts living in urban areas.

The study objectives are recast as the following three research questions:

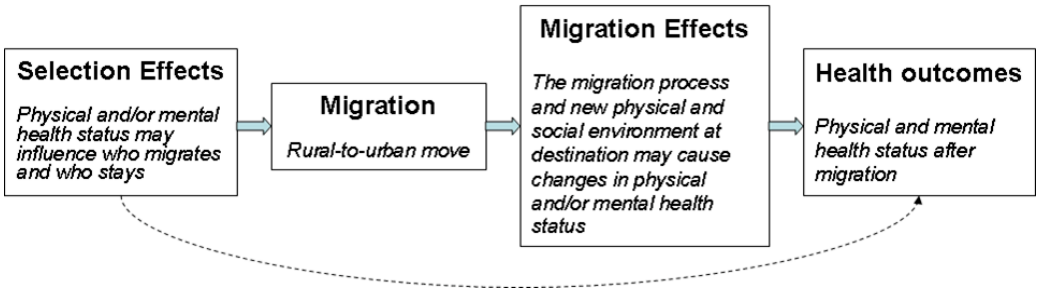
1. Do rural-to-urban migrants differ in *a priori* health status from their counterparts who remained at origin?
2. Do rural-to-urban migrants experience changes in health status from pre- to post-migration that differ from the changes in health status observed over the same timeframe among those who remained in the rural areas of origin?
3. Does the post-migration health status of rural-to-urban migrants differ from the health status of longer-term urban residents in the destination areas and those who remained at origin?

Conceptual Model

The conceptual model depicts a two-stage relationship between health and migration. First, individual health status among the population at origin may influence who migrates versus who stays. This stage represents the selection effects of health on migration. Next, the migration process and adjustment to a new physical and social environment at destination may cause changes in migrants' physical and mental health status. This stage denotes the effects of migration on health.

The dashed line that connects the first and last boxes in the framework indicates correlation between *a priori* health status and post-migration health outcomes. Because migrants typically constitute a healthier and more resilient subset of the population, they may retain this health advantage during and after migration and therefore may continue to exhibit healthy outcomes after the move. This is commonly referred to as the "healthy migrant" phenomenon, *i.e.*, health advantages of migrants are likely due in part to the fact that they were healthier than their non-migrant counterparts in the first place.

Conceptual Model: The relationship between health and migration



Data and Methods

This study employs a longitudinal survey design. Baseline data were collected in 2005 through a household-based census conducted in 80 rural villages and 20 urban/peri-urban geographic units in Kanchanaburi province, Western Thailand. Because migration is typically undertaken during young adulthood, the sample for this study includes the 18 – 29 year olds who were enumerated in the census in the 80 rural villages. A follow-up census was conducted in 2007, and those who remained in the rural study sites in Kanchanaburi were re-interviewed. The 2217 individuals re-interviewed in rural Kanchanaburi comprise a comparison group of young adults who stayed in the sending areas. Those who moved to urban areas, including Metropolitan Bangkok, Nakhon Pathom and Kanchanaburi City, during the two-year period were followed-up at destination; these 179 individuals constitute the sample of rural-to-urban migrants. During the follow-up survey, a sample of longer-term urban residents was selected in communities where the rural-to-urban migrants had settled. This additional comparison group included 252 individuals who had lived in the urban destination areas for at least 2 years.

The survey collected demographic and socioeconomic information, a migration history, several health status indicators, and other measures. The Short-Form 36 (SF-36) Health Survey, developed by RAND Corporation and J. E. Ware, is a widely-used and highly-regarded instrument for assessing functional health and well-being. The SF-36 is particularly well-suited for this study as it was designed to detect variations in health status within generally healthy populations. Consisting of 36 questions with scaled response options, the SF-36 is an easily administered and concise way of measuring self-assessed physical and mental health status. The SF-36 comprises validated and standardized psychometric scales that measure eight specific dimensions of physical and mental health status, including: physical functioning; role limitations due to physical problems; role limitations due to emotional problems; social functioning; mental health; vitality; bodily pain; and general health perceptions. These scales are computed such that higher scores indicate better health outcomes. Two summary measures – a mental health component summary (MCS) score and a physical health component summary (PCS) score – are computed by aggregating data from the eight subscales.

This study uses the SF-36 to assess *a priori* differences in health status that distinguish those who subsequently migrated to urban destinations from those who stayed in the rural sending areas. For the rural-to-urban migrants, SF-36 measures are compared over time to reveal changes in health status from pre- to post- migration. Changes in health status over time within the rural comparison group are driven by secular trends affecting the population of interest. Comparing changes in health status between the two groups ascertains whether migrants experience health impacts that can be attributed to the migration experience. The results reported in this paper focus on the two summary measures of mental and physical health status (MCS and PCS).

Multivariate logistic regression models are used to assess the effect of *a priori* health status on subsequent migration while controlling for demographic and socioeconomic factors. These analyses will indicate whether those who subsequently migrated were initially healthier or less healthy than those who stayed in the rural villages. Fixed effects regression models are then used to assess the effect of migration on changes in health status while controlling for time variant demographic and socioeconomic characteristics as well as unobserved time-invariant characteristics they may influence migrant selection. A discussion of the rationale for using fixed effects analysis in the context of this study is provided in Appendix 1. The fixed effects regressions will indicate whether rural-to-urban migrants experience changes in health status from pre- to post-migration that are significantly different from changes in health status observed within the rural comparison group during the same timeframe. Finally, using data from the follow-up survey, a cross-sectional analysis compares the health status of rural-to-urban migrants with the comparison groups of those who stayed in rural Kanchanaburi and longer-term urban residents in the destination areas.

Results

Socio-demographic characteristics of the rural-to-urban migrants and the comparison group of those who stayed in Kanchanaburi province are compared in Table 1. The migrants are younger, on average, than the comparison group. While the numbers of male and female migrants are nearly equal, there are more women than men in the comparison sample. The most notable difference is in marital status; while the majority of migrants were single at T_0 (before migrating), the majority of those who remained at origin were married. Overall, the migrants are more educated than their counterparts who stayed in the rural communities. There is also a much larger proportion of students among the migrants than in the comparison group. These significant differences in socio-demographic characteristics between the rural-to-urban migrants and those who remained at origin underscore the need to address potential selection bias by accounting for fundamental differences between migrants and their counterparts in the sending areas.

Table 2 presents *a priori* differences in physical and mental health status that distinguish those who subsequently migrated to urban destinations from those who stayed in rural Kanchanaburi. On average, those who subsequently migrated scored higher on the PCS scale, compared to those who remained at origin. This finding is consistent with the “healthy migrant hypothesis” which posits that migrants typically constitute a more physically robust subset of the sending population. On the other hand, a lower mean MCS score was observed for the migrants than for the comparison group. This may indicate relative dissatisfaction among those who subsequently

migrated with regard to their circumstances at origin before they moved. When analyzed independently, similar results for both physical and mental health were observed for males and females; however, the results are only statistically significant for females.

In Table 3, pre- and post-migration health status is compared for the rural-to-urban migrants. The mean MCS score increased significantly over time; however the slight decline in physical health (PCS) from pre- to post-migration was not a statistically significant change. On average, MCS scores increased more for female migrants, compared to the increase in MCS observed among the male migrants.

Health status at baseline and follow-up for the rural comparison group is shown in Table 4. The mean PCS score decreased over time. Although the difference is statistically significant, the magnitude of change is small. In general, physical health declines gradually with age. Therefore, this slight decrease in the PCS score could be expected, because the population aged by 2 years between the two survey waves. Meanwhile, the results show a modest improvement in mental health over time. This could be due to emotional maturity that comes with age, particularly during young adulthood. External circumstances, such as economic conditions, environmental factors, and social and political changes, may also contribute to improved emotional well-being in the population.

The results presented in Tables 3 and 4 are illustrated graphically in Figures 1 – 6. Figure 1 shows that rural-to-urban migrants are overall more physically robust than those who stayed in rural Kanchanaburi, and both groups experienced a slight decline in physical health over time. The degree of change appears to be about the same for migrants and the rural comparison group. A similar pattern of results is shown for males and females separately in Figures 2 and 3, respectively. However, the difference in physical health status between migrants and the comparison group is more pronounced for females than for males. A marked increase in the mental health status of rural-to-urban migrants, compared to those who stayed in rural Kanchanaburi, is depicted in Figure 4. While migrants initially exhibited lower MCS scores than the rural comparison group, the average mental health status of migrants increases to a level that surpasses the average MCS score of the comparison group at follow-up. As shown in Figures 5 and 6, this pattern of results is repeated when examined separately for males and females. However, the gradation of change differs more between the female migrants and females who stayed in rural Kanchanaburi (shown in Figure 6), relative to the same comparison for males (shown in Figure 5). At follow-up, the average mental health status of male migrants is comparable to that of males in the comparison group.

The results presented in Table 5 indicate that the gradation of change in mental health status over time differs significantly between rural-to-urban migrants and those who stayed in rural Kanchanaburi, particularly for women. Changes in physical health status over time are not significantly different between the migrants and the rural comparison group.

To address the selection effects of *a priori* health status on subsequent migration, Tables 6 and 7 present odds ratios (ORs) for physical and mental health status, respectively, predicting subsequent migration while controlling for socio-demographic characteristics that may also influence migrant selection. The results show that the PCS score is positively associated with

migration while the MCS score is inversely associated with migration. These findings corroborate the results in Table 2; however, after controlling for socio-demographic characteristics that are also associated with migration, the effects of physical and mental health status on subsequent migration lose statistical significance. The odds ratio for PCS predicting subsequent migration is borderline significant for females in the sample (shown in Table 6).

Tables 8 and 9 present the results of fixed effects regression models assessing the impact of rural-to-urban migration on changes over time in physical and mental health status, respectively, while controlling for time variant socio-demographic characteristics included in the model as well as unobserved time-invariant characteristics that may influence migrant selection. The findings indicate that changes in physical health status are not significantly different between rural-to-urban migrants and their rural counterparts. This is evident in Figures 1 – 3, because the lines depicting changes in physical health status over time for migrants and the rural comparison group are nearly parallel. The positive effect of rural-to-urban migration on mental health status is evident in the findings shown in Table 9. The observed changes in mental health status are significantly different between migrants and the rural comparison group. The positive coefficient indicates that migrants experienced a greater improvement in mental health status than those who stayed in the rural sending areas, which can be seen in Figure 4. The impact of rural-to-urban migration on mental health status is most pronounced for females, as shown in Figure 6.

A cross-sectional comparison of health status (measured in 2007) for rural-to-urban migrants and the comparison groups of rural and urban residents is shown in Table 10. These results are also depicted graphically in Figures 7 and 8. On average, higher PCS scores were observed for rural-to-urban migrants compared to the rural and urban residents at origin and destination. The differences were statistically significant for females, but not males, when analyzed independently. This finding supports the "healthy migrant hypothesis" by indicating that those who migrate are, on average, more physically robust than their non-migrating counterparts. Mental health status was lower, on average, among the longer-term urban residents compared to rural-to-urban migrants and those who stayed in rural Kanchanaburi. This may indicate that their urban lifestyles carry certain stressors that are not experienced by people living in rural areas. Meanwhile, the migrants may sustain higher mental health status than longer-term urban residents due to the initial excitement and novelty of city life. Rural-to-urban migrants may also maintain some aspects of their rural lifestyles, such as cultural practices or mentalities, that render them resistant to some of the stressors of city life.

The results of multivariate analyses presented in Tables 11 and 12 corroborate the bivariate results shown in Table 10 and Figures 7 and 8. After controlling for socio-demographic characteristics, being a rural-to-urban migrant is associated with having better physical health status, relative to those who stayed in rural Kanchanaburi (shown in Table 11) and longer-term urban residents (analyzed but not shown). When analyzed separately, this finding is statistically significant for females but not for males. Being a longer-term resident of the urban destination areas is associated with having worse mental health status, relative to rural-to-urban migrants (analyzed but not shown) and the rural comparison group (shown in Table 12). This finding is statistically for both males and females when analyzed independently.

Discussion

To limit selection bias, we used a longitudinal research design to assess the effects of rural-to-urban migration on physical and mental health. Measuring pre-migration health status allowed us to determine the extent to which *a priori* health status influenced who subsequently migrated versus who stayed at origin. Our results support what other studies have posited as the "healthy migrant hypothesis" which suggests that migrants are physically healthier before they move compared to those who stay at origin. Pre-migration *mental* health status has received much less attention in the literature. We found that migrants actually score lower on the mental component summary (MCS) indicator measured before the move, compared to the mean MCS score observed at baseline for the rural comparison group. However, we also found that, after moving to the city, the disadvantage in mental health status among migrants – vis-à-vis the comparison group – disappeared. After moving to the city, migrants exhibited slightly better mental health status compared to those who stayed in rural Kanchanaburi. This suggests that, before moving to urban destinations, migrants may have been disaffected with rural life. This disaffection may have enticed them to migrate to urban destinations, leading to an improvement in mental health that negates the original deficiency they suffered while living in the rural areas.

Our results clearly demonstrate the merits of using a longitudinal study design in which potential selection factors for migration, such as health status, are measured before and after migration. Our findings revealed that baseline health status of those who subsequently migrated differed from the health status of those who remained at origin. We observed that mental health status measured at follow-up was nearly equivalent, on average, for migrants and their counterparts who stayed in rural Kanchanaburi, with migrants exhibiting slightly higher mean MCS scores than the comparison group. However, the results of fixed effects regressions showed a significant association between rural-to-urban migration and an improvement in mental health status. Without the benefit of observing the change in MCS from pre- to post-migration and over the same timeframe for the comparison group, it would seem that migration did not affect mental health, given the lack of a significant difference in MCS measured in 2007. This would clearly be an erroneous conclusion. In contrast, our longitudinal results demonstrate that rural-to-urban migration actually does affect mental health status, since migrants experienced an improvement in mental health from pre- to post-migration.

Key limitations of this study include attrition and a fairly short window of time between survey waves. Some loss to follow-up is typical in longitudinal research studies, and it is particularly difficult to avoid when following migrants. To address the potential selection bias introduced through attrition, statistical analyses were conducted comparing socio-demographic characteristics and baseline health status of those lost to follow-up with those retained in the sample for both survey waves. While a fairly short length of time between survey waves can help reduce attrition, it also limits the number of individuals who migrate within that timeframe, which restricts the statistical power of the analyses. Also, if some of the impacts of migration on physical and mental health manifest more slowly, the magnitude of change detected within the timeframe of the study will be minimal.

Tables & Figures

Table 1. Sample characteristics at T_0 (in 2005) for those who subsequently migrated before 2007 compared to respondents who stayed in Kanchanaburi province

Characteristics	*Rural-to-Urban Migrants (N=179)* Mean (Std.) or % (n)	*Kanchanaburi Residents (N=2217)* Mean (Std.) or % (n)
Age*** (years: 18-29)	21.07 (3.11)	24.37 (3.43)
Sex**		
Male	48.6% (87)	36.9% (819)
Female	51.4% (92)	63.1% (1398)
Marital status***		
Single	63.1% (113)	25.4% (563)
Married	34.1% (61)	72.0% (1597)
Divorced, widowed, separated	2.8% (5)	2.6% (57)
Occupation***		
Professional	5.0% (9)	8.3% (185)
Skilled	31.8% (57)	50.3% (1116)
Manual labor	19.6% (35)	16.8% (373)
Student	34.6% (62)	4.0% (88)
Not working	8.9% (16)	20.5% (455)
Education***		
None	1.1% (2)	10.2% (225)
Primary (1-6 yrs)	24.0% (43)	40.9% (906)
Secondary (7-12 yrs)	58.1% (104)	40.9% (906)
Undergraduate / masters level (13+ yrs)	16.8% (30)	8.1% (179)
Birthplace***		
This village / tambon	73.2% (131)	57.8% (1281)
Other district / province	26.3% (47)	32.9% (728)
Other country	0.6% (1)	9.3% (207)
Ever moved from birthplace*	72.1% (129)	78.2% (1733)
Moved since July 2004***	41.9% (75)	28.8% (638)

Significance: *p<0.05, **p<0.01, ***p<0.001

Table 2. Health status at T_0 (in 2005) for those who subsequently migrated before 2007 compared to respondants who stayed in Kanchanaburi province

SF-36 summary scales	***Rural-to-Urban Migrants***	***Kanchanaburi Residents***
Whole sample	Mean score *(N=179)*	Mean score *(N=2217)*
PCS**	54.19	52.74
MCS*	47.13	48.63
Males	Mean score *(N=87)*	Mean score *(N=819)*
PCS n.s.	54.49	53.75
MCS n.s.	48.00	49.23
Females	Mean score *(N=92)*	Mean score *(N=1398)*
PCS*	53.91	52.14
MCS*	46.30	48.28

Significance: n.s. p>0.10, *p<0.05, **p<0.01

Table 3. Pre-migration versus post-migration health status among young adult rural-to-urban migrants, 2005 – 2007

SF-36 summary scales	***Pre-migration 2005***	***Post-migration 2007***	***Change over time***
Whole sample (N=179)	Mean score	Mean score	Mean
PCS n.s.	54.19	53.78	↓ 0.41
MCS***	47.13	50.32	↑ 3.19
Males (N=87)	Mean score	Mean score	Mean
PCS n.s.	54.49	53.82	↓ 0.67
MCS*	48.00	50.47	↑ 2.47
Females (N=92)	Mean score	Mean score	Mean
PCS n.s.	53.91	53.75	↓ 0.16
MCS***	46.30	50.18	↑ 3.88

Significance: n.s. p>0.10, *p<0.05, ***p<0.001

Table 4. Health status in 2005 versus health status in 2007 among the non-migrant comparison group of young adults interviewed in Kanchanaburi province in both years

SF-36 summary measures	***2005***	***2007***	***Change over time***
Whole sample (N=2217)	Mean score	Mean score	Mean
PCS**	52.74	52.19	↓ 0.55
MCS***	48.63	49.72	↑ 1.09
Males (N=819)	Mean score	Mean score	Mean
PCS n.s.	53.75	53.40	↓ 0.35
MCS**	49.23	50.30	↑ 1.07
Females (N=1398)	Mean score	Mean score	Mean
PCS**	52.14	51.49	↓ 0.65
MCS***	48.28	49.38	↑ 1.10

Significance: n.s. p>0.10, **p<0.01, ***p<0.001

Table 5. Mean change in health status from 2005 to 2007 for rural-to-urban migrants and rural residents of Kanchanaburi province

SF-36 summary scales	***Rural-to-Urban Migrants***	***Kanchanaburi Residents***
Whole sample	Mean score *(N=179)*	Mean score *(N=2217)*
PCS n.s.	-0.41	-0.54
MCS*	3.19	1.09
Males	Mean score *(N=87)*	Mean score *(N=819)*
PCS n.s.	-0.66	-0.35
MCS n.s.	2.46	1.07
Females	Mean score *(N=92)*	Mean score *(N=1398)*
PCS n.s.	-0.17	-0.66
MCS*	3.87	1.10

Significance: n.s. p>0.10, *p<0.05

Table 6. Association between physical health status (PCS) at T_0 (in 2005) and subsequent migration, controlling for socio-demographic characteristics

Covariates	***Whole sample*** *(N=2395)*		***Males*** *(N=906)*		***Females*** *(N=1489)*	
	O.R.	***p***	***O.R.***	***p***	***O.R.***	***p***
PCS (continuous)	1.021	.141	1.003	.887	1.035	.071
Sex (ref: female)	1.255	.217	--	--	--	--
Age at T_0 (continuous)	0.833	.000	0.806	.000	0.835	.000
Single at T_0 (ref: married)	1.593	.030	1.164	.607	2.313	.007
Wid/div/sep at T_0 (ref: married)	2.299	.092	10.876	.000	0.587	.607
Primary education at T_0 (ref: no education)	4.954	.029	4.071	.176	5.366	.105
Secondary education at T_0 (ref: no education)	5.850	.015	4.679	.134	7.041	.057
Higher education at T_0 (ref: no education)	6.091	.018	6.406	.090	6.228	.087
Working at T_0 (ref: not working)	2.066	.040	1.323	.793	2.016	.068
Looking for a job at T_0 (ref: not working)	3.323	.039	3.561	.283	0.977	.968
Student at T_0 (ref: not working)	7.065	.000	4.121	.203	5.632	.001

Table 7. Association between mental health status (MCS) at T_0 (in 2005) and subsequent migration, controlling for socio-demographic characteristics

Covariates	***Whole sample*** *(N=2395)*		***Males*** *(N=906)*		***Females*** *(N=1489)*	
	O.R.	***p***	***O.R.***	***p***	***O.R.***	***p***
MCS (continuous)	.986	.105	.985	.200	.988	.310
Sex (ref: female)	1.331	.119	--	--	--	--
Age at T_0 (continuous)	0.836	.000	0.807	.000	0.838	.000
Single at T_0 (ref: married)	1.624	.024	1.162	.611	2.437	.004
Wid/div/sep at T_0 (ref: married)	2.232	.105	10.489	.000	0.571	.588
Primary education at T_0 (ref: no education)	4.882	.030	3.998	.182	5.375	.105
Secondary education at T_0 (ref: no education)	5.652	.017	4.503	.144	6.924	.059
Higher education at T_0 (ref: no education)	5.931	.020	6.390	.091	5.992	.094
Working at T_0 (ref: not working)	2.010	.048	1.334	.787	1.952	.081
Looking for a job at T_0 (ref: not working)	3.496	.031	3.749	.262	1.175	.949
Student at T_0 (ref: not working)	7.180	.000	4.348	.185	5.557	.001

Table 8. Effect of rural-to-urban migration between 2005 and 2007 on change in PCS from 2005 to 2007 using fixed effects regression

Covariates	*Whole sample (N=2396)*		*Males only (N=906)*		*Females only (N=1490)*	
	Coefficient (s.e.)	*p*	*Coefficient (s.e.)*	*p*	*Coefficient (s.e.)*	*p*
Migration status (ref: rural resident)	.471 (.701)	.501	-.076 (.969)	.937	.979 (1.008)	.332
Married (ref: single)	-.563 (.817)	.491	1.009 (1.018)	.322	**-3.032 (1.348)**	**.025**
Wid/div/sep (ref: single)	-.260 (1.184)	.826	-.183 (1.684)	.913	-1.804 (1.752)	.303
Looking for a job (ref: not working)	.174 (1.336)	.896	1.307 (2.244)	.560	-.295 (2.107)	.889
Working (ref: not working)	-.667 (.424)	.116	.675 (1.757)	.701	-.800 (.449)	.075
Student (ref: not working)	-.098 (1.120)	.931	2.767 (2.293)	.228	-1.563 (1.482)	.292
Primary education (ref: no education)	1.627 (1.729)	.347	.765 (3.140)	.808	1.980 (2.085)	.343
Secondary education (ref: no education)	1.846 (1.992)	.354	.201 (3.461)	.954	2.761 (2.482)	.266
Higher education (ref: no education)	.722 (2.229)	.746	-1.198 (3.814)	.754	1.478 (2.793)	.597
Moved within village (ref: did not move)	.477 (.732)	.515	.486 (1.107)	.661	.555 (.976)	.570
Year 2007 (ref: 2005)	**-.524 (.198)**	**.008**	-.379 (.319)	.236	**-.610 (.253)**	**.016**
Constant	52.778 (1.798)	.000	52.555 (3.546)	.000	53.872 (2.308)	.000

Note: Age and sex are fixed characteristics, so not included in the models.
Hausman test for whole sample: Chi^2=25.87, p=0.007
Hausman test for males: Chi^2=13.88, p=0.240
Hausman test for females: Chi^2=20.83, p=0.035

Table 9. Effect of rural-to-urban migration between 2005 and 2007 on change in MCS from 2005 to 2007 using fixed effects regression

Covariates	*Whole sample (N=2396)*		*Males only (N=906)*		*Females only (N=1490)*	
	Coefficient (s.e.)	*p*	*Coefficient (s.e.)*	*p*	*Coefficient (s.e.)*	*p*
Migration status (ref: rural resident)	**2.024 (.885)**	**.022**	1.574 (1.252)	.209	**2.476 (1.258)**	**.049**
Married (ref: single)	.002 (1.032)	.998	-.479 (1.316)	.716	.630 (1.682)	.708
Wid/div/sep (ref: single)	-1.824 (1.495)	.223	-.649 (2.176)	.766	-2.182 (2.187)	.319
Looking for a job (ref: not working)	2.837 (1.688)	.093	4.648 (2.899)	.109	1.197 (2.631)	.649
Working (ref: not working)	.123 (.535)	.819	1.048 (2.271)	.644	.125 (.561)	.824
Student (ref: not working)	.209 (1.414)	.883	1.796 (2.963)	.544	-.245 (1.850)	.895
Primary education (ref: no education)	-.998 (2.183)	.647	2.325 (4.057)	.567	-2.301 (2.604)	.377
Secondary education (ref: no education)	-.822 (2.516)	.744	3.729 (4.473)	.405	-2.936 (3.100)	.344
Higher education (ref: no education)	-.246 (2.815)	.930	3.949 (4.929)	.423	-2.294 (3.488)	.511
Moved within village (ref: did not move)	-.307 (.925)	.740	.159 (1.431)	.912	-.549 (1.219)	.652
Year 2007 (ref: 2005)	**1.140 (.250)**	**.000**	**1.059 (.412)**	**.010**	**1.170 (.316)**	**.000**
Constant	48.040 (2.270)	.000	44.230 (4.583)	.000	48.783 (2.883)	.000

Note: Age and sex are fixed characteristics, so not included in the models.
Hausman test for whole sample: Chi^2=9.36, p=0.588
Hausman test for males: Chi^2=8.52, p=0.666
Hausman test for females: Chi^2=8.09, p=0.705

Table 10. Health status at T_1 (in 2007) for rural-to-urban migrants, respondents who stayed in Kanchanaburi province and longer-term urban residents in the destination areas

SF-36 summary measures	***Kanchanaburi Residents***	***Rural-to-Urban Migrants***	***Longer-term Urban Residents***
Whole sample	Mean score *(N=2217)*	Mean score *(N=179)*	Mean score *(N=252)*
PCS	52.19$^{**, n.s.}$	53.78**	52.11
MCS	49.72$^{n.s.,***}$	50.32**	47.56
Males	Mean score *(N=819)*	Mean score *(N=87)*	Mean score *(N=121)*
PCS	53.40$^{n.s., n.s.}$	53.82$^{n.s.}$	53.49
MCS	50.30$^{n.s.,**}$	50.47*	47.72
Females	Mean score *(N=1398)*	Mean score *(N=92)*	Mean score *(N=131)*
PCS	51.49$^{**,n.s.}$	53.75**	50.82
MCS	49.38$^{n.s.,*}$	50.18*	47.42

Significance: $^{n.s.}$p>0.10, *p<0.05, **p<0.01, ***p<0.001

Table 11. Association between migration status and physical health status (PCS) at T_1 (in 2007)

Covariates	***Whole sample*** *(N=2647)*		***Males*** *(N=1026)*		***Females*** *(N=1621)*	
	ß	***p***	***ß***	***p***	***ß***	***p***
Rural-to-urban migrants (ref: rural comparison group)	1.121	.045	0.231	.756	1.993	.015
Longer-term urban residents (ref: rural comparison group)	-0.636	.202	-0.269	.689	-1.018	.156
Sex (ref: female)	1.718	.000	--	--	--	--
Age at T_1 (continuous)	0.014	.737	-0.058	.364	0.066	.242
Single at T_1 (ref: married)	0.270	.461	0.352	.447	0.006	.991
Wid/div/sep at T_1 (ref: married)	0.535	.473	0.901	.439	0.466	.630
Primary education at T_1 (ref: no education)	-1.440	.007	-1.260	.158	-1.509	.023
Secondary education at T_1 (ref: no education)	-1.402	.008	-1.234	.160	-1.404	.035
Higher education at T_1 (ref: no education)	-1.190	.076	-1.025	.336	-1.066	.227
Working at T_1 (ref: not working)	0.661	.110	4.377	.008	0.426	.347
Looking for a job at T_1 (ref: not working)	2.128	.111	4.907	.025	3.219	.150
Student at T_1 (ref: not working)	1.633	.044	4.633	.015	1.966	.063

Table 12. Association between migration status and mental health status (MCS) at T_1 (in 2007)

Covariates	***Whole sample*** *(N=2647)*		***Males*** *(N=1026)*		***Females*** *(N=1621)*	
	ß	***p***	***ß***	***p***	***ß***	***p***
Rural-to-urban migrants (ref: rural comparison group)	0.521	.473	0.279	.783	0.763	.459
Longer-term urban residents (ref: rural comparison group)	-2.366	.000	-2.336	.011	-2.181	.016
Sex (ref: female)	0.776	.039	--	--	--	--
Age at T_1 (continuous)	0.100	.070	0.212	.015	0.025	.725
Single at T_1 (ref: married)	0.847	.066	0.723	.251	1.357	.064
Wid/div/sep at T_1 (ref: married)	0.249	.796	0.764	.629	0.037	.976
Primary education at T_1 (ref: no education)	-2.175	.002	-3.516	.004	-1.531	.068
Secondary education at T_1 (ref: no education)	-2.013	.003	-2.944	.014	-1.689	.045
Higher education at T_1 (ref: no education)	-1.806	.038	-3.890	.007	-0.962	.389
Working at T_1 (ref: not working)	-0.150	.779	2.702	.227	-0.382	.505
Looking for a job at T_1 (ref: not working)	0.570	.742	4.036	.177	-0.546	.846
Student at T_1 (ref: not working)	0.368	.726	5.836	.024	-1.789	.180

Figure 1

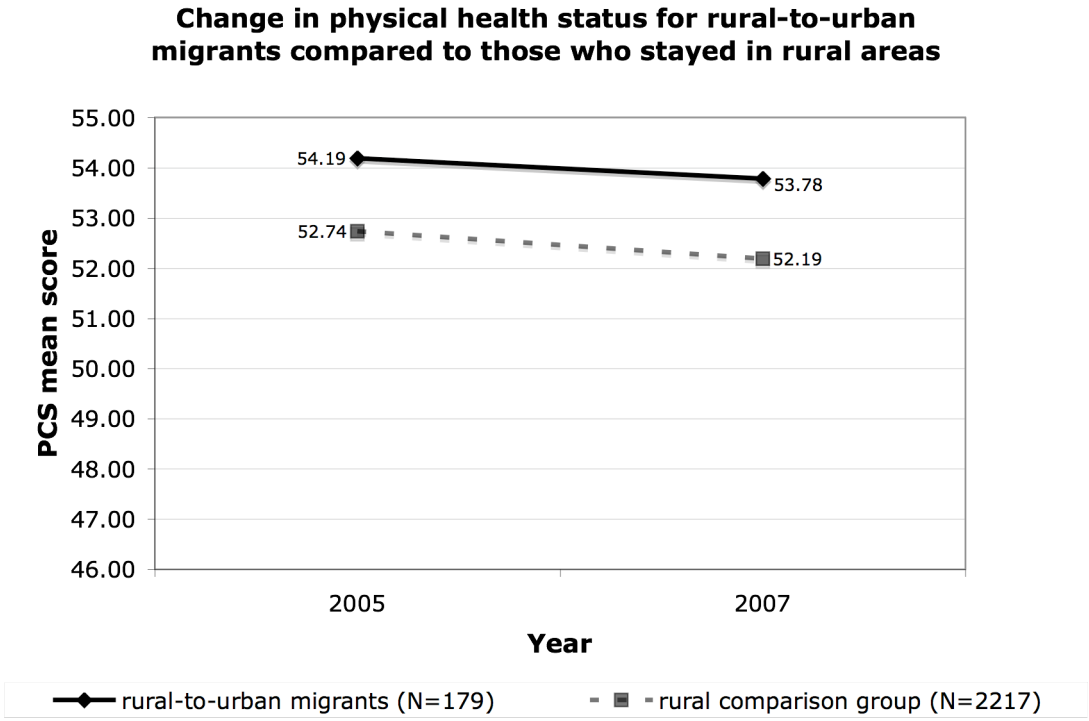


Figure 2

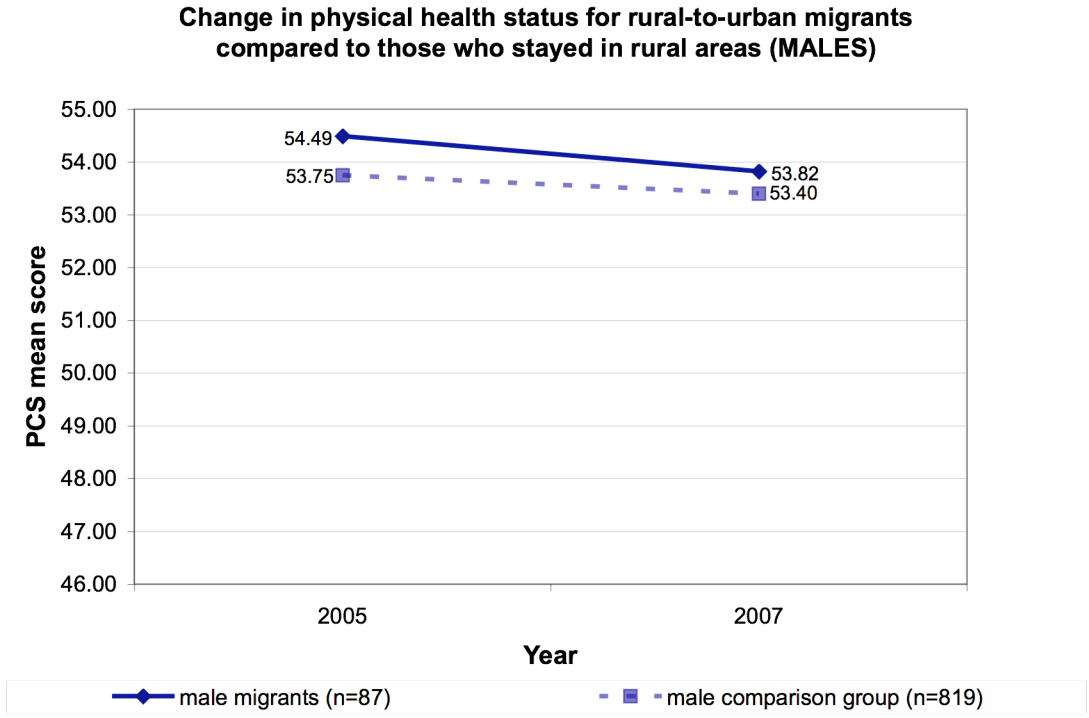


Figure 3

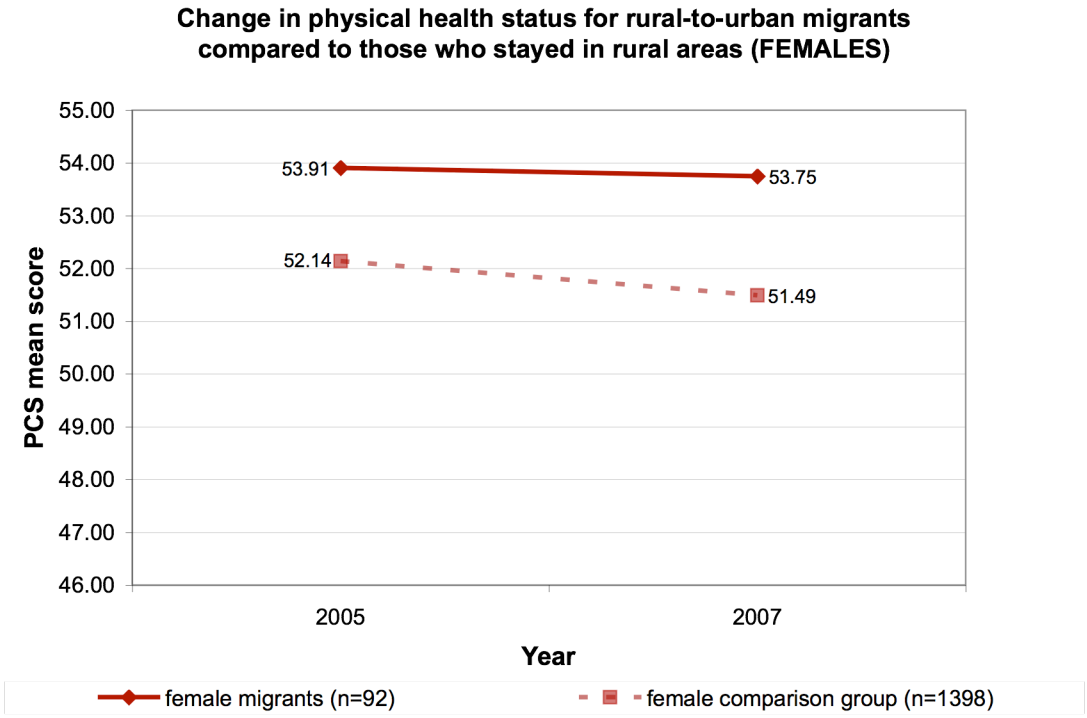


Figure 4

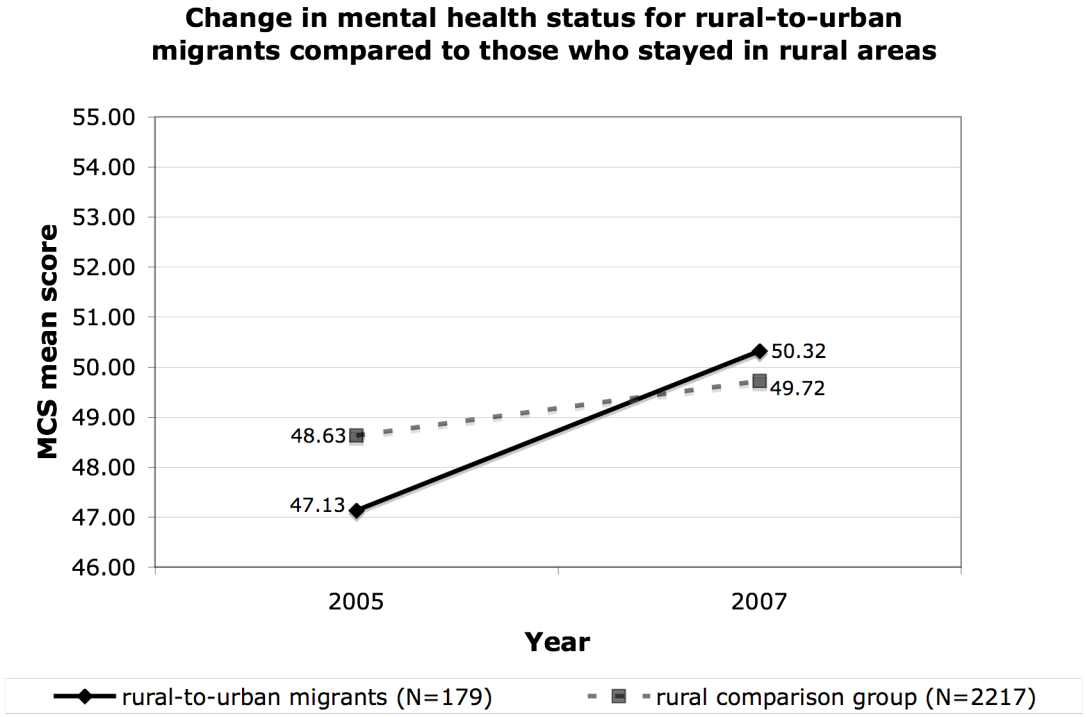


Figure 5

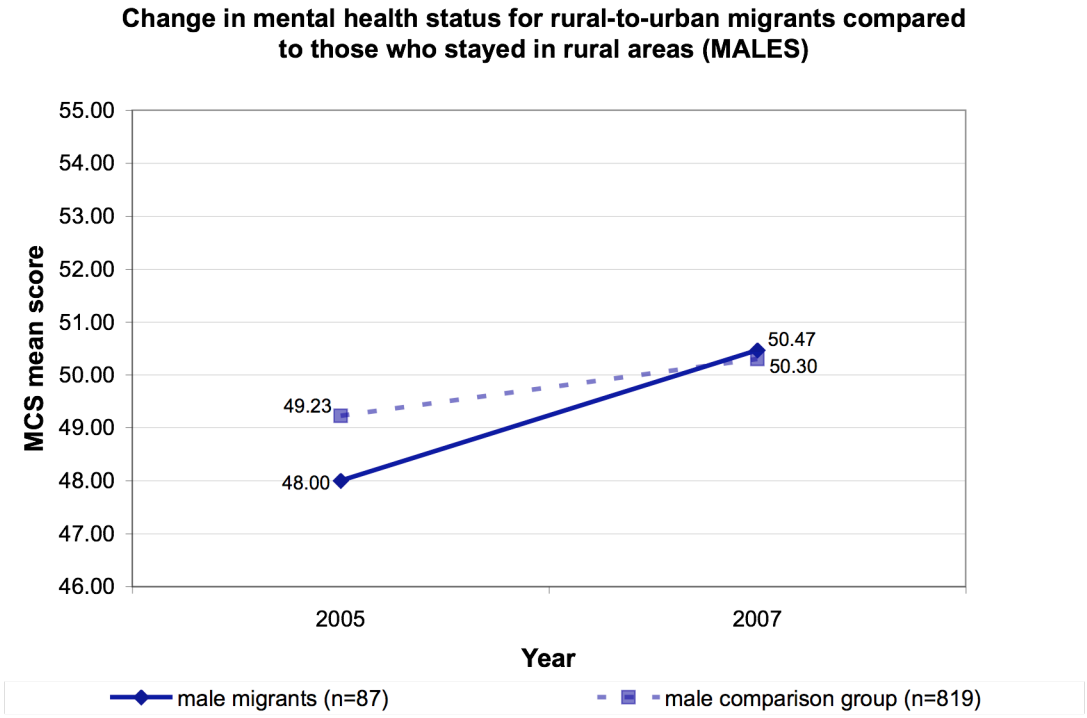


Figure 6

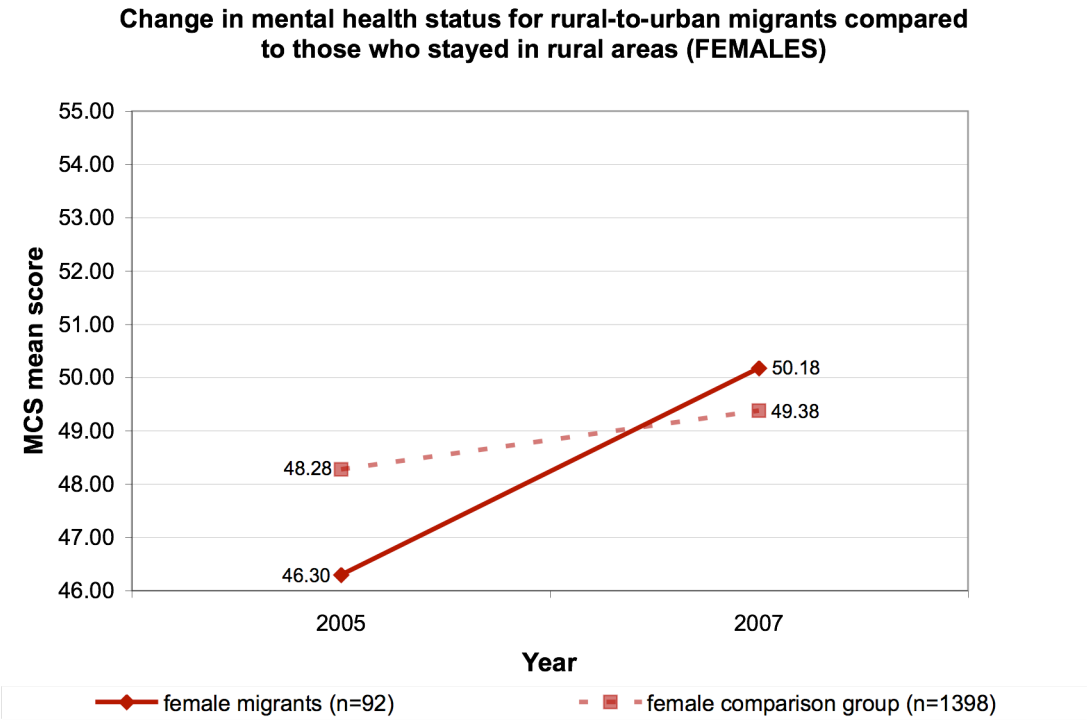
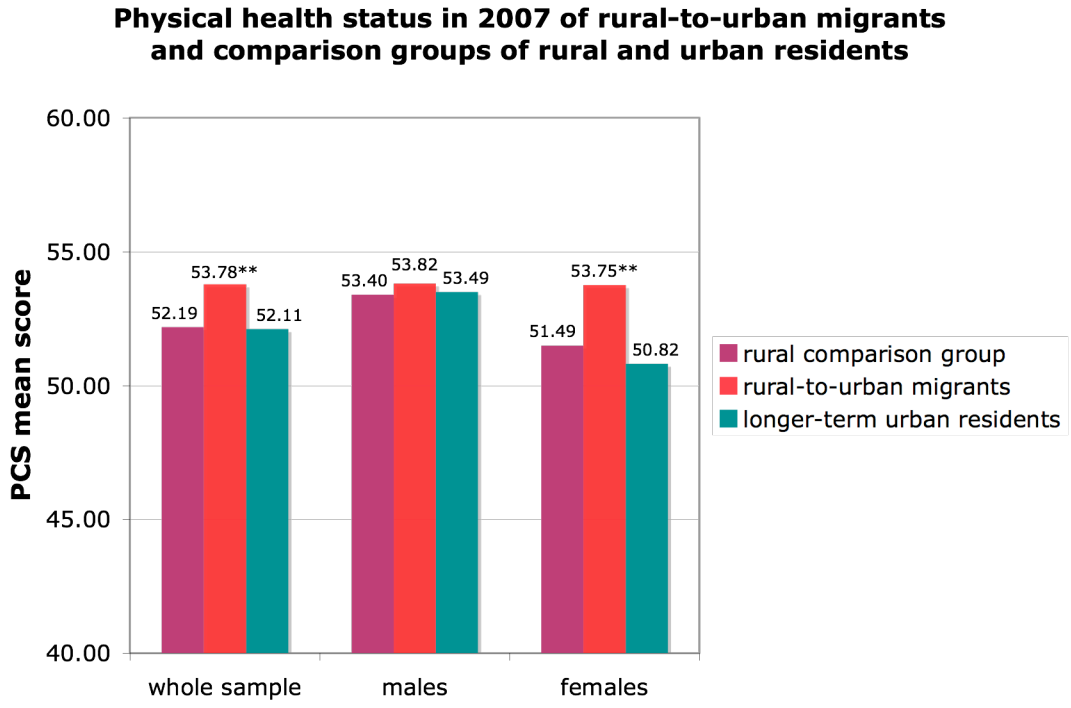
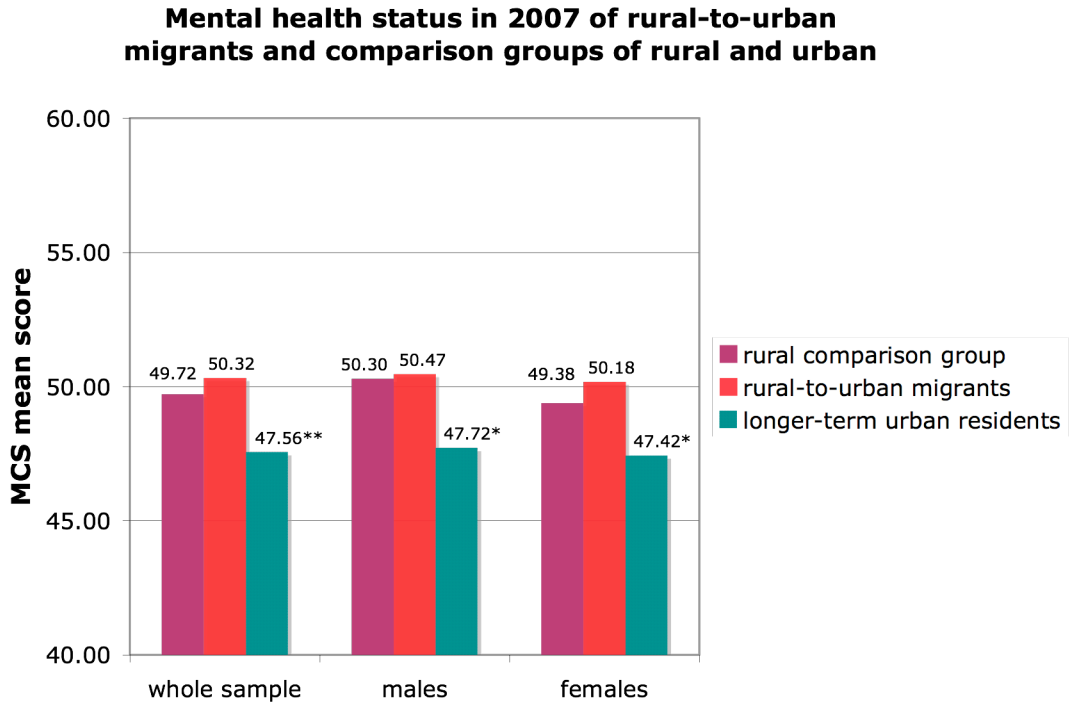


Figure 7



Significance: **p<0.01

Figure 8



Significance: *p<0.05, **p<0.01

Appendix 1

Because migrants are self-selected, they may differ in fundamental ways from their peers who stay at origin. Therefore, we cannot assume that rural-to-urban migrants and their non-migrating counterparts are the same, on average, with respect to their personal characteristics. In fact, we know that migration is typically associated with particular selection factors, such as age, sex and educational attainment – measurable characteristics that can be controlled for in statistical analyses. For this study, these are important control variables, because such characteristics may also affect health status.

The conceptual framework for this study shows that physical and mental health status may affect who migrates versus who does not. The study design is therefore inherently prone to endogenous selection. In this case, selection refers to being a rural-to-urban migrant versus a member of the comparison group of those who stayed in rural villages. Selection is endogenous when it is not random and is related to the dependent variable. As stated above, migration is not random, and health status may be associated with the propensity to migrate.

In addition to selection bias, this study is also vulnerable to endogeneity due to the omission of any covariates that are correlated with an explanatory variable in the model. This can lead to bias in estimating the effects of variables included in the model. Of particular concern is the omission of factors associated with both migration and health status, which could confound the relationship between the two. Such factors could include measurable or unobserved characteristics. Some variables, especially subjective characteristics, are difficult to measure, and imperfect measurement can also result in biased coefficient estimates.

Fixed effects regression is an analytic method that addresses these potential threats to validity. This method controls for characteristics of the respondents that do not change during the timeframe of the study, even those that were not measured. Therefore, coefficient estimates are impervious to bias by any stable characteristics associated with health status or the propensity to migrate. Since this method can be applied when the dependent variable is measured at two points in time for each respondent, it is well suited to this study in which health status was measured pre- and post-migration among those who moved to urban areas and at the same points in time for those who stayed in the rural villages of origin.

While fixed effects regression controls for unchanging personal characteristics, there are also factors that may change over time and affect both migrant self-selection and physical or mental health status, such as employment status, educational attainment and marital status. These are included in the fixed effects regression model as control variables so that the *ceteris paribus* effect of rural-to-urban migration on health status can be ascertained. The model also estimates the effect of a change in each of the covariates on the health status outcome.

Fixed effects analysis addresses within-subject variance but ignores between-subject variance – the disadvantage being that standard errors are higher than those produced by ordinary least squares regression. However, between-subject variance is vulnerable to contamination by unmeasured characteristics or omitted variables. Focusing only on within-subject variance eliminates these potentially large sources of bias, thereby providing more accurate coefficient

estimates. Fixed effects analysis also adjusts for the lack of independence among multiple observations for each individual.

In contrast, random effects methods assume that unobserved factors are not correlated with any of the explanatory variables. This method uses both between-subject and within-subject variation. While this requires the inclusion of time-constant control variables, the advantage is that estimates are obtained for the effects of these unchanging characteristics on the outcome. The disadvantage is that all relevant personal characteristics must be measured and included in the model. While fixed effects analysis controls for time-invariant characteristics, it does not provide coefficient estimates for them. Like fixed effects methods, random effects analysis also adjusts for the correlation between repeated measures among individuals.

While the random effects model will lead to more efficient estimates (i.e. smaller standard errors), the estimates are vulnerable to bias if the assumptions of the model are violated, specifically if there are unobserved or omitted factors that are correlated with any of the covariates. By controlling for time-invariant personal characteristics, the fixed effects model is less prone to bias but at the expense of efficiency (i.e. larger standard errors).

The Hausman test compares the random effects model versus the alternative fixed effects model by testing the null hypothesis that the individual effects of regressors in the random effects model are uncorrelated. If so, the biases inherent to random effects estimation do not significantly impact the results. If the Hausman test is statistically significant, thereby rejecting the null hypothesis, fixed effects analysis is required to avoid biased coefficient estimates. The fixed effects model remains a suitable default even if the Hausman test is not significant if larger standard errors can be tolerated.

Fixed effects regressions are used to estimate the effect of rural-to-urban migration on changes in physical and mental health status. Because fixed effects estimation mitigates bias that may result from endogenous selection, omitted variables, and unobserved characteristics, it is well suited to address the potential threats to validity discussed above.

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