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Project-induced displacement, secondary stressors, and health

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ABSTRACT

It has been estimated that about 15 million people are displaced by development projects around the world each year. Despite the magnitude of people affected, research on the health and other impacts of project-induced displacement is rare. This study extends existing knowledge by exploring the short-term health impact of a large scale population displacement resulting from China's Three Gorges Dam Project. The study is theoretically guided by the stress process model, but we supplement it with Cernea's Impoverishment Risks and Reconstruction (IRR) model widely used in displacement literature. Our panel analysis indicates that the displacement is associated positively with relocatees' depression level, and negatively with their self-rated health measured against a control group. In addition, a path analysis suggests that displacement also affects depression and self-rated health indirectly by changing social integration, socioeconomic status, and community resources. The importance of social integration as a protective mechanism, a factor that has been overlooked in past studies of population displacement, is highlighted in this study.

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Introduction

The Three Gorges Dam Project (TGDP) on the Yangtze River in China is the largest hydropower project in the contemporary world. Although the project promises to boost China's economic development and deliver many benefits, the resettlement of 1.4 million (Zhang & Tang, 2009) people from the affected areas, however, is an unprecedented challenge. The economic and social losses incurred by those displaced by development projects is well known (Cernea & Mathur, 2008; Chakrabarti & Dhar, 2009; Verma, 2004), but little is known about the health impact of project-induced displacement on the displaced. This study expands the scope of displacement studies by attempting to identify the possible mechanisms linking population displacement and negative health outcomes.

Significance of the study

Displacement induced by development projects has been classified as one type of involuntary migration sharing many characteristics with other types of involuntary migration resulting from natural or man-made disasters (Chakrabarti & Dhar, 2009). Unlike voluntary migrants, involuntary migrants tend not to be self-selected and self-motivated. Rather, they were made to move by an external force which they have little power to resist. Development project-induced displacement is the largest contributor to involuntary migration, accounting for the relocation of roughly15 million people worldwide every year (Cernea, 2006).

Project-induced displacement is a significant research topic not only because of its enormous scale, but also because of its sociological ramifications. For example, while relocatees' often bear most of the burdens incurred by a developmental project, they receive little benefit from the development (Cernea, 2000). Although most development projects are meant to reduce poverty and improve the lives of people as a whole, project-induced displacement, ironically, often ends up putting displaced people in worse conditions. It is estimated that 75 percent of the population displaced by developmental projects in India since Independence now live in poverty (Chakrabarti & Dhar, 2009). Similarly, a World Bank estimate suggests that 60 percent of individual displaced by China's dam projects live below the poverty threshold (Robinson, 2003). Despite its sociological ramifications, project-induced displacement research has been dominated by economists and geographers with little participation by sociologists (Castles, 2003). Research on the health impacts of project-induced displacement is especially scarce. Jayewardene (1995) pointed out that such research emerged only after health problems reached a crisis level.

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This study contributes to displacement literature by providing solutions to several difficult methodological difficulties often encountered in the previous studies. First, most displacement studies have been done retrospectively. Retrospective designs confound measurement errors resulting from faulty memories and post-factum rationalizations (Campbell & Stanley, 1966). Second, to measure the effect of displacement effect, past studies often compared relocatees with residents at the destination instead of the more comparable non-migratory population at the place of origin. Third, past studies have been flawed by the inability to separate the pre-existing differences between relocatees and non-relocatees from the effect of displacement.

We address these problems by using "natural experiment" design, which is an ideal design for studying relocatees' health (Kasl & Berkman, 1983). Three Gorges Dam Project (TGDP)-induced displacement provides us with a golden opportunity to conduct such a design. Since all residents living in the areas to be flooded by the dam were required to relocate, selective migration was not a problem. The project also afforded us the rare opportunity to collect pre-displacement data from TGDP relocatees and their non-migrating counterparts, thus avoiding recollection errors commonly associated with retrospective studies. The pre-displacement information also enabled us to control for pre-existing differences between relocatees and non-relocatees as potential confounding factors. Furthermore, the use of non-relocatees from the same region as the comparison group helped to control the effects of intrinsic factors such as history, maturation, and experimental mortality.

In addition, our study makes a unique contribution to the literature on the health impact of displacement by demonstrating that health problems among the displaced are related not only to uprooting itself, which affects all relocatees uniformly, but also to the differential experiencing of secondary stressors that often accompanied displacement (i.e., deterioration in social integration, socioeconomic status, and community resources) by different relocatees.

Theoretical framework

This study employs the stress process model (Pearlin, Menaghan, Lieberman, & Mullan, 1981) as its primary theoretical framework. The stress process model consists of three conceptual domains: stressors, psychosocial resources, and stress outcomes. The model has been widely used to study relations between a wide variety of stressors and stress outcomes by suggesting plausible psychosocial processes that link the two (Thoits, 1995; Turner & Lloyd, 1999). While it was not designed to study migration process in particular, the flexibility of the model has allowed many researchers to adapt it to study the health of involuntary migrants (Beiser, 1999, 2005; Hwang, Cao, & Xi, 2007, 2010; Ryan, Dooley, & Benson, 2008; Xi, 2007).

Although there is little disagreement that displacement produces changes to relocatees' life, no consensus exists regarding whether all the changes contribute to distress. Some scholars emphasize the importance of change itself and predict that all life-changes, including benign ones, lead to create stress (Dohrenwend, 1975; Holmes & Rahe, 1967; Selye, 1982). They argue that all life-changes, regardless of their nature, are stressful because they disrupt life patterns and require that the organism adapt to the changes. Other scholars maintain that whether or not changes are stressful depends on their psychological and social meanings (Mirowsky & Ross, 2003; Pearlin, 1989; Thoits, 1995). Although abundant evidence supports an association between migration and distress, it is not clear whether migration itself or other undesirable changes associated with migration which lead to distress (Ben-Sira, 1997). While some scholars believe that displacement experience itself plays a primary role in causing physiological, psychological and socio-cultural stress because such an experience often consists of "grieving for a lost home" and "anxiety about an uncertain future" (Colson, 1971; Scudder, 2005; Scudder & Colson, 1982); others (Desjarlais, Eisenberg, Good, & Kleinman, 1995) maintain that displacement itself does not necessarily lead to distress, rather, distress results from changes in life circumstances of personal or social significance, such as changes in employment and social network, as well as from the experience of traumatic events during the migration process.

In this study, we argue that not only displacement (which affects all displaced) but also the proliferation of secondary stressors associated with displacement (which may affect different relocatees differently) should be regarded as correlates of distress. Because Cernea's Impoverishment Risks and Reconstruction (IRR) model (Cernea, 1996, 1997, 2000) provides a useful framework for identifying negative consequences of displacement, we incorporate its components into our research model. Cernea's IRR model names eight risk factors commonly accompanied population displacement: "landlessness, joblessness, homelessness, marginalization, increased morbidity and mortality, food insecurity, loss of access to common property, and social disintegration". Among these factors, increased morbidity and mortality directly address the adverse health effects of displacement; other factors affect health in a more circuitous manner. For example, landlessness, joblessness, homelessness, and loss of access to common property are expected to elevate depression by raising the level of distress on the displaced; marginalization and social disintegration are likely to heighten psychological distress among the displaced by downgrading their social status, self-esteem, and social support. Finally, food insecurity may increase displaced people's vulnerability to illness, as a result of poor nourishment. Because these changes often accompany displacement and because of their direct and indirect links to health, it is appropriate to conceptualize these changes as secondary stressors. Doing so enables us to incorporate the IRR model as a component of the stress process model.

Primary and secondary stressors

According to Pearlin, it is useful to distinguish between primary and secondary stressors. Whereas "primary stressors can be conceptualized as occurring first in experience, secondary stressors come about as a consequence of the primary stressors" (Pearlin, 1989: 248). A more detailed framework of stress proliferation is introduced by Pearlin and his colleagues (Pearlin, Aneshensel, & Leblanc, 1997; Pearlin, Mullan, Semple, & Skaff, 1990), in which primary stressors refer to stress-arousing demands that are directly rooted in the acute or chronic stressful event, while secondary stressors, in contrast, are defined as stressful experiences that are triggered by primary stressors. For instance, divorce impairs adults' and children's well-being through loss of emotional support, economic hardship, and disruptions in parent–child relationships (Amato, 2000); the death of a spouse will contribute to loneliness in survivors (Pearlin & Lieberman, 1979); involuntary job loss may result in marital conflict (Pearlin et al., 1981).

Making a distinction between primary and secondary stressors helps us to understand why the well-being of relocatees appears to be differentially affected by a displacement process that is apparently similar. According to Thomas and Thomas (2004), the displacement experiences are "heterogeneous and multi-faceted". Because not all displaced who are exposed to the primary stressor are similarly exposed to secondary stressors, the distinction between primary and secondary stressors helps to better link stressful conditions to stress outcomes.

Involuntary migration has long been seen as a stressful event that affects relocatees' well-being because it transplants them from a familiar environment to an unfamiliar one and forces them to readjust (Ben-Sira, 1997; Bhugra, 2004; Hull, 1979; Hwang et al., 2007). TGDP-induced displacement can be seen as a primary stressor because it is an uprooting and irreversible process. The hardship experienced in the displacement process can make the displaced vulnerable to disease, and increase their chance of injury. The coercive nature of involuntary displacement may heighten relocatees' feelings of powerlessness. Furthermore, the TGDP may be perceived as unjust because it requires the displaced to make sacrifices for the benefits of others (Albrecht, 1995). In summary, we regard displacement as a primary stressor because it can generate distress through nostalgia for a lost home, a sense of injustice, and the hardships experienced in the resettlement procedure.

In addition to its direct effects, displacement often has negative economic and social consequences (Cernea, 1997; Hwang et al., 2010). The IRR model provides a systematic review of those negative consequences. In this study, we conceptualize the risk factors relocatees experience after displacement with three secondary stressors: the weakening of social integration, socioeconomic status downgrading, and the reduction of community resources. The weakening of social integration captures such risk factors as social disintegration, homeless, and marginalization identified in the IRR model. Socioeconomic status downgrading captures the risks of landlessness, joblessness, and food insecurity in the IRR model. Reduction of community resources is an indication of the loss of access to common property.

Specifically, we expect to see a significant weakening in the level of social integration among the TGDP relocatees in the displacement process as their community is broken up and villagers of the same clan are sent in fragments to diverse destinations. Because the process decreases relocatees' social integration when it is most needed, we have reasons to regard decline in social integration as one of the secondary stressors.

We also expect a downgrading in the socioeconomic status of the displaced. The TGDP submerged 25.9 thousand hectares of mostly fertile farmland. It is reported that many farmers who moved uphill experienced a significant drop in living standard because the degraded land on the mountains produces a smaller harvest (Yardley, 2007). The absorption of the ousted farmers into non-farm industries as an initially proposed solution has proven a failure because farmers have neither the skills nor the qualifications for non-farm jobs. We expect to see a negative effect on health as a result of the downgrading of socioeconomic status among the displaced.

Finally, relocatees' access to community resources (for example, access to healthcare, shopping, and education facilities) at the receiving communities are expected to be greatly restricted by factors such as differences in dialects, mistrust, and socio-cultural barriers. While all relocatees have resettled within China, they may still experience communication difficulties due to regional differences in dialect and culture (Chen, 2004). Psychological discomforts may also present due to lack of trust and difficulties in social interaction. Relocatees' access to community's resources after relocation is likely to be hampered by these differences. Because the restriction of access to community resources will inevitably affect health in a negative way (Berkman & Kawachi, 2000; Ross & Wu, 1995), we see it as another secondary stressor.

Stress outcomes

This study examines the impact of displacement, the primary stressor, and the three secondary stressors on two outcome variables. Although there are different manifestations of stress outcomes, depression is by far the most commonly used one in sociological studies of distress (Thoits, 1995; Turner & Lloyd, 1999; Vega & Rumbaut, 1991). The deterioration of physical health is another important indicator of stress outcome. McFarlane, Norman, Streiner, and Roy (1983) argued that exposure to undesirable and uncontrollable events leads to distress, which in turn causes health to deteriorate. For example, there is consistent evidence showing a link between stress and infectious diseases (Cohen & Herbert, 1996; Cohen & Williamson, 1991). In this study, we choose depression and the deterioration of physical health as two interrelated stress outcomes.

Hypotheses

Our conceptual framework suggests that the vulnerability of relocatee's results from a combination of several factors outlined in Fig. 1. The arrows linking different variables serve as a graphic translation of the following hypotheses:

1. A project-induced displacement is related to secondary stressors: the deterioration of social integration (path a), worsened socioeconomic status (path b), and restricted access to community resources (path c).
2. Social integration, socioeconomic status, and community resources are negatively associated with depression (paths d, e, f).
3. Depression is negatively associated with self-rated health (path l).
4. Social integration, socioeconomic status, and community resources are positively associated with self-rated health (paths g, h, i).
5. The displacement elevates depression directly (path j).
6. The displacement negatively affects self-rated health directly (path k).
7. The displacement affects depression and health indirectly through three secondary stressors (i.e., deterioration in social integration, socioeconomic status, and community resources).

Method

Data

The data for this study comes from a pre-displacement and a post-displacement survey of a panel of relocatees and non-relocatees from the same region (control group). In late 2002 and early 2003, 975 designated relocatees and 555 non-relocatees were recruited using a combination of systematic sampling (for large communities) and censuses (for small communities) from five communities in the Wanxian Relocation and Development Region (WRDR), where 80% of designated relocatees resided (Weng, 1999). By the design of the TGDP, all residents in the region who lived below the altitude of 574 feet were designed for relocation and those who lived above the line were exempted. The response rate was 99%, which is considered extremely high in standards familiar to U.S. researchers, but it is common for face-to-face interviews in China (Feng, 2007; Wang, 1996). We successfully traced and re-interviewed 1070 subjects in the follow-up survey conducted in early 2006, with a success rate of 70%. The final sample size used in the analysis is 1056 after we excluded 14 ineligible respondents who had relocated before the first survey but were captured by mistake in our pre-displacement survey. While the recapture rate is respectable given the highly mobile nature of the population being studied, an attrition of 30% inevitably raises concerns about whether the study might be biased by the attrition. A sensitivity

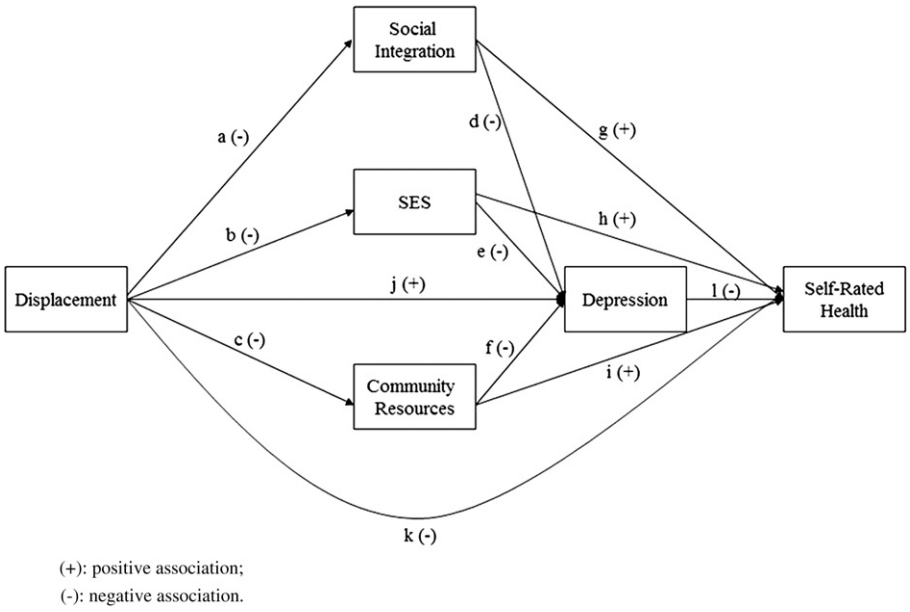

Fig. 1. Research model for the displacement and health.

analysis conducted by Hwang et al. (2010) indicates that the attrition problem is more pervasive among relocatees than non-relocatees and more so for urban than rural respondents. We address the attrition problem further in the analysis by controlling an *attrition correction* factor, which is computed as the predicted probability that a respondent captured in wave 1 was lost in wave 2, minus 1 (Berk, 1983).

Analytical strategy

The analysis involves two steps. First, we use the "difference model" (Allison, 1990, 1994; Halaby, 2004; Liker, Augustyniak, & Duncan, 1985) to evaluate a structural model linking changes in dependent variables to changes in independent variables as expressed in the following equation:

$$Y_{i2} - Y_{i1} = (\alpha_2 - \alpha_1) + \delta X_i + \gamma(W_{i2} - W_{i1}) + (\varepsilon_{i2} - \varepsilon_{i1}) \quad (1)$$

The model acquires its name because it relates the *difference scores* (i.e., the difference between time 2 and time 1) of the dependent variable Y to the *difference scores* for a set of independent variables (W). In the equation, X is a dummy variable contrasting relocatees and non-relocatees. Its coefficient, δ, which measures the difference between relocatees and non-relocatees in the change score of outcome variable (see equation (2), is known as *difference-in-differences* (DID) estimator (Allison, 1990; Halaby, 2004).

$$\text{DID} = \delta = (\overline{Y}_{M2} - \overline{Y}_{M1}) - (\overline{Y}_{N2} - \overline{Y}_{N1}) \quad (2)$$

The DID estimator quantifies the extent to which the change in outcome between time 1 and time 2 for relocatees ($Y_{M2} - Y_{M1}$) exceeds the corresponding change for non-relocatees ($Y_{N2} - Y_{N1}$). Allison (1994) points out that in non-experimental data, the DID estimator is nearly always preferable for estimating the effects of events, or intervention, because it automatically controls for all unmeasured time-invariant factors which may or may not correlate with the likelihood of event occurrence.

Next, we use Structural Equation Modeling (SEM) to evaluate the direct and indirect links between displacement and the two outcome measures, as outlined in Fig. 1. SEM proceeds in two steps (Anderson & Gerbing, 1988). First, we conduct Confirmatory Factor Analysis (CFA) to evaluate the fitness of measurement model. Second, we construct structural regression models to synthesize path and measurement models. The overall fitness of alternative specifications of the model are evaluated to identify a model with the best fit. Except for displacement, all the variables in the SEM models will be measured using change scores. The SEM method has been applied to analyses involving change scores and for testing mediation hypotheses (Judd, Kenny, & McClelland, 2001; Roth, Mittelman, Clay, Madan, & Haley, 2005).

Measures

This study focuses on two outcome variables: depression and self-rated health. Depression was measured by the 20-item Center for Epidemiological Studies Depression (CES-D) Scale (Radloff, 1977). This instrument has well-established validity in both Western (Ensel & Lin, 1991; Pearlin, 1989) and non-Western cultures (Ling, Wei, Yi, Xiao, & Yao, 2008; Zhang, Kong, & Zhou, 2009). The scale has a reliability of 0.87 for pre-displacement survey and 0.89 for post-displacement survey. *The change score in depression* is used in analysis, which reflects the difference between the wave 2 and wave 1 measure of the CES-D score. Self-Rated Health (SRH) was measured by a single item 5-point scale ranging from 1 to 5, with a higher score indicating better health. *The change in SRH* is the difference between wave 1 and 2 measures. SRH is the most widely used measurement of health in population surveys (Idler & Benyamini, 1997), and generally regarded as reliable and valid in survey research (Idler & Benyamini, 1997; Johnson & Wolinsky, 1993; Lynch, 2003).

The primary stressor was measured by displacement status, a dummy variable which differentiates relocatees (coded 1) from non-relocatees (coded 0). The change scores for social integration, socioeconomic status, and community resources served as three mediators. Negative changes in social integration, socioeconomic status, and community resources are conceptualized as secondary stressors in this study.

Three indicators were used to measure *social integration*: social support, social network size, and rapport with neighbors. *Social*

support was measured by *perceived routine support* scale (Lin, Ye, & Ensel, 1999), which is reliable with a Cronbach's alpha of 0.83 in wave 1 and 0.88 in wave 2. The construct validity of perceived social support has been demonstrated in many empirical studies showing the anticipated protective effect on health in both Western (Lin et al., 1999; Ren, Skinner, Lee, & Kazis, 1999) and in Chinese culture (Cornman, Goldman, Glei, Weinstein, & Chang, 2003; Son, Lin, & George, 2008). *Social network size* was measured by asking the respondents whether or not they have interacted with any of the following individuals with whom they do not share a residence during the past 30 days: (1) parents; (2) adult children; (3) siblings; (4) other relatives; (5) good friends; (6) neighbors; (7) colleagues; (8) local cadres; and (9) other significant others. The sum of the 9 items yielded a count measure, ranging from 0 to 9. *Rapport with neighbors* was measured by asking respondents, "In general, how would you describe your relationship with your neighbors?" Respondents used a 5-point scale ranging from 1 to 5, with 1 for "Very bad," 2 for "bad," 3 for "Just so–so," 4 for "good," and 5 for "very good."

Socioeconomic status was also measured by three indicators: household income per capita, household debt per capita, and possession of necessities. *The household income* per capita equaled last year's household income divided by the number of household members. *The household debt* per capita was current household debt divided by the number of household members. We measured *the household possession of necessities* by the sum of the following household necessities: a washing machine, an air conditioning unit, a motorcycle, a computer, or a refrigerator—material goods that reflect a better economic condition in China.

We measured *community resources* by asking respondents how convenient it was for them to do the following things in their current place of residence: (a) see doctors, (b) send children to school, (c) shop, and (d) find entertainment. Answers were coded 1 for "Very inconvenient," 2 for "Inconvenient," 3 for "Hard to say," 4 for "Convenient," and 5 for "Very convenient." The scale had a Cronbach's α of 0.81 for wave 1 and 0.85 for wave 2.

Results

Difference model

Table 1 presents the means for each of the ten indicators of our explanatory variables and the two dependent variables measured in time 1 ($\overline{Y}_1$) and time 2 ($\overline{Y}_2$) separately for relocatees and non-relocatees. It also reports the time 1 and time 2 differences between the two averages and the unadjusted and adjusted DID scores. The unadjusted DID scores are computed using equation (2). Adjusted DID scores further control for the attrition correction factor in the difference model.

The first group of indicators is social integration. The results show that relocatees' social support after displacement was 0.68 points lower than before displacement, while non-relocatees' social support was 0.66 points higher in wave 2 than wave 1, which resulted in a statistically significant relative loss in social support (DID $= -0.68 - 0.66 = -1.34$, $p = 0.03$). Although both relocatees and non-relocatees' social network sizes were smaller in wave 2, the relocatees experienced greater changes than non-relocatees (DID $= -0.21$, $p = 0.06$). The DID score of rapport with neighbors was also statistically significant (DID $= -0.25$, $p < 0.01$). Together, the three indicators show that relocatees' social integration was lower after displacement relative to their non-migrating counterparts.

Our findings indicated that both relocatees and non-relocatees' income per capita was higher in the follow-up, but the amount of increase was larger for the latter group (240 yuan vs. 1147 yuan), making a statistically significant DID score of 907.51($p < 0.01$). On average, relocatees saw a greater increase in debt per capita than non-relocatees (DID $= 1444.68$, $p < 0.01$). The socioeconomic

Table 1
DID scores measuring the displacement's impacts ($n = 1056$).

		$\overline{Y_1}$	$\overline{Y_2}$	Differences	Migrants vs. non-migrants	
					Unadjusted DID	Adjusted DID[a]
Social integration						
Perceived routine social support (10 items)	Migrant	33.00	32.31	−0.68	−1.34[b]	−1.20[b]
	Non-migrant	34.72	35.38	0.66		
Social network size (0–9)	Migrant	3.55	3.29	−0.26	−0.21	−0.18
	Non-migrant	3.80	3.75	−0.05		
Rapport with neighbors (1–5)	Migrant	4.10	3.89	−0.21	−0.25[b]	−0.24[b]
	Non-migrant	4.00	4.04	0.03		
Social economic status						
Per capita income (¥)	Migrant	3166.18	3406.19	240.01	−907.51[b]	−899.87[b]
	Non-migrant	2790.73	3938.25	1147.52		
Per capita debt (¥)	Migrant	1033.74	3406.19	2372.45	1444.68[b]	1248.50[b]
	Non-migrant	817.41	1745.18	927.77		
Possession of household necessities (0–5)	Migrant	0.84	1.15	0.31	0.08	0.07
	Non-migrant	1.24	1.47	0.22		
Community material resources						
Medical resources (1–5)	Migrant	4.25	4.06	−0.18	−0.11	−0.10
	Non-migrant	4.47	4.40	−0.07		
Education resources (1–5)	Migrant	3.87	3.58	−0.29	−0.32[b]	−0.30[b]
	Non-migrant	4.18	4.21	0.03		
Shopping resources (1–5)	Migrant	4.24	4.00	−0.24	−0.18[b]	−0.18[b]
	Non-migrant	4.46	4.40	−0.06		
Entertainment resources (1–5)	Migrant	3.73	3.93	0.19	−0.08	−0.03
	Non-migrant	3.85	4.12	0.27		
Outcome						
CES-D (20-items)	Migrant	21.95	26.25	4.31	3.49[b]	3.72[b]
	Non-migrant	20.82	21.64	0.82		
Self-rated health (1–5)	Migrant	3.48	3.19	−0.29	−0.18[b]	−0.20[b]
	Non-migrant	3.53	3.42	−0.11		

[a] Controlling for attrition correction factor.
[b] Indicates a coefficient is statistically significant at the 0.05 level.

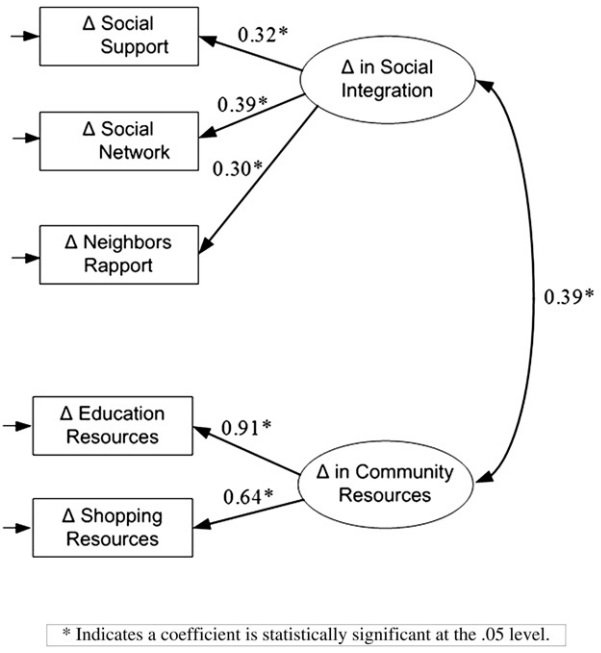

Fig. 2. Two latent factors measurement model of change (Δ) with the standardized solution.

impact of the project was also measured by changes in the possession of household necessities. However, there was no statistically significant difference between the two groups (DID = 0.08, $p = 0.18$). In terms of changes in accessibility to community resources, we found that all indicators of community resources were lower for relocatees after displacement relative to non-relocatees. However, only changes in education resources (DID = −0.32, $p < 0.01$) and shopping resources (DID = −0.18, $p = 0.03$) were statistically significant.

For two outcome variables, we found that both relocatees and non-relocatees experienced an increase in depression (4.31 vs. 0.82), with the increase of relocatees' CES-D scores being much higher than that of non-relocatees (DID = 3.49, $p < 0.01$). Relocatees also experienced a relative significant decline in self-rated health (DID = −0.18, $p < 0.01$).

Controlling for the attrition correction factor did not significantly affect the DID scores. The only noticeable change was that the DID score for social network size became non-significant. Taken together, the results were consistent with our hypotheses that project-induced displacement would be associated with undesirable changes in relocatees' mental and physical health. In addition, the same process also correlated with negative changes in social integration, socioeconomic status, and community resources; changes which we see as constituting secondary stress to the displaced.

Structural equation modeling

Following the two-step procedure used in structural equation modeling (Bollen, 1989; Kline, 2005), we first conducted Confirmatory Factor Analysis (CFA) to assess the fitness of the three-factor measurement model for the secondary stressors. Based on the results in Table 1, we kept 7 indicators with a statistically significant DID score in the measurement model. (We used a liberal cutoff point of $p < 0.1$ during the model trimming process. This was a strategic decision intended to prevent premature elimination of variables that might later become statistically significant when models were specified differently. Once the final model was decided upon, we would revert back to the conventional

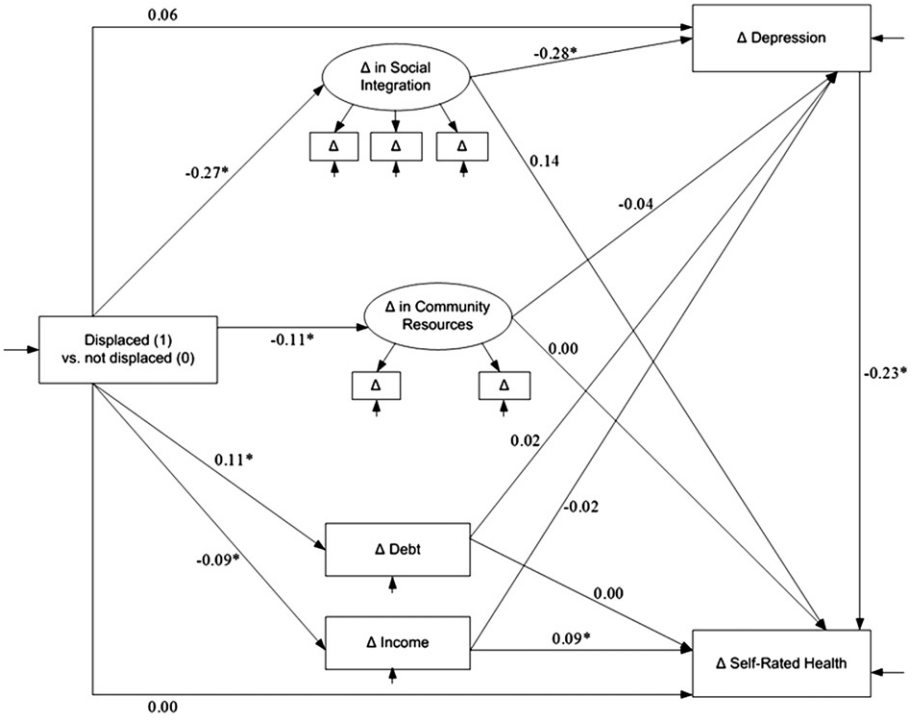

Fig. 3. Structural regression model of displacement effects on changes in depression and health with the standardized solution.

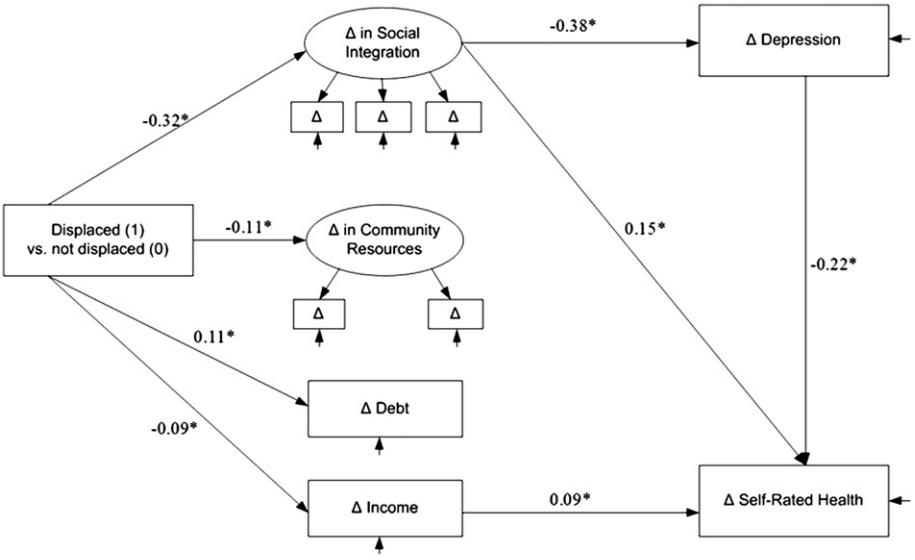

Fig. 4. Final structural regression model of displacement effects on changes in depression and health with the standardized solution.

significance level of $p < 0.05$.) Although the three-factor measurement model had a good fit, the standardized loading of debt on the latent factor SES was very low (0.04), which indicated that this factor lacked convergent validity and the measurement model was not reasonably constructed (Kline, 2005). Thus, we tried a simpler measurement model with two latent variables. Fig. 2 represents the revised measurement model with two latent factors. The two-factor measurement model fitted the data well ($\chi^2 = 4.34$ (4 degree of freedom), $p = 0.36$; RMSEA = 0.01, p (RMSEA < 0.05) = 0.96). All factor loadings were statistically higher than zero (p's < 0.01). A check of modification indices did not warrant further model simplification. We used this two factors measurement model in all the subsequent combined SEM models.

The structural regression (SR) model combines the path and measurement models. Besides the two latent factors, changes in income per capita and debt per capita were also included as covariates of depression and health. A full SR model (Fig. 3) was first evaluated that included all possible paths linking displacement to the two outcome measures both directly and indirectly. The model fitted the data very well ($\chi^2 = 22.70$ (20 degree of freedom), $p = 0.30$; RMSEA = 0.01, p (RMSEA < 0.05) = 1.00). As expected, the associations between displacement and secondary stressors were statistically significant. Specifically, compared to non-relocatees, relocatees had a lower level of social integration ($\beta = -0.27$, $p < 0.01$), smaller community resources ($\beta = -0.11$, $p < 0.01$), and lower income ($\beta = -0.09$, $p < 0.01$) after displacement; but had larger debt per capita ($\beta = 0.11$, $p < 0.01$) after displacement. The direct association between displacement and depression was marginally significant ($\beta = 0.06$, $p = 0.09$). Although there was no statistically significant evidence suggesting a direct link between the displacement and poor self-rated health, we did find a negative relationship between change in depression change in self-rated health ($\beta = -0.23$, $p < 0.01$).

Turning to the indirect links between displacement and mental and physical health via the secondary stressors, our SEM model indicated that less social integration was associated with higher depression ($\beta = -0.28$, $p < 0.01$), and worse self-rated health ($\beta = 0.14$, $p = 0.09$). Finally, income decrease was related to a drop in self-rated health ($\beta = 0.09$, $p < 0.01$).

We modified the model by forcing the 6 non-significant paths to be zero. The result of the Likelihood Ratio test for this model trimming ($\chi^2 = 0.78$, df = 6, $p = 0.99$) indicated that excluding these 6 paths did not change the overall model fit significantly. For the sake of parsimony, we decided to eliminate the 6 paths. The revised model had an excellent fit to the observed data ($\chi^2 = 23.48$ (26 degree of freedom), $p = 0.61$; RMSEA = 0.00, p (RMSEA < 0.05) = 1.00) with little loss in overall performance. As a result of these changes, the direct path from displacement to changes in depression was no longer statistically significant, so we deleted this path to obtain the final model (Fig. 4). Our final model not only fitted the data very well ($\chi^2 = 25.34$ (27 degree of freedom), $p = 0.56$; RMSEA = 0.00, p (RMSEA < 0.05) = 1.00) but also performed equally well as the preceding one ($\chi^2 = 1.86$, df = 1, $p > 0.15$).

Fig. 4 clearly shows that displacement is linked to depression and self-rated health mainly through changes of social integration and income (all paths' p-values < 0.01). Table 2 shows the pathways of all indirect effects that are statistically significant using Sobel test (Sobel, 1982).

Table 2
Test for the unstandardized indirect effects in the final structural regression model.

Indirect effect	a	SE_a	b	SE_b	ab	SE_{ab}	z
Displace → Integration → Depression	−1.93	0.39	−1.50	0.29	2.89	0.80	3.61[a]
Integration → Depression → Health	−1.50	0.29	−0.02	0.00	0.03	0.01	4.20[a]
Displace → Integration → Health	−1.93	0.39	0.09	0.02	−0.17	0.05	−3.10[a]
Displace → Income → Health	−0.10	0.03	0.18	0.06	−0.02	0.01	−2.01[a]

[a] Indicates a coefficient is statistically significant at the 0.05 level.

Conclusion and discussion

The results of the study support the hypotheses that displacement affected depression and self-rated health primarily through the mediation of secondary stressors. Although displacement as a primary stressor was also expected to have a direct link to the same outcome variables of interest, our findings failed to substantiate such expectations.

Although displacement's indirect effect on self-rated health is statistically significant, the effect size is small. There are two possible explanations for the small effect size: first, the study covers only a short period of time, but displacement effect on self-rated health may take longer to fully unfold. Second, the small effect size could also reflect the success of China's new relocation policy. China has learned important lessons from previous failed resettlement efforts, and started reforming its resettlement practices as early as late 1980s. Prior to the beginning of the Three Gorges project, a new policy known as Development-Oriented Resettlement Policy was implemented. The new policy emphasized developing the local economy of the area affected by a major project to improve the quality of life and employment opportunities for the displaced. In addition to providing monetary compensation to the displaced for their land and housing losses, the government also allots a large sum of funds for developing the economy and infrastructure of the affected areas. World Bank resettlement experts have praised the new resettlement policy as a model for other developing countries (Heggelund, 2004). Circumstantial evidence exists to support the success of the new relocation policy. A recent study by Hwang, Cao, and Xi (2011), indicated that the TGDP relocatees experienced relative income drop, but they also saw an improvement in living conditions such as per capita living space, house condition, home ownership, and access to running water compared with non-relocatees. The improved housing, clean water access, and purchasing power help to prevent most infectious diseases (Jayewardene, 1995).

Another finding which warrants further discussion concerns an increase in social support between wave 1 and wave 2 among non-relocatees. When facing tremendous changes in the shared living environment, people in the entire community are expected to be more supportive of one another in order to get through the difficult time together. While this should benefit both relocatees as well as non-relocatees, the latter got benefited disproportionately because they were exempted from relocation.

Although our natural experiment design is superior to the previous cross-sectional studies for suggesting a causal link between the displacement and its consequences (i.e., secondary stressors, and health outcomes), the causality of the associations between secondary stressors and health outcomes is made equivocal by the overlapping temporal order. There are also other limitations in our study that may weaken the generalizability of our findings. First, the attrition of our panel data is not random, with relocatees being more likely to be missed in the follow-up survey. There is a possibility of bias in analysis even though we controlled for an attrition correction factor. Second, our two-wave data can not provide a definite test of mediation effects of secondary stressors, which needs at least three-wave data. Third, in the construction phase of the dam project, there was a sudden increase in population, cultural conflicts, and social disruption as a result of the so called "boom town effect". Such changes would affect not only relocatees but also non-relocatees in the same area (Jayewardene, 1995; Summers & Branch, 1984). This contamination might attenuate the displacement's effects. Fourth, TGDP area is known for its prolonged period of under-investment and poverty. The designated places for TGDP resettlement are generally perceived to have better job and education opportunities than the places of origin (Li & Rees, 2001). It is possible that our estimated effect of displacement may be confounded by differences in the level of economic development and life chance between regions of origin and destination. Fifth, our depression measurement, CES-D scale, contains items that refer to fatigue, poor appetite, and sleep problems. It is therefore possible that the observed correlation between depression and self-rated health may be an artifact of the lack of definitional independence. Sixth, community resource is a contextual factor, which should ideally be measured at the aggregated level. Our measurement, however, is based on the individual respondent's perception of having easy access to the community's healthcare, education, shopping and entertainment facilities. The gap between the concept and its operational definition may limit our ability to make any definitive statement about the effects of community resources based on our measurement.

Despite these limitations, our study provides an additional perspective to the ongoing debates about the benefits and costs of large dam projects internationally. The proponents argue that large dams contribute to flood control, irrigation, and power generation, while the opponents stress a possible degradation of the quality of life among the displaced and the adverse effects on environment. Like it or not, the building of large dams has continued, especially in developing countries. With increasing global energy consumption, the demand for clean energy is greater than ever. Because hydropower produces less greenhouse gases than other alternatives, it seems that instead of debating whether or not dams should be built, governments and environmentalists should focus on maximizing the benefits of dam projects and minimizing their risks to both the environment and the people affected by them. In order to achieve these goals, the agents of development projects, be they government or private developers, should be more sensitive to and accountable for any consequences that their actions may cause. Developers should not only provide adequate compensation to the displaced for their loss of property and other quantifiable economic losses, they should also take responsibility, at least morally, for losses that are more difficult to quantify, such as the long-term health and social impact of development projects on those who were displaced. This study presents evidence that, to minimize the negative health impact of displacement, social integration of the displaced should receive greater attention than it has been accorded. While many current resettlement policies assume that economic compensation alone is sufficient to restore the livelihood of the displaced (Cernea & Mathur, 2008), our conclusion is a helpful reminder that a sound resettlement policy must bring social factors to the center of attention.

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