

**Moving along with migrants:  
A life-course perspective on migration, residential  
environments, and mental health in urban China**

**Min Yang**

## Assessment committee

Prof. dr. Ye Liu	Sun Yat-Sen University
Prof. dr. Jamie Pearce	University of Edinburgh
Prof. dr. Peter Groenewegen	Utrecht University
Prof. dr. Stan Geertman	Utrecht University
Dr. Carlijn Kamphuis	Utrecht University

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A life-course perspective on migration,  
residential environments, and mental health in urban China**

In beweging met migranten: Een levensloop perspectief op migratie,  
woonomgevingen en geestelijke gezondheid in stedelijk China

(met een samenvatting in het Nederlands)

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**Min Yang**

geboren op 14 januari 1989  
te Shandong, China

**Promotor**

Prof. dr. M.J. Dijkstra

**Copromotor**

Dr. M. Helbich

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Chapter

# 1

Introduction

Mental health is a significant determinant of people's quality of life (Chaudhury et al., 2018). However, mental health problems are the leading cause of the global burden of disease among all disease groups, accounting for 32.4% of years lived with disability (Vigo et al., 2016). The adverse social and economic costs associated with mental illness are massive, considering the estimation that more than 50% of the populations of middle- and high-income countries will be affected by at least one mental health problem in their lives (Trautmann et al., 2016).

According to the Global Burden of Disease Study 2013, in that year China accounted for 17% of the global burden of mental disorders (Charlson et al., 2016). It is estimated that about 17.5% of Chinese people suffer from mental health problems (Que et al., 2019). The country's annual economic burden caused by mental illness increased from US\$21.0 billion in 2005 to US\$88.8 billion in 2013 (Xu et al., 2016). However, a World Health Organization report (World Health Organization, 2018) suggests that only 50% of global mental illness is recorded, and that China's percentage is far below the average (Que et al., 2019), meaning that the actual number of people suffering from mental illness and the associated economic cost is much larger. Therefore, researchers and policymakers have made significant efforts to investigate approaches that promote and factors that threaten mental health.

Urban environments are considered to threaten people's mental health. Peen et al. (2010) found that psychiatric disorders were significantly more common in urban areas than in rural areas. The rapid growth of cities and urban populations is associated with stressors such as overcrowding, environmental pollution, and increased levels of violence in urban areas (Srivastava, 2009). In addition, social and individual stressors associated with urban environments – such as inactive lifestyles, social isolation, and unhealthy eating habits – also increase the burden on people's mental health in urban areas (Carod-Artal, 2017). China is undergoing a rapid process of urbanization: The proportion of its population living in urban areas grew from 35.88% in 2000 to 59.15% in 2018 (World Bank Group, 2018). About half of the growth was the result of rural-urban migrants leaving their homes in the countryside to seek better jobs and living opportunities in urban areas (Chen et al., 2015).

Since migrants make a significant contribution to urban population growth and their mental health is challenged by various stressors caused by the migration and adaptation process, it is important to understand their mental health journeys in order to promote healthy living in urban China. Studies suggest that depressive symptoms are among the most common mental health problems experienced by Chinese internal migrants (Guo et al., 2017; Mou et al., 2011; Qiu et al., 2011). Compared to native urban residents, migrants' mental health is challenged by economic stress, the living environment, the experience of discrimination, and acculturation difficulties in their urban lives in host cities (Li and Rose, 2017; Zhang et al., 2009; Zhong et al., 2016). While there are numerous studies on correlations between basic socio-demographics and mental health problems among migrants (Cheung, 2013; Li et al., 2014; Qiu et al., 2011), little is known about migration-related factors and mental health problems. In fact, the simplified operationalization of migration

as an individual characteristic limits our understanding of the psychological consequences of migration over time (Pyakuryal et al., 2011). Therefore, this thesis focuses on migrants' individual and residential trajectories based on a life-course perspective, and links them to mental health outcomes.

## 1.1 Determinants of mental health for migrants

Mental health is shaped by various factors over people's lives. The socio-ecological model suggests that people's mental health is shaped not only by their individual characteristics, but also by the neighborhood environment in which they live (Silva et al., 2016). The development of a person's mental health involves complex interactions between the individual and their surrounding physical, natural, and social environments (Halfon et al., 2017). This thesis focuses on the individual level and the neighborhood level of the mental health determinants for migrants since there is extensive evidence for the general population at both levels (e.g., (Diez Roux and Mair, 2010; Meyer et al., 2014; Renalds et al., 2010; Truong and Ma, 2006), yet the results for migrants' mental health remain limited and controversial.

### 1.1.1 Individual-level determinants of mental health

Individual characteristics such as age and gender are the core factors influencing people's mental health (Smith et al., 2015). Studies have shown that mental health among the general population is influenced by both gender and age differences (Afifi, 2007; Hopman et al., 2009). The different mental health performance across age and gender groups could be attributed to factors such as different social positions and responsibilities (Rosenfield and Smith, 2012), help-seeking behaviors (Mackenzie et al., 2006), recognition of one's mental illness (Farrer et al., 2008), and lifestyle differences (Afifi, 2007).

Individual SES, including personal income and educational level, was also found to be significantly related to people's mental health (Wen et al., 2006). Studies have shown that higher personal income is associated with better mental health, while poverty experiences are closely related to poor mental health (Knifton and Inglis, 2020; Lund, 2012). In addition, low educational level has been constantly reported as a risk factor for mental health (Jain and Konefal, 2015). Low SES is a risk factor for poor mental health since it can increase stresses from financial pressure (Silva et al., 2016), undesirable working conditions and job uncertainties (Östergren et al., 2016), and other life stresses.

Mental health and physical health are both key indicators of people's general health. In addition, it has been suggested that mental health and physical health are highly interdependent (Bauer et al., 2006). Therefore, good physical health could have positive impacts on people's mental health by enabling healthy lifestyle choices (e.g., physical activities) (Ohrnberger et al., 2017). Likewise, poor

physical health is associated with negative mental health outcomes. For instance, people suffering from chronic diseases are more likely to develop mental health problems over time (Chen et al., 2017).

### **1.1.2 Residential neighborhood-level determinants of mental health**

The neighborhood environment has been suggested to have impacts on people's mental health outcomes (Kearns and Parkinson, 2001; Silva et al., 2016). The key proposed mechanisms linking neighborhood and mental health are residents' exposure to risk and to protective environments in the neighborhood context (Mair et al., 2008a; Renalds et al., 2010; Richardson et al., 2015).

The neighborhood environment and its health effects have been investigated through three main aspects, namely the built environment (Firdaus, 2017; Gao et al., 2016; Tan et al., 2014), the natural environment (e.g., green space) (Dzhambov et al., 2018a; Sugiyama et al., 2016; Zhang et al., 2017), and the social environment (Echeverría et al., 2008; Liu et al., 2017; Ward Thompson et al., 2016). The neighborhood built environment has been broadly acknowledged as having positive effects on residents' health status by influencing their health behaviors, such as leisure time physical activity and active travel behavior (e.g., walking and cycling) (Firdaus, 2017; Tan et al., 2014; Wang et al., 2016). Recent reviews have suggested that an adverse neighborhood built environment is associated with a higher risk of mental health problems (Rautio et al., 2018). For instance, the experience of crowdedness, noise pollution, and fear of crime in the neighborhood are related to negative mental health outcomes (Firdaus, 2017). It has also been suggested that such experiences are usually considered undesirable, and therefore increase residents' stress level (Ma et al., 2018; von Lindern et al., 2016), which in turn leads to mental health problems (Rautio et al., 2018).

Likewise, the neighborhood natural environment, such as green space, has also been linked to residents' mental health outcomes (Sarkar et al., 2018). Neighborhood green space could affect residents' mental health by protecting them against harmful exposure to air pollution and noise, enabling psychological restoration, and promoting physical activities and social interactions (Markevych et al., 2017). Empirical findings suggest that a higher perceived level of neighborhood greenness is associated with a better reported mental health status (Dzhambov et al., 2018b; Ruijsbroek et al., 2017).

Finally, the neighborhood social environment – such as social support, trust, and social cohesion within the neighborhood – also plays a significant role in people's mental health (Chen and Chen, 2015). Studies have found that people who live in socially chaotic and problematic neighborhoods reported higher level of depression symptoms and worse overall mental health statuses (Ross and Mirowsky, 2009; Veling et al., 2015). On the contrary, neighborhoods with a higher level of social cohesion and support between neighbors have positive effects on residents' mental health (Van Dyck et al., 2015; Ward Thompson et al., 2016). Of these three aspects of neighborhood environment, the neighborhood social environment has been found to have stronger effects on residents' mental health than the other two aspects (Mair et al., 2008b; Ward Thompson et al., 2016)

### 1.1.3 Migration and mental health

Migration is commonly treated in literature as an individual-level factor influencing mental health (Davies et al., 2009; Mou et al., 2013; Stillman et al., 2009). Studies have compared the mental health of migrants with that of non-migrants (Liu et al., 2015; Mao and Zhao, 2012; Pyakuryal et al., 2011) or incorporated migration and related individual factors (e.g., hukou) as independent variables when analyzing the migration – mental health relationship (Chen, 2011; Qiu et al., 2011); however, results remain unclear and controversial. Some suggest that migration is a factor that threatens mental health (Wang et al., 2010; Wen et al., 2017), while others found better mental health status among migrants than non-migrants (Kearns et al., 2017; Lu and Qin, 2014). The mental health benefits arising from migration are mainly related to an improvement in economic status post-migration (Ham et al., 2011). In addition, it has been suggested that migration is a selective process whereby people with sufficient financial and physical means are more likely to migrate (Kearns et al., 2017), resulting in the “healthy migrant” phenomenon being observed in urban areas (Lu and Qin, 2014). However, the stress of migration – such as leaving family and friends behind, and the experience of social inequality and social exclusion in host cities – threatens migrants’ mental health in their post-migration lives (Li et al., 2007; Lin et al., 2011; Pyakuryal et al., 2011).

**Hukou** – the Chinese household registration system – has been recognized as a crucial factor in migrants’ mental health in China (Guo et al., 2017). Holding a local hukou in the host city is positively related to a migrant’s mental health (Song and Smith, 2019). Migrants are likely to experience hukou-based social exclusion in host cities because it is difficult to transfer hukous to host areas (Li and Rose, 2017). Hukou is closely linked to a series of economic and social rights in host cities, including health insurance (Lam and Johnston, 2012), employment and education opportunities (Liu, 2005), and access to public housing and housing choices (Logan et al., 2009), all of which have long-lasting impacts on migrants’ mental health. In many studies on Chinese migrants, hukou was used to differentiate between migrants and non-migrants (Hu et al., 2007; Liu et al., 2017; Qiu et al., 2011). This approach emphasizes the disadvantaged position of migrants arising from the institutional barriers created by the lack of local hukous. However, this also limited the scope of analysis, since some migrants manage to transfer their hukous to host cities by purchasing local commodity housing, being given employment contracts, or getting married (Tao et al., 2015). With increasing number of migrants transferring their hukous and living in host cities permanently (Sun and Fan, 2011), studies need to expand the research scope to the entire migrant population in order to fully understand the relationship between migration and mental health. Migrants without local hukous were found less likely to adopt healthy behavior than those who had local hukous (Song and Smith, 2019). This is attributed to unstable social networks and higher stress levels caused by the job and housing instability of non-local hukou migrants (Pampel et al., 2010). With the focus increasingly shifting toward high skilled migrants and local-hukou migrants, some research has defined migrants by birthplace (Cui et al., 2016). Using birthplace can capture both hukou and non-hukou migrants, and with different migrant samples the prevalence rate of mental health problems can vary accordingly.

Apart from hukou, migration distance is also considered to have a potential influence on migrants' mental health at the individual level. In China, it is common to differentiate between inter- and intra-provincial migration (Huang et al., 2014). Inter-provincial migrants cross provincial borders, which makes them more likely than intra-provincial migrants to experience cultural and habitual differences. Consequently, inter-provincial migrants have been found to experience lower levels of life satisfaction than intra-provincial migrants (Chen et al., 2019), suggesting there might be mental health differences between the two groups.

In literature on health mobility, many have suggested that frequent moving threatens people's mental health outcomes (Morris et al., 2018). Studies have shown that people who experienced higher residential mobility rates are more likely to have poorer mental health performance compared to those who are residentially stable (Oishi and Schimmack, 2010). However, the results are not always consistent: Some studies have reported no significant mental health effects of a high mobility level, or even a positive association between a high mobility level and improved mental health (Bartram, 2013; Ham et al., 2011).

## **1.2 Examining migration and mental health using a life-course perspective**

### **1.2.1 Understanding migration based on life-course perspective**

The life-course perspective has recently been broadly introduced in both migration and mental health studies (Elder et al., 2003; Halfon et al., 2014). A combination of both study areas can provide in-depth insights into mental health development throughout the process of migration over a person's life course.

The life-course framework provides a systematic framework that breaks down migration into the timing, duration, and temporal sequence of the journey (Wingens et al., 2011). Some studies have investigated the role of timing (i.e., age when migrating) in migrants' mental health. For instance, empirical studies have found that migrants who moved during childhood or early adolescence are more likely to experience mental problems in their later life stages (Mendelson et al., 2010; Montes de Oca et al., 2011; Wong et al., 2009). Other studies, however, argue that migrant adolescents do not necessarily have a worse mental health performance than their local counterparts or migrant adults (Cheung 2013; Mao & Zhao 2012). It has been suggested that age at the time of migration plays an important role in a migrant's health development over their life course (Wingens et al., 2011).

Life-course events – such as entering the labor market or leaving the parental home – and job insecurity and instability have been suggested to influence people's migration intentions (Evandrou et al., 2010; Kley, 2011). For example, Clark and Maas (2015) investigated several motivations that trigger migration, including employment opportunities, job transfer, family reasons, lifestyle, and

housing needs. They found that while economic motivations are still the main drivers of migration, non-economic migrations, such as for marriage or family reasons, play powerful roles in migration decisions. However, such studies are based on the assumption that migration is a single transition that takes place at one point in time in a person's life-course trajectory. Robette (2010) criticized the focus on transitions because it overlooks the fact that a transition between stages is a long-term and complex process. For instance, the transition from school to work can involve several periods of temporary employment and unemployment before a person achieves a stable occupational position (Murphy et al., 2010). Similarly, migrants might have moved to several places before they arrived at their final destinations (Collyer and De Haas, 2012). The migration trajectories formed by the distinct journeys across life stages can serve as key factors in understanding the different mental health outcomes for migrants (Brazil and Clark, 2017; Sharkey and Faber, 2014). Figure 1.1 presents an example of a migration trajectory that a person may follow over their life course. The trajectory entails distinct life and environmental experiences that may have long-term impacts on a person's mental health.

1



**Figure 1.1** Example of a migration trajectory over the life course

### 1.2.2 Understanding neighborhood exposures based on a life-course perspective

One of the challenges in current neighborhood mental health research is treating the neighborhood environment as a point-in-time exposure, rather than as a bundle of risk and/or protective factors that vary over time (Helbich, 2018). Such an approach may risk over- or under-estimating the effect of the current neighborhood environment on residents' mental health due to ignorance of the

residential/migration history, which may have long-lasting mental health impacts over the course of people's lives (Bolster et al., 2007). In fact, if we acknowledge that migrants may make multiple migration journeys over time and that they can experience different residential environments while on those journeys, the life-course perspective should be introduced when examining migrants' mental health in relation to their individual and neighborhood characteristics.

It is therefore important to consider people's residential history when studying the relationship between the neighborhood environmental context and mental health (Brazil and Clark, 2017). Life-course epidemiology (Kuh et al., 2003) suggests that environmental exposures at different life stages could influence one's mental health along different pathways. For instance, there could be latency effects, whereby the risk exposures in early life may have long-lasting impacts on people's mental health in later life. Studies have shown that living in a socially deprived neighborhood during childhood has a negative impact on mental health at the age of 70 years (Pearce et al., 2018). Similarly, early experiences of residential environments were found to be independently related to health status in later life (Curtis et al., 2004). Other identified mental health risk factors in early life include exposure to air pollution and poor access to green spaces (Cherrie et al., 2018; Hansell et al., 2016).

In addition, the life-course perspective stresses that early life risk factors may contribute to health inequalities over a person's life development (Pearce, 2015). Pathway models emphasize that a person's SES in early life could affect their social and residential trajectories, which in turn have impacts on their mental health status in later life (Niedzwiedz et al., 2012). For instance, adverse childhood experiences could negatively affect one's mental health in adulthood by increasing the chance of adult adversity and a low income (Jones et al., 2018). As people move between different social and physical environments over time, the residential trajectories they form based on their social and economic capacities could have serial impacts on their mental health.

### 1.3 Research gaps

The first research gap addressed in this thesis concerns the heterogeneity of migrants by comparing two definitions of migrant (i.e., defined by hukou or by birthplace) in examining the migration-mental health relationship. Most migration studies in China have defined migrants by hukou, meaning that local hukou holders were considered non-migrants despite their actual history of migration (Chen, 2011; Lin et al., 2011; Wong et al., 2008). Such an approach could be problematic since a considerable number of migrants have managed to transfer their hukous to host cities. This group of people were considered non-migrants, although they had experienced separation from their original homes and social networks. In addition, the composition of the migration population is changing, with an increased proportion of highly skilled and educated people joining the labor market in metropolitan areas (Liu and Shen, 2014). Compared with traditional rural-urban migrants, who mainly have labor-intensive jobs as construction workers, housekeepers, factory workers, etc.

(Chan, 2013), high skilled migrants have a greater chance of obtaining urban hukous and are more determined to settle down permanently in host cities (Cui et al., 2016). It therefore seems more appropriate to define migrants by birthplace, since the definition captures the broader migrant population. However, there is limited knowledge of the migration – mental health relationship in China when defining migrants by birthplace. Furthermore, there is no knowledge of the effect that using one or the other of the two definitions has when examining the migration – mental health relationship.

The second research gap addressed in this thesis is the identification of the unique migration trajectories over time of individual migrants and the linkage between those trajectories and migrants' mental health. Specifically, the discussion in recent decades on the effect of migration and mental health remains inconclusive (Morris et al., 2018; Oishi and Schimmack, 2010). A common limitation of migration – mental health studies is that they treat migration as a one-time event (Hilario et al., 2015; Pyakuryal et al., 2011; Wong et al., 2008), whereas migration can be a long-term process involving multiple moves over the life course before people reach their final destinations (Collyer and De Haas, 2012). While studies have identified many life course events (e.g., separation from the parental house, marriage, or entering/exiting the labor market) as triggers of migration (Burton-Jeangros et al., 2015; Elder et al., 2003), it is necessary to establish the link between migration trajectories formed by a sequence of life-course events and migrants' mental health. Adopting the concept of migration trajectory could help to better understand the diverse and complex experiences hidden behind the word "migration" and therefore reveal a more accurate relationship between migration and mental health.

The third research gap concerns the pathways between green space and the mental health of migrants. Studies have pointed out the beneficial influence of green space on people's mental health (Dzhambov et al., 2018a; Sarkar et al., 2018; Zhang and Li, 2017). Pathways linking green space to positive mental health include encouraging physical activities, mitigating risk exposures such as air pollution and noise annoyance, and promoting social cohesion by facilitating social interactions (Markevych et al., 2017). It is therefore reasonable to consider green space an effective tool to promote migrants' mental health in host cities. However, few studies have examined the green space – mental health pathways with respect to migrants' distinct characteristics in the Chinese context (Helbich et al., 2019). In addition, because most studies on green space-mental health pathways only considered single-mediator pathways, it is unknown how multiple mediators may interact when examined simultaneously (Dzhambov et al., 2018a).

Fourthly, according to the social – ecological model of mental health, people's mental health is shaped by factors at both the individual and the neighborhood level (Lachowycz and Jones, 2013; Mair et al., 2008a). Studies on migrants' mental health and the neighborhood environment in host cities have suggested that a favorable neighborhood environment – such as having good access to shops and transportation, green space, enjoyable neighborhood aesthetics, and high neighborhood social capital – is related to positive mental health outcomes for migrants (Hilario et al., 2015;

Wen et al., 2010; Xiao et al., 2018). However, the current operationalization of neighborhood environment measured at one point in time is problematic in fully understanding the neighborhood effect on mental health, since the neighborhood where people previously lived is left out of the equation (Helbich, 2018). This limitation is particularly relevant when examining migrants' mental health in relation to their neighborhood environment, because they experience the neighborhood environment in both pre- and post-migration stages, and there is little knowledge about the impact of pre- and post-migration neighborhood environments on migrants' mental health.

Finally, although we acknowledge the importance of both pre- and post-migration neighborhood environments in understanding migrants' mental health by adopting models from life-course epidemiology (Ahrens and Pigeot, 2014), we do not know the associations between mental health and changes in the residential environment. Specifically, the same neighborhood environment may have different mental health implications for migrants who moved from less favorable environments compared to migrants who moved from more advantaged neighborhoods. Studies have found that people reported improved mental health when they had experienced housing improvements (Egan et al., 2013). However, evidence is scarce on the relationship between mental health and the upgrading or degrading of the neighborhood environment. Furthermore, no knowledge has been gained of which aspect of the changed neighborhood experience is the most important for migrants' mental health, even though this information would be valuable in promoting migrants' mental health at the neighborhood level.

## 1.4 Research objectives and questions

The overall objective of the research underlying this thesis was to use a life-course perspective to improve our understanding of how individual and neighborhood characteristics affect the mental health of migrants in Shenzhen, China. To do so, we deconstructed migration into a dynamic process involving multiple moves across time and space. We then examined migrants' neighborhood exposures throughout one migration journey, namely before and after they migrated to Shenzhen. Accordingly, the present research addressed the following questions:

1. *What is the impact of defining migration by hukou or by birthplace on the migration–mental health relationship?*

Defining “migrants” by hukou or by birthplace can affect the migrant population that is captured. Therefore, it is rational to assume that different results will be yielded when examining the migration – mental health relationship using one or other of the two definitions. However, little is known about the relationship between birthplace-defined migrants and mental health and the different implications for mental health arising from the use of the two definitions. Chapter 2 examines the migration – mental health relationship utilizing both definitions of migrants and compares the different meanings behind them.

2. *How do migration trajectories differ from one another, and how are these trajectories associated with migrants' mental health?*

The mis-conceptualization of "migration" has led to inconsistent results regarding the migration – mental health relationship. The neglect of the actual migration process and the possibility of multiple migrations could explain these inconsistent results. Chapter 3 therefore re-examines the migration – mental health relationship by using sequence alignment methods (SAMs) to explore migration trajectories in China, and investigates the relationship between these trajectories and mental health.

3. *What are the pathways linking neighborhood green space exposure to migrants' mental health in the host city?*

Neighborhood green space in urban areas has been broadly proposed to promote residents' mental health. The direct and mediatory pathways have been widely studied for the general population, but it is unknown whether these pathways are the same for migrant groups, considering their relatively short period of residence and high level of residential mobility in host cities. Chapter 4 discusses several green space – mental health pathways that account for migrants' individual characteristics. To examine the potential interplay between multiple mediators, structural equation modeling (SEM) was utilized to examine the pathways simultaneously.

4. *How are migrants' pre- and post-migration neighborhoods associated with their mental health in the host city?*

Neglecting people's residential histories may lead to the misinterpretation of the neighborhood effect when examining neighborhood mental – health relationships. This is particularly true for migrants, since they experience substantial changes of residential environment at larger institutional and geographical scales. Chapter 4 addresses this gap by assessing how both the old and the new neighborhood environment are associated with migrants' mental health in the host city. SEM was utilized to examine both the direct and the indirect effects of the pre-migration neighborhood on mental health.

5. *How are changes in neighborhood characteristics associated with migrants' mental health in the host city, and which neighborhood changes have the most influence on migrants' mental health?*

Neighborhood experience is not an absolute value but rather a relative experience that is influenced by people's previous neighborhood experience. For instance, the same neighborhood environment may lead to mental health outcomes for people who moved from an advantaged neighborhood that differ from those for people who moved from a disadvantaged neighborhood. In this case, the perceived change of neighborhood environment before and after may be more important in explaining a person's mental health outcome. Chapter 5 explores the relationship between migrants'

mental health and the perceived neighborhood environment changes in pre- and post-migration neighborhoods. Since the neighborhood changes and mental health outcomes are potentially non-linearly associated, a random forest was used to assess the associations. The importance of explanatory variables and variable interactions was also examined.

## 1.5 Conceptual framework

The conceptual framework (Figure 1.2) presents the factors that influence migrants' mental health at the individual and the neighborhood level. Migration is broken down into several such factors at the two levels. At the individual level, the definition of migration was first compared when examining migrants' mental health. By defining migrants by birthplace, it enabled us to further break down the migration trajectories into a sequence of places to which people had moved to triggered by several life-course events. At the neighborhood level, migrants' mental health is related to the neighborhood environment in the host cities. In addition, with respect to migrants' residential histories, their exposure to neighborhoods in which they previously lived also influences their mental health. Finally, the model indicates that the experienced differences between pre- and post-migration neighborhoods could also have associations with migrants' mental health. The individual and the neighborhood level factors together shape migrants' mental health status.

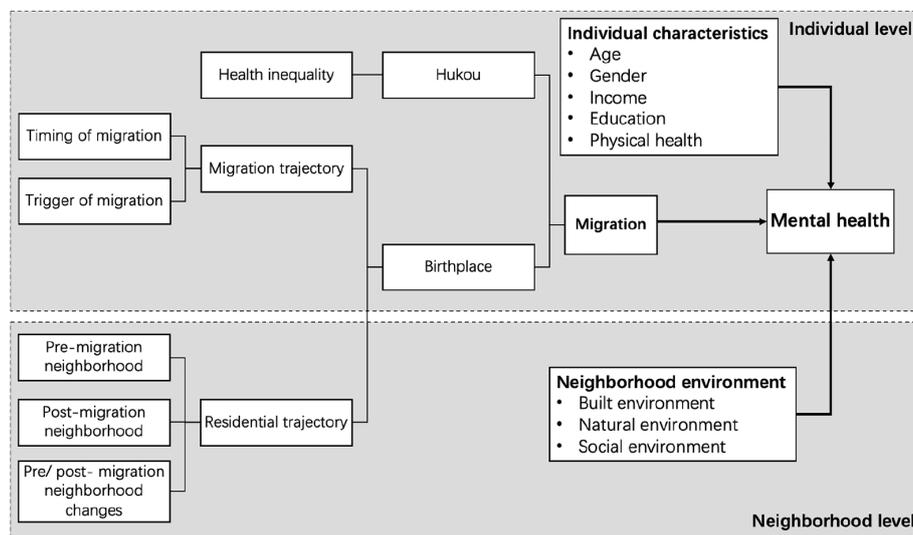


Figure 1.2 Conceptual model

## 1.6 Case study area and data collection

Shenzhen is a major city in Guangdong Province, China. It is a coastal city and situated immediately north of Hong Kong Special Administrative Region. It was the first Special Economic Zone (SEZ) to be established in China following the opening up in the late 1980s and is now one of the most successful. It is a sub-provincial administrative area, which means that its powers are slightly less strong than those of a province. According to the government report for 2014, in that year Shenzhen had a permanent population of 10.78 million, of whom only 3.32 million held permanent Shenzhen hukous.

Shenzhen was chosen as the study area for this research for several reasons. First, as mentioned, Shenzhen is a city of migrants: Over 70% of its permanent population are migrants. The actual number of migrants is much larger, since data on permanent migrants are not included in the population census. This characteristic made it easy to approach the target group, namely migrants. Second, Shenzhen's economic structure is diverse, comprising both labor-intensive and high-tech manufacturing industries, and modern service industries. Shenzhen is also the financial and logistic center of southern China. The diversity of the economic structure leads to a diversity of migrants, and both skilled and less skilled migrants can be found in the city. These characteristics made Shenzhen a good research location in which to investigate migration from the perspective of diversity.

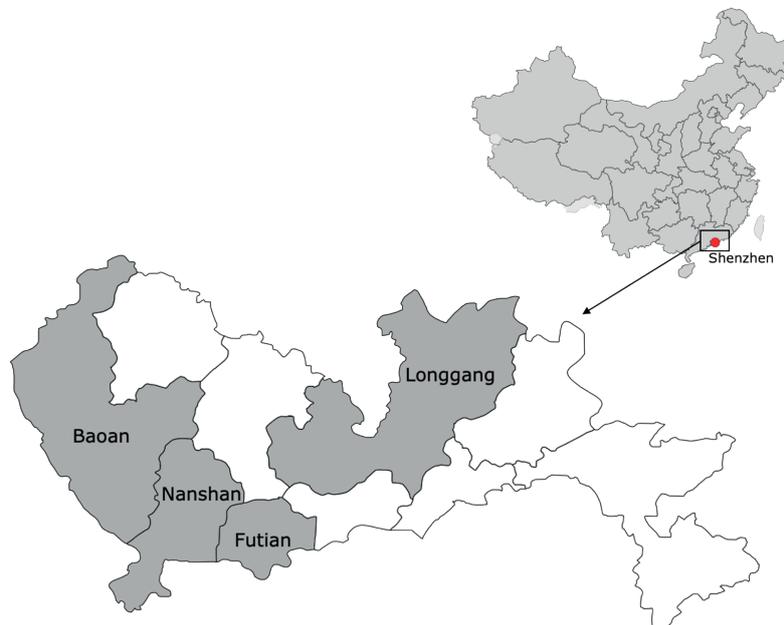


Figure 1.3 Location of Shenzhen and the case study districts

We conducted a survey between January and April 2017 in seven neighborhoods in Shenzhen. In total, 855 questionnaires were collected; 591 had been completed by migrants (people who were not born in Shenzhen) and 264 by non-migrants (people who were born and raised in Shenzhen). The overall sample size and the sample size for each population group fits the rules of thumb whereby the minimum sample size (n) has to be 15 times the number of predictors (p) (Harrel, 2001). Table 1.1 below presents the general characteristic of the sample population. The mean score on the 12-item General Health Questionnaire (GHQ-12) for the whole sample was 1.36 (SD=1.64). The average age of the whole sample was 31.18 years (SD±7.89) and 45.85% were female. Both age and gender distributions of our sample closely matched the demographic profile of people in Shenzhen in 2018, where the average age of the permanent residents was 32.5 years and 46% of the permanent residents were female (Statistics Bureau of Shenzhen Municipality, 2019).

**Table 1.1** Description of the sample population

		Mean	Standard Deviation	N	Percentage
GHQ-12		1.36	1.64		
Age		31.18	7.89		
Gender	Female			392	45.85%
	Male			463	54.15%
Education	High school or lower			235	
	Bachelor's degree			569	
	Master's degree or above			51	
Personal income	< 4000 yuan			199	23.27%
	4001 – 8000 yuan			351	41.05%
	> 8001 yuan			305	35.67%
Household income	< 8000 yuan			206	24.09%
	8001 – 16,000			324	37.89%
	> 16,001 yuan			325	38.01%
Physical health	Fair and poor			295	34.50%
	Good			246	28.77%
	Very good			190	22.22%
	Excellent			124	14.50%
Birthplace	Shenzhen			264	30.88%
	Guangdong Province			188	21.99%
	Other provinces			403	47.13%
Hukou status	Non-Shenzhen hukou			457	53.45%
	Shenzhen hukou			398	46.55%
Length of residence in Shenzhen		24.99 years	9.58 years		

Multi-stage stratified cluster sampling procedures were used to select respondents for the surveys. Four districts were first selected in two stratified geographic zones, namely the central city (Nanshan and Futian) and the suburban area (Baoan and Longgang). Within each of the districts, neighborhoods were selected such that the sample included a broad range of neighborhood types and migrant concentrations. To maximize variation within the sample and to control for residential environment, respondents living in neighborhoods were selected based on higher and lower classification of the residential environment. To emphasize this differentiation, both data at the level of the neighborhood and the characteristics of location, environmental quality, access to social and health services and facilities, residential density, and the social identification of residents were considered. Previous research also stressed the differences in socioeconomic composition and physical environment between different neighborhood types (Cai, 2010; Knox and Pinch, 2000; Wu, 1992). Empirical studies of Chinese neighborhood environments have classified neighborhood types into three categories: 1) Older, unplanned neighborhoods. These neighborhoods are usually present because of some institutional issues during China's transformation period. The typical example is the inner-city village, which is highly unplanned with high residential density and poor neighborhood management. Such neighborhoods attract newcomers to the city because of the low housing prices and the location advantages. 2) Work unit compounds. This type of neighborhood is a left-over from China's collective economy in the 1950s to the late 1980s. The housing was constructed by work units and sold to workers in the unit at very low prices. It was usually provided by state-owned enterprises and public sectors. 3) New high-rise neighborhoods ("commodity housing"). This type of neighborhood started to emerge in the late 1990s and has become increasingly popular since 2004, following the reform of the housing market. These neighborhoods are well designed and managed by developers and property management companies. However, as the housing market in China attracts more and more investments, the price of housing in this type of neighborhood has become extremely high for most urban residents. Finally, the factory dormitory and social housing were included, as they are residential areas with distinct physical and social characteristics.

1



**Figure 1.4** Examples of neighborhood environments: inner-city village, work unit compound, and commodity housing

Taking into consideration the location, sociodemographic characteristics, and physical environment features, seven typical neighborhoods were selected, each representing a different type of neighborhood. After identifying the neighborhoods within each district, housing units in each selected neighborhood were randomly selected.

## **1.7 Thesis outline**

This thesis consists of seven chapters. Chapters 2 to 6 are based on journal articles that have been published in or are under review by international peer-reviewed journals.

Chapter 2 compares the differences that arise by defining migrants by hukou or by birthplace when examining the migration – mental health relationship in China. Chapter 3 investigates the migration experience by examining migration trajectories and their relationship to mental health. Chapter 4 draws upon multiple pathways between neighborhood green space and mental health for migrants in the host city. Chapter 5 discusses the relationship between neighborhood environment and mental health over the migration trajectory, and identifies the pathways linking both individual level and neighborhood-level characteristic to mental health. Chapter 6 focuses on the perceived changes in neighborhood environment and discusses how the perceived improvement or degradation of the neighborhood environment is associated with migrants' mental health in the host city. Chapter 7 draws overall conclusions, reflects on the outcomes of the research as a whole and propose avenues for future research.

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# Chapter

# 2

## Mental health among migrants in Shenzhen, China: Does it matter whether the migrant population is identified by hukou or birthplace?

This chapter is based on the article: Yang, M., Dijkstra, M. and Helbich, M. (2018) 'Mental health among migrants in Shenzhen, China: Does it matter whether the migrant population is identified by hukou or birthplace?', *International Journal of Environmental Research and Public Health*, 15(12), p. 2671. doi: 10.3390/ijerph15122671.

## **Abstract**

Massive rural-Urban migration in China has drawn attention to the prevalence of mental health problems among migrants. Research on the mental health of Chinese migrants has a narrow focus on rural-Urban migrants, emphasizing the institutional role of hukou in migrant mental health. We argue that the heterogeneity of migrants, including their place of origin and whether they are temporary or permanent migrant, should be taken into account when trying to understand the meaning of migration as an actual movement from one place to another. The data used for this study is from a cross-sectional survey (N=855) conducted in Shenzhen to compare the differences in migrants' mental health that arise when using the two definitions (e.g., hukou and birthplace). Binary logistic regression models were estimated to assess the associations between people's mental health and migration, while controlling for settlement experiences, self-reported physical health, and socio-demographics. The results reveal inconsistent findings across both definitions: General migrants by birthplace were found to be unlikely to have mental problems compared to non-migrants, whereas temporary migrants were at higher risk of mental problems. The study provides important evidence that different migrant groups have different mental health outcomes. The choice of the definition used influences both migrant group selection and the actual linkage between migration and mental health.

*Keywords: Migration; Mental health; Hukou; Birthplace; China*

## 2.1 Introduction

Since the 1980s, China has undergone rapid urbanization accompanied by massive migration from the countryside to urban areas. Approximately 286.5 million migrants left their rural homes to seek better life opportunities in cities in 2017 (NHCPRC, 2017).

Increasing population mobility triggered interest among academics in migrants' physical and mental health in host cities (Jahn et al., 2011; Qiu et al., 2011; Zhong et al., 2016). Yet previous studies of Chinese migrants' mental health have been producing mixed findings (Li and Rose, 2017). Some suggested migrants' mental health status was worse than urban non-migrants because of limited social welfare, low socioeconomic status, acculturation issues, risks of discrimination, and marginalization (Wang et al., 2010; Wen et al., 2017; Zhong et al., 2016). Others, observed the healthy migrant phenomenon where migrants reported better health status than non-migrants (Li et al., 2007). Some suggested that since the process of migration is difficult and stressful, people with relatively better physical and mental health are more likely to migrate while people with poorer health are more likely to remain home (Lu and Qin, 2014). However, the initial health advantages of migrants may reduce overtime with increasing length of residence in host society (Tong and Piotrowski, 2012). In addition, the observed healthy migrants phenomenon could be caused by a selection bias where those migrants who are physically and mentally less healthy have returned home for treatments. Thus, they are excluded from the sample selection in host cities (Ullmann et al., 2011). In short, migrants' mental health status can be influenced by various factors that may cause positive or negative mental health outcomes.

In Chinese migration studies, hukou – China's household registration system – is seen as an institutional barrier preventing migrants from enjoying equal rights in host cities, for example, the right to access housing, employment, education, and social and healthcare services (Chen, 2011). Consequently, most studies on migrant mental health in China focus on rural-to-urban migrants (Nongmin Gong) who hold rural Hukous but work and reside in urban areas (Li et al., 2009; Li et al., 2007). In addition to a disadvantaged socioeconomic status caused by hukou situation (Jahn et al., 2011), rural-urban migrants were found to be more likely to experience discrimination and stigmatization in host cities (Han, 2010; Lin et al., 2011). Social and spatial exclusion was also reported by rural-urban migrants (Hoi et al., 2015; Li and Rose, 2017; Su et al., 2016). Rural-urban migrants' self-identification and sense of belonging are constantly challenged in host cities, leading to higher risk of depression and other mental health problems (Hoi et al., 2015; Lin et al., 2016). Meanwhile, migrants were forced to live in certain parts of the city, primarily in suburban areas and "urban villages" that have poor housing conditions due to housing disadvantages created by the hukou system (Li and Liu, 2018; Shen, 2017). The lack of a local hukou was clearly shown to increase a migrant's living stress and mental health problems.

However, mental health studies in China have a narrow focus on rural-urban migrants, neglecting the heterogeneity of migrants and excluding a significant portion of the migrant population. First,

migrants are different based on the temporary or permanent nature of migration, which is partly indicated by the hukou registration (Zhu, 2007). “Temporary migrants” are people whose place of residence is different from their place of registration. In contrast, “permanent migrants” are people who transferred their place of registration to their current place of residence (Cui et al., 2015; Sun and Fan, 2011). Many migrants expect to settle down in their host cities for a long time or even permanently (Zhu and Chen, 2010). Therefore, transferring their hukous to the host cities has become the ultimate goal of migrants (Huang et al., 2017). The current hukou regulation allows individuals to transfer their hukou to a host city by pursuing higher education, working in the public sector, or having family connections (Cui et al., 2015; Wu and Treiman, 2004). It can also be done by purchasing an urban dwelling, although it takes years of hard work to save enough to purchase an urban dwelling (Huang et al., 2017). Permanent migrants are ignored in most studies since they are no longer registered as “migrants” in the census once they have obtained a local hukou (Sun and Fan, 2011). Second, migrants are different in terms of their place of origin, namely rural-urban migrants and urban-urban migrants. Yet, urban-urban migrants are not included in migrant mental health studies. Compared to rural-urban migrants, urban-urban migrants may experience less urban-rural difference and therefore adapt to their new lives much quicker. In addition, they are more determined to establish their homes permanently in host cities and to obtain local hukous (Li and Liu, 2011). Besides, the initial health status may differ between migrants who came from rural areas and urban areas, due to the big difference between the physical and natural environment in rural and in urban settings (Dean and Sharkey, 2011). Some reported that rural residents are in general healthier than urban residents because they have a better natural environment, a less stressful and unhealthy lifestyle, and healthier diets (Dean and Sharkey, 2011; Lederbogen et al., 2011; Peen et al., 2010)

To address the narrow focus on rural-urban migrants, some attempts at broadening the population of migrants have been made. Skilled migrants have received attention from researchers with respect to issues of housing conditions, residential mobility, and social integration (Li and Liu, 2011). In migrant health studies, the healthy migrant phenomenon was examined among both rural-urban migrants and urban-urban migrants, where place of birth was used to differentiate between migrants and non-migrants (Chen, 2011). Despite these efforts, little progress has been with respect to the heterogeneity of migrants and identifying migrant – mental health associations for a broader migrant population. Since the institutional disadvantage due to the absence of local hukou only applies to temporary migrants who migrate without hukou transfers, we would expect different mental health performance between temporary migrants and the general migrant population.

To sum up, this paper addresses the research gap caused by overlooked heterogeneity of migrants in existing migrant mental health studies. The ignorance of the greater migrant population, including their place of origin and whether they are temporary or permanent migrants, might be problematic and biased when trying to identify the mental health effects of migration. To address the gap, we analyzed novel data from a cross-sectional survey conducted in Shenzhen to investigate the differences that arise when exploring migration – mental health associations for: 1) temporary

migrants, including both rural-urban and urban-urban migrants, without local hukou; and 2) the general migrant population, which includes all people who experienced migration regardless their hukou status, but using birthplace as criterion of migration.

## 2.2 Material and methods

### 2.2.1 Study area

The city of Shenzhen has been the prime destination for migrants since the start of China's economic reform in the 1980s. By the end of 2015, Shenzhen has a population of 11.37 million people, of whom only 3.54 million have local hukous, which means that over 70% of Shenzhen's population are temporary migrants. This figure would be even larger if migrants were defined by their birthplace instead of possession of a Shenzhen hukou. Being a Special Economic Zone as well as the financial and logistic center of southern China, the city is home to both labor-intensive and high-tech manufacturing industries, as well as modern service industries. The diversity of the economic structure has attracted a broad array of migrants, ranging from low-skilled to high-skilled and highly educated migrants. All this made Shenzhen an ideal city for this research.

### 2.2.2 Research design and sampling

A cross-sectional survey investigating the mental health of migrants in Shenzhen was conducted between January and April 2017. A multi-stage sampling procedure was used to select respondents. The two inner city districts of Nanshan and Futian, and the two suburban districts of Baoan and Longgang, were selected as sampling areas. Within each area, five neighborhoods were identified based on various neighborhood characteristics, including work unit compound, inner-city village, open-market apartment community, social housing, and factory dormitory. However, minor deviation from the initial sampling design was necessary, because a few of the neighborhoods were gated and a security pass was required to gain admission. We therefore also considered the surrounding neighborhoods within the selected district that match the abovementioned neighborhood characteristics. Next, housing units in the identified neighborhoods were randomly selected without replacement to avoid repeated measurements. The head of each household was asked to fill out the questionnaire. If the household head was not available, another household member older than 18 was asked to complete the questionnaire. Since college students were considered a special group of migrants in terms of residence type (concentrated in school-provided dormitories), they were excluded from the sampling. In total, 855 questionnaires were considered valid for the analysis. This overall sample size fits the rule of thumb that the minimum sample size should be 15 times the number of independent variables (Walker, 2003).

### 2.2.3 Data

**Mental health:** The dependent variable for the analysis mental health status was derived from the General Health Questionnaire (GHQ-12), which contains 12 items measuring potential mental health problems (Goldberg, 1988). The validity and reliability of GHQ-12 questionnaire have been

extensively tested in previous empirical studies (Baksheev et al., 2011; Gouveia et al., 2010; Politi et al., 1994). For this study, the well-tested Chinese version was utilized (Shek, 1987; Ye, 2009). The GHQ-12 questionnaire contains six questions measuring positive attributes (e.g., being able to concentrate, feel useful and enjoy life), and six that measure negative attributes (e.g., loss sleep, losing confidence and feel unhappy). The total score is obtained by summing up the scores on each individual question, and ranges from 0 to 12. In this paper, we use the binary scoring method for case identification: 0 refers to an absence of mental health problems, and 1 refers to possible mental health deficits (Goldberg, 1988). Cronbach's alpha of the GHQ-12 was 0.85 for our sample.

**Migration:** Migrants were defined by two variables. The first is based on the conventional hukou definition of temporary migrants: Respondents who reported having Shenzhen hukous were identified as non-migrants, and people without Shenzhen hukous were identified as migrants. The second variable was birthplace which is used to identify migrants in general term: People born in Shenzhen were identified as non-migrants, and people born outside Shenzhen were identified as migrants.

In addition, three variables representing people's settlement experience in Shenzhen were considered. First, information about the length of residence in Shenzhen was collected. The more time that people spend in a host city, the more likely they are to better adjust themselves to the new society. Length of residence is generally associated with people's positive feelings and interactions with the place (Beiser et al., 2015). Second, we asked the respondents about house ownership. Owning a dwelling in a host city contributes to migrants' psychological wellbeing and enhances their connections to that city (Brown et al., 2003; Exeter et al., 2015). Third, residential mobility was measured by the number of residential moves within Shenzhen. Studies suggest that people who are residentially stable, report better general mental health compared to those who are residentially highly mobile (Oishi & Schimmack, 2010). Migrants in China have substantially higher mobility rates and more residential instability compared to local urban residents (Cui et al., 2015; Wu, 2006).

**Control variables:** The following confounding variables were also considered: age in years, gender, level of education, personal monthly income in RMB (RMB 1=USD 0.15), and number of jobs held. Since people's mental health is related to their physical health (Biddle and Asare, 2011; Scott and Happell, 2011), we adjusted for that on the basis of a self-rated question on a Likert scale of 1 to 5. This type of operationalization is widespread (Emerson and Llewellyn, 2008) and is well validated for the Chinese context (Lu and Qin, 2014).

#### 2.2.4 Statistical analysis

Descriptive analyses were conducted to reveal the properties of each variable. We utilized chi-square tests for categorical variables and independent t-tests for continuous variables to investigate differences concerning the prevalence of mental health problems between migrants and non-migrants, as well as across the two definitions of migration.

Since the dependent variable was binary coded, we estimated binary logistic regression models to test the associations between the prevalence of mental health problems and the independent variables. The following four models were fitted into two groups: Model 1 tested the relationship between migration and mental health using migrants defined according to hukou. Model 2 tested the same relationship in Model 1, adjusting for confounders including settlement experience in Shenzhen, self-reported physical health, and sociodemographic attributes. In Model 3, we tested the relationship between migration and mental health using birthplace to define migrants. Model 4 tested the same relationship as in Model 3, adjusting for the confounders. Variables with  $p < 0.05$  are considered statistically significant. SPSS 24 was used for the statistical analyses.

## 2.3 Results

The 855 participants had a GHQ-12 mean score of 1.36 (SD=1.637). The cut-off point for unlikely/likely to have mental health problems was set at 1/2, which is in line with previous studies (Goldberg et al., 1997). The prevalence of mental health problems (GHQ-12 score  $\geq 2$ ) was 28.8% for the sample.

Table 2.1 presents the descriptive statistics. The sample comprised 457 (53.5%) temporary migrants according to hukou definition. The general migrant group comprised 591 people (69.1%) when using birthplace as the definition.

The results of the chi-square tests (Table 2.1) show that significantly higher mental health problem prevalence rates were present among temporary migrants (defined by hukou), non-migrants (defined by birthplace), people who did not own their dwellings, people who reported "fair and poor" general physical health, and people whose personal monthly incomes were less than RMB 4,000. The t-test shows a significantly lower average number of years of residence in Shenzhen and higher average number of residential moves among the group that had a high prevalence of mental problems. Variance inflation factors provided no evidence for multicollinearity.

**Table 2.1** Descriptive statistics and mental health prevalence rate

Variable	Category	Whole sample N (%) / Mean	Prevalence of mental health problems	
			N (%) / Mean	Chi <sup>2</sup> -test/t-test
<b>Definition of migrants</b>				
Temporary migrants by hukou	Non-migrants	398 (46.5%)	106 (26.6%)	1.66*
	Migrants	457 (53.5%)	140 (30.6%)	
General migrants by birthplace	Non-migrants	264 (30.9%)	90 (34.1%)	5.27*
	Migrants	591 (69.1%)	156 (26.4%)	
<b>Settlement experience</b>				
Length of residence in Shenzhen (years)		25.5	23.8	2.83*
Housing ownership	No	586 (68.5%)	184 (31.4%)	6.27*
	Yes	269 (31.5%)	62 (23.0%)	
Residential mobility in Shenzhen		1.7	2.0	-2.87**
<b>Physical health</b>				
Self-reported physical health	Fair and poor	295 (34.5%)	138 (46.8%)	72.08**
	Good	246 (28.8%)	52 (21.1%)	
	Very good	190 (22.2%)	35 (18.4%)	
	Excellent	124 (14.5%)	21 (16.9%)	
<b>Sociodemographic variables</b>				
Age (years)		31.5	30.4	1.74
Gender	Female	392 (45.8%)	109 (27.8%)	0.33
	Male	463 (54.2%)	137 (29.6%)	
Education	High school or lower	235 (27.5%)	78 (33.2%)	3.09
	Bachelor's or lower	569 (66.6%)	154 (27.1%)	
	Master's or above	51 (5.9%)	14 (27.5%)	
Personal income	< RMB 4000	199 (23.2%)	76 (38.2%)	11.72**
	RMB 4001 – 8000	351 (41.1%)	95 (27.1%)	
	> RMB 8000	305 (35.7%)	75 (24.6%)	
Number of jobs	None	57 (6.7%)	20 (35.1%)	1.37
	1 job	664 (77.6%)	186 (28.0%)	
	> 1 job	134 (15.7%)	40 (29.9%)	

\*\*=0.05 significance level; \*\*\*=0.01 significance level

Table 2.2 presents the results of the binary logistic regression models. Consistent with the chi-square test, both definitions of migrants were found to be significantly associated with the prevalence of mental health problems independently. Migrants defined by hukou type were at higher risks of having mental health problems, whereas lower risks were found when migrants were defined by birthplace. The relationships remained significant after controlling for confounding factors. The effects of the control variables were different when different definitions were applied.

Table 2.2 Results of the binary logistic regressions (N=855)

Independent variables	Model 1		Model 2		Model 3		Model 4	
	Coef.	Stand. Err.	Coef.	Stand. Err.	Coef.	Stand. Err.	Coef.	Stand. Err.
<b>Temporary migrants by hukou</b> (reference: Non-migrants)								
Migrants	0.430**	0.154	0.517*	0.206				
<b>General migrants by Birthplace</b> (reference: Non-migrants)								
Migrants					-0.366*	0.160	-0.630**	0.203
<b>Settlement experience</b>								
Length of residence in Shenzhen (years)			-0.029*	0.013			-0.001	0.013
Housing Ownership (reference: No)			0.023	0.211			-0.367	0.202
Housing Ownership (Yes)			0.137**	0.047			0.130**	0.047
Residential mobility								
<b>Perceived physical health</b> (reference: Poor and fair)								
Good			-1.201**	0.201			-1.193**	0.201
Very good			-1.333**	0.229			-1.358**	0.230
Excellent			-1.590**	0.283			-1.660**	0.285
<b>Sociodemographic variables</b>								
Gender (Female)			0.298	0.171			0.354*	0.170
Age (years)			0.011	0.015			-0.011	0.015
Education (reference: High school and lower)								
Bachelor's degree			-0.072	0.201			-0.265	0.198
Master's degree			0.266	0.397			0.034	0.389
Personal monthly income (reference: < RMB 4000)								
RMB 4001 – 8000			-0.487*	0.217			-0.470*	0.217
> RMB 8000			-0.407	0.255			-0.420	0.255
No. of jobs (reference: None)								
1 job			-0.145	0.325			-0.061	0.328
> 1 job			0.025	0.374			0/075	0.377
<b>Constant</b>			-1.146**	0.117	0.012	0.522	-0.659**	0.130
<b>Nagelkerke R<sup>2</sup></b>			0.013		0.164		0.019	

\*\*=0.05 significance level; \*\*\*=0.01 significance level

When migrants were defined according to hukou, length of residence in Shenzhen was negatively correlated with prevalence of mental health problems. The association was no longer significant when migrants were defined according to birthplace. Instead, gender was found to be significantly associated with the prevalence of mental health problems. A significant positive relationship was found between residential mobility and prevalence of mental health problems in both models. This means that making multiple housing moves in Shenzhen might be a risk factor for mental health problems. The results also show that the worse people perceive their physical health condition, the more likely they are to have mental health problems. Finally, people with monthly incomes of RMB 4,001 – 8,000 are significantly less likely to have mental health problems compared to those who earn less than RMB 4,000 per month. In order to test whether the covariables are different across migrants and non-migrants, the models were re-run with interaction terms as well. As the interactions were insignificant, the results are not reported.

## 2.4 Discussion

This study addressed the nature of migration and its relation to mental health by comparing two groups of migrants, namely temporary migrants (according to their current hukou registrations) and the general migrant group by birthplace (with hukou transfers). The results show that a significant number of migrants had managed to transfer their hukous to Shenzhen (134 cases, 15.6% of the total sample). We found a prevalence rate of mental health problems of 28.8% of the sample, assessed by GHQ-12 with a cut-off score of 2. Using this measurement, the prevalence rate of temporary migrants was 30.6% and 26.6% for non-migrants while the number became 26.4% for general migrants and 34.1% for non-migrants when birthplace was used to identify migrants. The regression analysis showed migration to be significantly associated with the prevalence of mental health problems. Yet, the directions of the association differ when defining migrants differently. Temporary migrants identified by hukou were significantly less mentally healthy than non-migrants while the general migrants by birthplace are mentally healthier than non-migrants. As a large proportion of migrants managed transferring their hukous to Shenzhen after arrival, we conclude that great caution is needed in defining migrants when investigating the relationship between migration and mental health in China.

The choice between hukou and birthplace is not merely a selection of sample size. Instead, it has implications on understanding migrants' mental health status in the Chinese context. Our results showed that temporary migrants (non-Shenzhen hukou) have significantly higher chance to suffer from mental health problems comparing to non-migrants in Shenzhen (Shenzhen hukou). This finding is in line with previous empirical findings (Qiu et al., 2011; Zhong et al., 2016). The hukou system is a key factor for health inequality among Chinese migrants and the biggest institutional barrier for migrants' desired urban lives (Guo et al., 2017; Tani, 2017). Hukou has been closely linked with healthcare services, including medical insurance, access to professional health consultation, and access to proper medication (Lam and Johnston, 2015). The inequality issue caused due to the

lack of local hukous also appears in employment, social security, and housing. For instance, migrants have limited access to subsidized housing in host cities and the majority of them end up in poor living conditions. Another major issue for migrants is the difficulty of acquiring a place in school in host cities for their children (Tani, 2017). As a result, migrants have to leave their children in their home towns for schooling and suffer from family separation, which challenges both migrants and their left-behind children's mental health (Li et al., 2015).

The general migrants, on the other hand, contains a broader selection of migrant types, including those who transferred their hukous to Shenzhen (Cui et al., 2015). Tani (2017) reported that transferring hukous to host cities significantly improves migrants' mental wellbeing, since doing so addresses most of the inequality issues caused by the hukou system. In addition, hukou migrants are more likely to have better employment opportunities, higher incomes, and a higher level of education (Tani, 2017). This financial and human capital contributes to better mental health (Kaplan et al., 2008; Thoits, 2010). Moreover, international migration studies observed the healthy migrant phenomenon where immigrant reported better health performance than the native-born when they arrived in destination countries (Qiu et al., 2011). We found similar effect using for general migrants by birthplace. The intertwined relationship between migration and mental health is well represented by the healthy migrant phenomenon where healthier people tend to be migrants and move further away from home (Lu and Qin, 2014), resulting in a better initial health status than non-migrants. Yet, migrants' mental health status may vary during their migration experiences, including being away from home place and original social network, as well as coping and adapting experiences in destinations. Moreover, migration is associated with improved socioeconomic status and quality of life. Apart from economic gains, migrants also benefit from relatively good social resources, such as better schooling for their children and improved living conditions, both of which seem to enhance mental health status (Stillman et al., 2009).

As evidenced by our study, the choice between two definitions of migrants has significant implications. The hukou-based definition selects migrants whose place of residence differs from their hukou registration, and in most cases these are rural-urban migrants (Sun and Fan, 2011). This definition is suitable for specific rural-urban migrant studies that address urban and rural areas (Li et al., 2009; Qiu et al., 2011) and focus on inequality between migrants and non-migrants in Chinese cities (Li et al., 2007; Lin et al., 2011; Wang et al., 2010). The birthplace definition, however, includes more people who changed their residence during any of their life stages. We believe that birthplace represents migration experiences more accurately, as it allows the incorporation of changes in exposures due to residential changes.

In addition to the different associations between mental health and migration for different migrant groups, the results also showed that residential mobility in Shenzhen plays a significant role in migrants' mental health status. We found that frequent residential moves were associated with a higher prevalence of mental health problems, which is congruent with previous studies (Exeter et al., 2015; Oishi and Schimmack, 2010). Empirical studies have reported a higher residential mobility

rate in migrants compared to local people (Bonvalet et al., 1995; Wu, 2006). In comparison to the locals, migrants tend to start at the bottom of the housing market due to their limited social and economic resources. They improve their living conditions over time, whereas locals have accumulated both social and economic resources over generations, and therefore enter owner-occupied housing earlier (Cui et al., 2015). Our findings also suggest that self-reported physical health is strongly associated with mental health where the better physical health reported, the less chance people have to have mental health problems. This result is in line with existing empirical results (Qiu et al., 2011). In addition, higher income was found to contribute for better mental health performance from our analysis. This finding is consistent with earlier research (Kaplan et al., 2008; Qiu et al., 2011) (Greene, 2012). All these factors mentioned above showed the same direction of association with prevalence of mental health problems, regardless which migrant group was analyzed. It means that these factors, including residential mobility rate in Shenzhen, perceived physical health and income are crucial factors affecting people's mental health performance.

There are several policy implications based on our findings. First, migrants who lack urban hukou are the most vulnerable group in terms of mental health problems. Policy makers should reduce the gap between local hukou and non-local hukou to better facilitate migrants' lives in cities. Second, although migrants with local hukou seem to have a lower risk of having mental health problems, pronounced residential mobility might act as additional risk factor. Efforts should be made to make migrants feel more at home, for example, granting them access to the public renting system to improve the quality of their initial housing. Social support should be provided at both the community and the neighborhood level to facilitate migrants' connection to the local environment and social groups, thereby enhancing their residential experiences and reducing their tendency to move.

Several limitations should be considered when interpreting the results. First, we did not include circulating migrants, namely migrants who constantly move back and forth between their original homes and the city, or migrants who had moved back to their original homes. Since these groups of migrants may differ in terms of sociodemographic attributes, they may hold different expectations of their migrant life compared to our sample. Second, the sample was recruited only in Shenzhen, which is a migration hotspot. This might restrict the generalization of our findings to other Chinese cities. Third, due to the cross-sectional nature of our study, causal relationships between the prevalence of mental health problems and migration-related factors cannot be inferred. Further longitudinal studies are required to establish and verify causation between mental health and migration. Finally, we cannot rule out endogeneity issues, because covariables are could be correlated with the error term. Future studies should address this issue by means of instrumental variables (Greene, 2012).

Despite these limitations, several strengths need to be highlighted. First, the study represents an initial effort to investigate the impact of different definitions of migrants in analyzing the relationship between migration and mental health. It draws attention to the potential impacts on analytical outcomes for different migrant groups. Second, the study stresses the importance of broadening the research scope of migrants in China according to birthplace. Without its role of identifying

migrants, hukou still serves as an important factor that indicates people's resettlement status and is closely associated with people's mental health. Therefore, the research represents an important exploration of how migration is related to mental health in urban China.

## 2.5 Conclusions

Migrant mental health research in China has been limited by the narrowed selection of rural-urban migrants. Yet, no knowledge has been built to understand the difference between the two definitions of migrants, namely hukou and birth place. By comparing the migrant populations identified according to each of the two definitions and their roles in analytical models, we found that the definition of migrant had a significant influence on the association between mental health and migration. Moreover, there are different implications behind each definition, including migrants' socioeconomic status and, more importantly, their capacity and intention to stay permanently in host cities. We suggest that future research could build on our outcomes by taking a closer look at the meanings represented by the two definitions. Studies could include migrant heterogeneity by looking at migrants' birthplace, so that we gain a better understanding of how and why certain migrants become better off than others. Our findings also suggest that along with migration, residential mobility, physical health, and personal income play significant roles in the prevalence of mental health problems.

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Chapter

# 3

Migration trajectories and their relationship to mental health among internal migrants in urban China: A sequence alignment approach

This chapter is based on the article: Yang, M., Dijst, M. and Helbich, M. (2019) 'Migration trajectories and their relationship to mental health among internal migrants in urban China: A sequence alignment approach', *Population, Space and Place*, e2304. doi: 10.1002/psp.2304.

## Abstract

Although migration trajectories over people's life courses seem to be associated with mental health outcomes, previous studies have considered migration at only one point in time when correlating migration with mental health. However, people can migrate multiple times during their life courses. The decision to migrate can be triggered by several life-course development events, such as education, entry to the labor market, marriage, or retirement. The present study addressed this research gap by focusing on the trajectories of migration and their relationship to mental health among internal migrants in China. Data were collected from a cross-sectional survey (N=534) in Shenzhen, China, in 2017. People's migration trajectories were aligned into migration groups using sequence alignment method. Binary logistic regression models were estimated to assess the associations between each migration trajectory group and the prevalence of mental health problems, controlling for socio-demographics and self-reported physical health. The results show that migration trajectories – namely the sequence of multiple migrations between migrants' places of origin and their final destinations – are significantly related to mental health outcomes. Our findings suggest that treating migration as a one-time transition could be problematic, since many migrants undertake multiple migration trips.

*Keywords: Migration trajectory; Mental health; Sequence alignment method; China*

### 3.1 Introduction

In 2018, 59% of China's population lived in urban areas (The World Bank, 2013). Among the reasons for rapid urbanization in China is the large-scale migration of people from rural to urban areas in pursuit of, for example, better job opportunities and better living conditions (Chan, 2013). Although it has been extensively studied, the relationship between migration and mental health remains unclear in international debates (Gatrell, 2011; Hilario et al., 2015; Li et al., 2014). Some scholars found that migrants are at higher risk for mental health problems due to acculturation stress, disconnected social networks, and unfamiliar environments (Rogler, 1994; Sirin, Ryce et al., 2012; Yoon et al., 2013), while others found the opposite. There are many reasons for the latter, including improved economic status, better life opportunities, and higher incomes than non-migrants (Lu and Qin, 2014; Stillman et al., 2009). Unlike international immigrants, who face such problems as acculturation stress and integration difficulties, Chinese internal migrants may experience fewer sociocultural differences. However, adapting to a new environment and differences in culture and lifestyle, remains a challenge (Li & Rose, 2017).

Previous studies on both international and internal migration had several limitations, which might be the cause of such contradictory results. Migration is commonly referred as a "transition point" in one's life course (Gong et al., 2011) and is presented as a one-time move modeled as a binary variable in regression models, along with migration-related factors such as place of origin, socioeconomic status, and – in the Chinese context – hukou<sup>1</sup> (Hilario et al., 2015; Pyakuryal et al., 2011; Wong et al., 2008). This conceptualization fails to address the multiple and shifting nature of migration, as people can be triggered by various motives to migrate from one place to multiple destinations multiple times throughout the course of their lives (Collyer and De Haas, 2012). Thus, migration should be seen as a trajectory<sup>2</sup> that takes place within a period of time and involves a series of decisions throughout people's lives.

Although theoretical models in life course epidemiology have stressed the role of sequences on mental health outcomes (Kuh et al., 2003), such a notion of multiple migrations has scarcely been acknowledged; in fact, previous studies do not consider the possibility of multiple migrations throughout one's life course (Collyer and De Haas, 2012). A related challenge for life course research is to determine when and why a change in the overall direction of a trajectory occurs (Wingens et al., 2011). Of particular relevance for this study is that the timing and motivation of migration play a central role in people's psychological development and mental health (Gong et al., 2011; Li et al., 2014). Analyzing the migration trajectories helps to unfold the sequence of risks and exposures that people experience over time, and frames how mental health develops through their life courses (Thoits, 2010).

<sup>1</sup> Hukou refers to China's household registration system. In host cities, migrants – especially those who migrate from rural areas to urban areas – have limited access to hukous, on which social welfare and political participation are based (Huang et al., 2017). Although difficult to achieve, a hukou can be transferred to the host city by, for example, pursuing higher education, working in the public sector, purchasing an urban dwelling, or having family connections (Cui, Geertman, & Hooimeijer, 2015).

<sup>2</sup> A migration trajectory refers to a spatiotemporal process comprising multiple journeys to various places (Schapendonk et al. 2018).

To address these research gaps, the present research explored 1) life course-based migration trajectories in China, by means of sequence alignment method (SAM), and 2) the relationship of such trajectories to mental health. The aim was to answer the following two research questions:

1. *How do migration trajectories sequenced by migration motivations differ from one another?*
2. *What are the relationships between migration trajectories and mental health?*

This article is structured as follows. The following section briefly reviews the literature, and the subsequent one introduces the research design. This is followed by details of eight migration trajectory groups that were aligned and tested in regression models to investigate the factors that affect migrants' mental health. The final two sections discuss the findings and present the conclusions, respectively.

### 3.2 Related work

Using the life course approach to understand the link between migration and mental health has only recently been embraced (Colman and Ataullahjan, 2010). Life course epidemiology emphasizes how the timing (i.e., critical/sensitive periods), duration (i.e., accumulation), and temporal sequence (i.e., triggers/interactions) of particular experiences affect mental health (Wingens et al., 2011).

The timing of life course transitions may affect people's mental health in both their present and their later lives (Bernard et al., 2014). Studies focusing on how age at migration affects migrants' mental health found that younger migrants, namely migrants who moved during their childhood or early adolescence, are more likely to experience mental health problems later in life (Mendelson et al., 2010; Montes de Oca et al., 2011; Wong et al., 2009). Others argue that migrant adolescents do not necessarily have poorer mental health compared to local residents or migrant adults (Cheung, 2013; Mao and Zhao, 2012; Mendelson et al., 2010). These studies emphasize the importance of migration experiences that occurred in specific periods across people's development stages. Such experiences at critical life stages may affect mental health in later life (Wingens et al., 2011). Previous research has highlighted the importance of certain life stages for psychosocial developments, including entering the labor market, leaving the parental home, and job insecurity and instability (Heckhausen et al., 2010).

Life course development stages are closely related to migration decisions. After spending the childhood and adolescent stages at the parental home, migration can be triggered by, for example, the desire to pursue an education elsewhere, to seek employment, or to get married. (Findlay, McCollum, Coulter, & Gayle, 2015). For example, an increase in family size is one of the motives for residential mobility (Brazil and Clark, 2017). Migration motivations may interact with the timing and sequence of moving and, in turn, affect mental health, since the same motivation may have different meanings for people at different life stages (Gong et al., 2011). For instance, when migrating for

family reasons, a migrant child may have experiences that are very different from those of her parents, because the voluntary or involuntary nature of migration and the cost of leaving the existing environment and adapting to the new one have different impacts at different life stages (Chen et al., 2017; Yoon et al., 2013). However, previous studies assume that migration is a single transition that takes place at one point in time in a person's life course trajectory (Angel & Angel, 1992; Findlay et al., 2015; Heckhausen et al., 2010; Hilario et al., 2015). Robette (2010) argued that such a conceptualization disregards the fact that a transition between stages is a complex, long-term process. For instance, the transition from school to work can involve several periods of temporary employment and unemployment before a stable occupational position is found (Murphy et al., 2010). Similarly, migrants might move to several places before they reach their final destination (Schapendonk et al., 2018). Previous studies are therefore limited by considering the migration trajectories as representing the accumulated migration experiences through time and space (Morris et al., 2018; Schapendonk et al., 2015; Schapendonk & Steel, 2014), challenging empirical results based on experiences at a single point in time (Helbich, 2018).

The notion of "migration trajectory" overcomes the limitation of treating migration as an action that takes place at the exact moments of departure and arrival. For instance, a migration trajectory may involve information about multiple attempts to reach the final destination, or decisions concerning future migrations (Collyer & De Haas, 2012; Phillips & Missbach, 2017a; Schrooten et al., 2016). Montes de Oca et al. (2011) analyzed migration groups in relation to their health outcomes based on the time of the first migration and the development of the migration trajectories to the United States. They showed that age at first migration and the conditions under which the migration trajectory developed, influence the elderly's health and quality of life differently. Integrating life course epidemiology into migration studies explicitly recognizes the role of time and the latency effects of migration experiences over people's life courses (Colman and Atallahjan, 2010). The health of migrants is influenced by accumulated experiences during their migration trajectories that are not experienced by the rest of the population. Migration is frequently reported to be associated with specific reasons during specific life course stages, for example, migrating with parents in childhood or adolescence, or leaving the parental home in early adulthood (Gong et al., 2011). Analyses have shown that positive and negative experiences during migration accumulate over time and influence migrants' psychological attributes (World Health Organization and Calouste Gulbenkian Foundation, 2014). The overall balance between the accumulated positive and negative experiences during migration contributes to shaping an individual's mental health outcome, leading to different mental health performance across individuals. In addition, people who migrate more frequently may cope more easily with new environments based on their past experiences, and their mental health status may be less disrupted compared to people who migrate less often. On the other hand, a higher mobility rate may affect mental health negatively due to the unstable living experiences (Oishi, 2010).

To summarize, this paper focuses on how migration trajectories are formed and how they are related to migrants' mental health. This is done by putting a strong emphasis on a reconceptualization

of migration toward a temporal and sequential progress that involves the possibility of multiple migrations.

### 3.3 Research design

#### 3.3.1 Study area

The data used for this research were derived from a cross-sectional survey conducted in Shenzhen, China, between January and April 2017. The survey adopted a multi-stage sampling procedure. Since inner cities and suburban neighborhoods have different characteristics in terms of the physical and social environments (Nelson et al., 2006), two inner-city districts (Nanshan and Futian) and two suburban districts (Baoan and Longgang) were chosen as the sampling areas. Within each sampling area, five neighborhoods differing in size and type of location, and whose populations had different socioeconomic compositions, were selected. These neighborhoods can broadly be classified as work unit compound, inner-city village, commodity housing community (a private real estate development), social housing, and factory dormitory. Households in each neighborhood were then randomly sampled without replacement to avoid repeated measurements. Heads of households who were older than 18 years were invited to participate.

In total, 855 people were approached for the data collection. Since the survey covered both the migrant and the non-migrant population, non-migrants were removed from analysis using the criteria of "birthplace." This allowed us to include those migrants who had successfully transferred their hukous to Shenzhen. This resulted in 591 participants (i.e., migrants). Due to missing data on the migration trajectory, 57 were excluded, which resulted in a final sample of 534 migrants.

#### 3.3.2 Data

Data on migration trajectories were collected by asking people to report the name of each place they had lived in for more than six months, starting with their birthplace and ending with Shenzhen, as well as the start and the end year of their stay in each place.

Respondents were also asked to indicate why they had migrated, namely to pursue education, to find a new job, transfer of workplace, family reasons (e.g., moving with family or family reunion), to marry, or other reasons. These life course-based migration reasons are grounded in previous studies (Clark & Maas, 2015; Heckhausen et al., 2010). To minimize recall bias, we limited the number of retrospective questions. In the analyses, we considered such data as the year of migration, main motivation, and destination, which can be validated by relevant documents (e.g., job offers, hukou transfer documents, and travel tickets). The information acquired was transformed into sequential data, whereby a letter was assigned to birthplace and each migratory motivation (i.e., b=birthplace, e=education, n=new jobs, t=transfer of workplace, f=family reasons, m=marriage, and o=other reasons). Sequences were recorded on an annual basis. The frequency of migration derived from this data also served as another key factor for this analysis.

Data on people's mental health status were collected through the General Health Questionnaire (GHQ-12), which contains 12 items measuring potential mental health problems. It is a self-administered screener that is used to identify the psychological distress experienced by an individual within the previous four weeks. The GHQ-12 is brief, easy to administer, and has shown good validity and reliability (Baksheev et al., 2011; Gouveia et al., 2010; Politi et al., 1994). The well-tested Chinese version (Ye, 2009) was utilized based on the purpose of this research. The total score is obtained by summing up the individual item scores, which range from 0 (=low risk of mental health problem) to 12 (=high risk of mental health problem). Subsequently, a binary scoring method was used for case identification, whereby 0 refers to an absence of mental health problems and 1 refers to possible mental health deficits (Goldberg et al., 1997). Since the threshold of the GHQ-12 varies across studies, the mean GHQ score for the respondents has been suggested as the appropriate cut-off point (Goldberg et al., 1998). In our case, the 534 participants had a GHQ-12 mean score of 2.01 (SD=2.14), which resulted in a cut-off point between two and three. A value  $\leq 2$  means that it is unlikely that a person faces mental health problems, while a value  $\geq 3$  indicates a high likelihood of mental health problems.

The following control variables were considered. Age and gender, which are closely related to migration decisions and individuals' health status (Gong et al., 2011; Takeuchi et al., 2007). Education level, occupational type, and personal monthly income (in RMB) were also included. Respondents' current hukou type served as an institutional factor for migrants in China (Chen, 2011). Data on people's general physical health were obtained from a self-rated question on a Likert scale of 1 (=poor) to 5 (=excellent) (Emerson and Llewellyn, 2008; Lu and Qin, 2014).

### 3.3.3 Data analysis

The analysis was carried out in two stages. First, SAM was conducted to analyze the sequential data on migration trajectories and to compute typology groups for the sequences. Briefly, SAM groups sequences that are similar to each other. This is done by utilizing three basic operations: insertion, deletion, and substitution (Shoval et al., 2015). SAM compares two strings of sequences and makes the two strings identical by adding or deleting characters and/or switching the order of certain characters. The idea is to count how many operations it takes to make one string of sequences identical to another string: The more operations needed, the larger the distance between the two sequences, and vice versa (Wilson et al., 1999). This operation of comparing two sequences ("pairwise alignment") is the basis for the algorithm of multiple alignments that compares more than three sequences. The multiple alignment process comprises four phases. In phase 1, pairwise alignment for all data sequences is conducted, which produces a sequence distance matrix. In phase 2, a dendrogram showing the similarity between sequences is constructed based on a neighbor-joining method. The dendrogram is used for the progressive multiple alignment of the sequences into groups in phase 3. Finally, information about the groups of the sequences is extracted, as in phase 2 (Aiyar, 2000; Higgins & Sharp, 1988; Thompson et al., 1997). The Clustal software package was utilized for sequence alignment (Higgins and Sharp, 1988).

Second, to explain associations between our binary outcome good/bad mental health and the migration sequences, we fitted logit regression models with increasing complexity. Model 1 examined the relationship between migration trajectory groups and migration frequency with prevalence of mental health problems. Model 2 tested the same relationship while also controlling for sociodemographic characteristics and physical health. Model 3 added to model 2 an extra interaction effect between migration trajectory and migration frequency. By doing so, it helps to understand the relationship between migration frequency and mental health across different migration trajectory groups.

### 3.4 Results

The descriptive statistics of the respondents are shown in Table 3.1. The prevalence of mental health problems (GHQ-12 score  $\geq 3$ ) was 26.8% for the sample using the cut-off point of 2/3. The gender ratio of our sample was 56% male and 44% female, which is close to the gender ratio of Shenzhen's general population in 2016 (53% male and 47% female). The mean age of our sample was 31.63 years, while it was 32.5 years for Shenzhen's general population in 2016 (Shenzhen Municipal Bureau of Statistics, 2018).

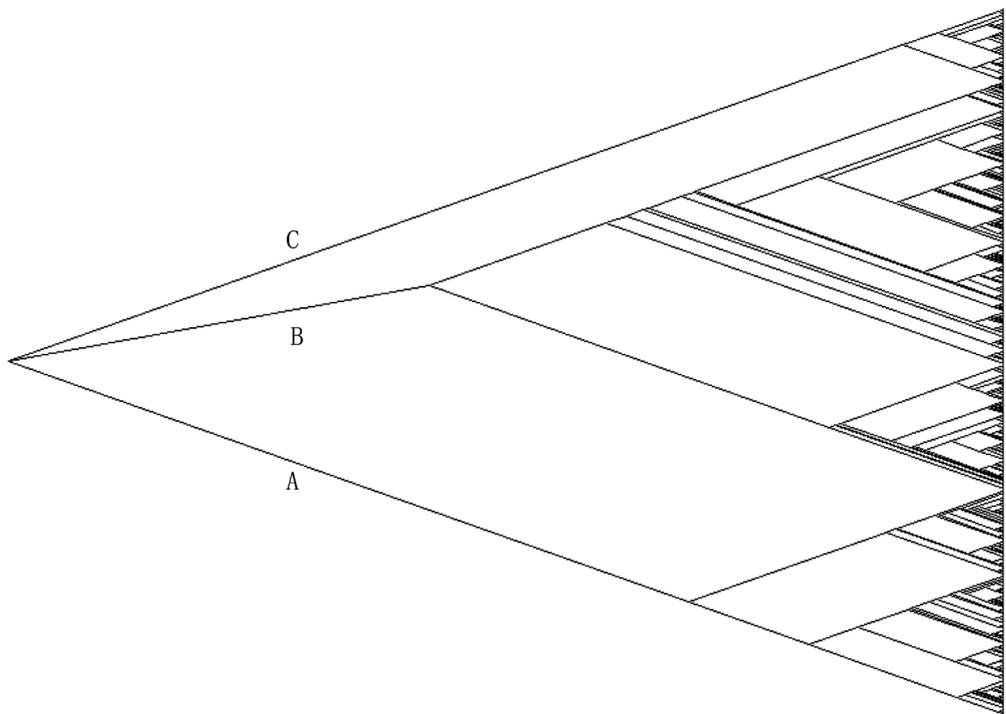
The typical migrant had moved more than once over the life course. Most respondents had a university education and a personal monthly income of RMB 4001 – 8000 or higher. One-third of the respondents had managed to transfer their hukous after migrating to Shenzhen; the rest still held non-Shenzhen hukous. The GHQ-12 showed that more than 73% of the respondents had relatively good mental health, and most respondents (46%) self-rated their physical health as poor or fair.

The alignment of all sequences resulted in a dendrogram that divided the samples into eight groups according to the order and length of stay in each place for different migration reasons (Figure 3.1). Three major groups (A, B, and C) were identified from the taxonomic tree. Subgroups were divided based on the first-level nodes in each major group. Group B2 is the result of a merger of multiple small groups, since each group aligned only a small number of cases and the distance between the nodes is relatively small. In addition, Table 3.2 shows descriptive statistics for each trajectory group. The majority of migrants (41%) are allocated to group B3, while the remaining sample is spread across the other groups, with percentage values ranging from 4 to 15. The average migration frequency varied from 1.69 for group C2 to 2.53 for group C1. This result suggests that many of our respondents had had multiple migration experiences, which has not been reported by previous studies. Although the sample distribution is uneven across the trajectory groups, the Hosmer-Lemeshow test result indicates a good model fit to the data ( $p > 0.05$ ).

**Table 3.1** Profile of respondents

Variable	Category	Whole sample/ Mean	Percentage/ (SD)
<b>Prevalence of mental health problems</b> (GHQ-12 score $\geq$ 3)	Low risk	391	73.2%
	High risk	143	26.8%
<b>Migration frequency</b>		2.28	0.84
<b>Age</b> (in years)		31.63	7.73
<b>Gender</b>	Male	297	56%
	Female	237	44%
<b>Education level</b>	High school and lower	154	29%
	Bachelor's degree	346	65%
	Postgraduate	34	6%
<b>Hukou type</b>	Shenzhen hukou	169	32%
	Non-Shenzhen hukou	365	68%
<b>Personal monthly income</b>	< RMB 4000	112	21%
	RMB 4001 – 8000	233	44%
	>RMB 8000	189	35%
<b>Occupation type</b>	Public sector	46	9%
	Private enterprise	215	40%
	Self-owned business	39	7%
	Blue-collar worker	100	19%
	Unemployed and other	134	25%
<b>Physical health</b>	Poor and fair	244	46%
	Good	157	29%
	Very good	91	17%
	Excellent	42	8%

Figure 3.2 summarizes the taxonomy of migration trajectory groups. It shows the average duration of stay in each place triggered by life course events, starting from birthplace. The segments of the diagram's bars are assigned letters representing birthplace and migratory motivation. Group C2 had the longest mean length of stay in their birthplaces compared to other groups. Therefore, group C2 was labeled "Old movers," as they had left their birthplaces at a relatively older age. Group C1 was labeled "Marriage movers," since the people in the group had migrated to get married. Group B shows a typical trajectory of labor migrants with adequate training and education. People allocated to group B1 had lived for a relatively short period near their first workplace and had then moved because of job transfer; this group was therefore labeled "Job transfers". In contrast, people in group B3 were more likely to have held on to their first jobs, and so this group was labeled "New job." Group B2 had a similar average composition of migration for new job and job transfer, as shown in Figure 3.2. We labeled this group "Work-related" movers. Migrants in group A had lived for a



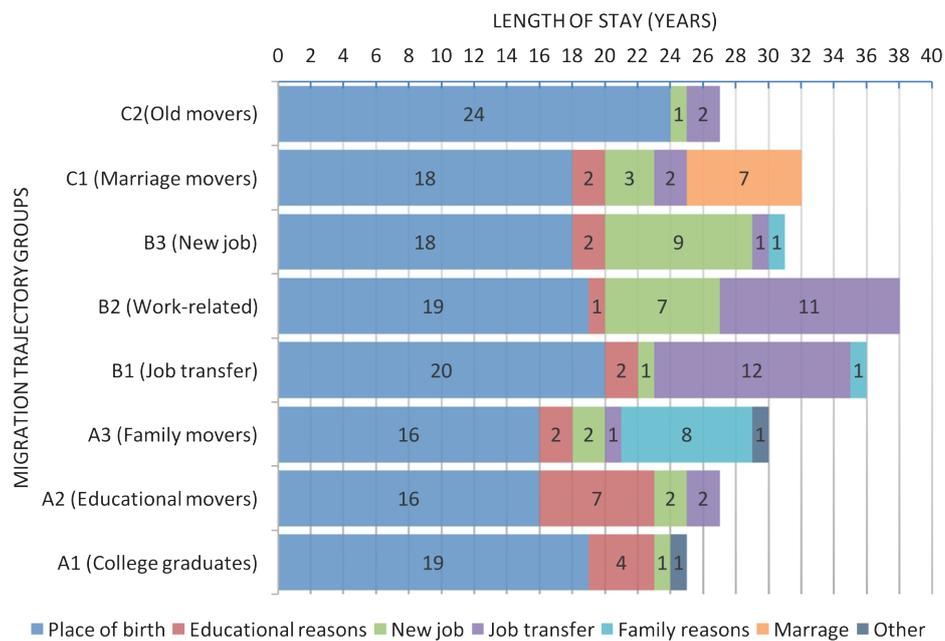
**Figure 3.1** Dendrogram showing types of migration trajectories

**Table 3.2** Sample distribution and average migration frequency over groups of migration trajectories

Groups of migration trajectories	Sample distribution		Migration frequency	
	Count	Percentage	Mean (times of migration trips)	
<b>C2</b>	36	7%	1.69	
<b>C1</b>	19	4%	2.53	
<b>B3</b>	218	41%	2.33	
<b>B2</b>	26	5%	2.42	
<b>B1</b>	67	13%	2.15	
<b>A3</b>	64	12%	2.27	
<b>A2</b>	78	15%	2.41	
<b>A1</b>	26	5%	2.31	

relatively short period in their birthplaces. This applies especially to groups A2 and A3, meaning that they migrated at a younger age compared to other groups. In addition, as indicated by the lengths of the bars, group A comprised relatively younger people compared to the other groups. Group A1 shows a standard pattern of a fresh university graduate who left home to attend university

at the age of 18 or 19, graduated four years later, and found a job somewhere else. This group (A1) was labeled “College graduates.” Group A2 was labeled “Educational movers,” as they spent longer than average in the place they had migrated to for educational purposes. Finally, based on the composition of the trajectory, group A3 was labeled “Family movers.” The migration trajectory groups were then included in a regression analysis to test group differences in mental health.



3

**Figure 3.2** Patterns of migration trajectories in divided groups

Table 3.3 presents the results of the binary logistic regression models. Nagelkerke’s  $R^2$  for the model fit improved from 0.464 in model 1 to 0.577 in model 3. This indicates that the migration trajectory plays a role in explaining migrant’s mental health. In model 1, group C2 (Old movers) had a higher risk of mental health problems compared to group A1 (College graduates). Groups B3 (New job), B1 (Job transfer), A3 (Family movers), and A2 (Educational movers) were less likely to have mental health problems than group A1 (College graduates). The relationships remained significant for group C2 (Old movers) and A2 (Educational movers) after controlling for sociodemographic characteristics and physical health, and the interaction effect between migration trajectory groups and migration frequency. No significant correlations were found for migration frequency and the prevalence of mental health problems.

**Table 3.3** Binary logistic regression on migration trajectory groups and prevalence of mental health problems

	Model 1		Model 2		Model 3	
	Coef.	Stand. Err.	Coef.	Stand. Err.	Coef.	Stand. Err.
<b>Migration trajectory groups</b> (Reference: A1)						
C2 (Old movers)	3.733**	1.031	4.804**	1.115	6.769*	3.214
C1 (Marriage movers)	0.368	0.534	1.389	0.727	1.122	1.858
B3 (New job)	-1.254**	0.3	-0.552	0.494	0.352	0.924
B2 (Work-related)	0.097	0.471	0.652	0.666	3.433	2.383
B1 (Job transfer)	-1.202**	0.384	-0.449	0.574	-3.964*	1.712
A3 (Family movers)	-1.135**	0.391	-0.26	0.538	-0.201	1.137
A2 (Educational movers)	-1.456**	0.404	-1.156*	0.530	-2.921*	1.385
<b>Migration frequency</b>	-0.104	0.107	0.09	0.144	0.167	0.366
<b>Gender</b> (reference: female)			0.073	0.246	0.103	0.255
<b>Age</b>			-0.009	0.016	-0.016	0.019
<b>Education level</b> (Reference: High school and lower)						
Bachelor's degree		0.131	0.303	0.117	0.324	
Postgraduate		0.329	0.548	0.318	0.583	
<b>Hukou type</b> (Reference: Shenzhen hukou)						
Non-Shenzhen hukou		-0.608*	0.276	-0.644*	0.303	
<b>Personal monthly income</b> (Reference: < RMB 4000)						
RMB 4001 – 8000		0.487	0.354	0.545	0.367	
> RMB 8000		0.327	0.418	0.388	0.428	
<b>Occupation type</b> (Reference: Public sector)						
Private enterprise		-0.089	0.402	-0.140	0.434	
Self-owned business		-0.095	0.554	0.079	0.581	
Blue-collar worker		-0.014	0.453	0.016	0.488	
Unemployed and other		-1.155*	0.485	-1.228*	0.509	
<b>General health</b> (Reference: Poor and fair)						
Good			-1.383**	0.308	-1.296**	0.315
Very good			-1.635**	0.408	-1.625**	0.424
Excellent			-0.938	0.481	-0.905	0.486
<b>Migration groups * Migration frequency</b>						
C2 * Migration frequency					-1.070	1.529
C1 * Migration frequency					0.129	0.719
B3 * Migration frequency					-0.403	0.408
B2 * Migration frequency					-1.136	0.982
B1 * Migration frequency					1.508*	0.699
A3 * Migration frequency					-0.035	0.495
A2 * Migration frequency					0.697	0.555
<b>Nagelkerke R<sup>2</sup></b>	0.464		0.555		0.577	

\*\*=0.05 significance level; \*\*\*=0.01 significance level

Apart from migration trajectory and frequency, hukou status was significantly related to the prevalence of mental health problems: Non-Shenzhen hukou holders were less likely to have mental health problems than those who had Shenzhen hukous. Occupation types were associated with mental health: The “Unemployed and other” group were found less likely to have mental health problems compared to people who worked in the public sector. Good physical health was found to be negatively associated with the prevalence of mental health problems. Finally, the interaction effect between the migration trajectory group B1 (Job transfer) and migration frequency showed a significant positive association with the prevalence of mental health problems.

### 3.5 Discussion

The present research investigated migrants’ mental health in relation to their migration trajectories. It contributes to the mental health literature as previous studies often disregarded migration histories over people’s life courses (Li et al., 2014).

Multiple migration trips were generally confirmed through our descriptive analyses. Instead of considering migration as “departure and arrival,” people migrated to a number of places before reaching the final destination. Our SAM results show that distinguishing migration trajectories is important to understand migrants’ mental health. Life course events – such as starting vocational training or a university study, starting or changing jobs, and household formation in terms of cohabitation or marriage were – found to trigger the decision to migrate (Wingens et al., 2011). Analyzing migration trajectories triggered by these events provides an opportunity to link migration to people’s life course development, and thus to better interpret the occurrence of each migration. For instance, “educational migration” is widely combined with “job migration” (Collyer and De Haas, 2012). We incorporated the sequence of transitions (migration) to reveal the actual trajectories of each migrant’s experiences. In line with Schwarz (2018)’s idea of a trajectory approach, the differences in mental health performance between migration trajectory groups were identified from our results.

Our investigation into migrants’ mental health across different groups of migration trajectories addressed the missing component of “trajectory” in existing migration studies by sequencing movements through people’s life courses. The regression analysis shows that group C2 (Old movers) were more likely to have mental health problems than group A1 (College graduates), while group B1 (Job transfer) and group A2 (Educational movers) had better mental health than group A1 (College graduates) after adjusting for control variables. A possible explanation for the poor mental health of people in group C2 (Old movers) is the age at migration: Migrating at an older age may be associated with more costs, including the loss of existing social networks and of certain physical or economic resources (Zhao, 2003), which is negatively related to mental health. Others found that poor health performance was related to an increased age at migration (Leão et al., 2009). In addition, some studies reported better initial health among younger migrants than among older ones, which could

affect their mental health performance in later life (Chen, 2011; Qiu et al., 2011). The compositions of each migration trajectory group may reflect their socioeconomic status and other health-related factors. According to the accumulation model from life course epidemiology, the initial advantages or disadvantages of each migrant may determine his or her migration trajectory later in life (Burton-Jeangros et al., 2015).

Our findings also suggest that hukou status is significantly associated with mental health status: Non-Shenzhen hukou holders were less likely to have mental health problems compared to those who held Shenzhen hukous. This finding seems to contradict previous studies (Wong et al., 2008; Cheung, 2013). During the fieldwork, a relatively low interest in transferring hukou to Shenzhen among skilled migrants and intra-provincial migrants was observed, since they were able to utilize social resources provided by their employers and the provincial administration. For this group of migrants, a local hukou may not be as important as it is for other groups of migrants. For instance, some highly skilled migrants were provided with high-quality accommodation by their employers. In addition, urban life in China has been found to be stressful and challenging for residents' physical and mental health (Li et al., 2007). Our sample contained both rural-urban and urban-urban migrants. Since hukou migrants tend to originate in urban areas and most non-hukou migrants were born and raised in rural areas (Chan et al., 1999), their initial health status may differ because of their original living environment. Despite the results and possible explanations, hukou still serves an important role in analyzing migration and mental health in urban China, since it is broadly acknowledged as the key institutional factor determining migrants' health in an urban setting (Chen, 2011; Liu, Dijst, and Geertman, 2015; Tao et al., 2015). Although multiple migration trips were generally observed, they were insignificantly related to migrant's mental health problems in our multivariate models. This result may be explained by minor differences in the mean migration frequency across the migration trajectory groups.

Several limitations should be considered when interpreting the results. First, although our data reconstruct the migration trajectories of people, we did not have longitudinal measurements of respondents' mental health. Therefore, due to the cross-sectional nature of this study, we cannot make statements about causalities. Second, we emphasized the "when" and "why" of migration in our research and did not address the "where," due to the limited sample size. Adding spatial characteristics to the analysis will certainly contribute to a better understanding of migration trajectories in relation to geographical attributes. Third, measures of environmental exposures during each stage of migration were not included in this research, since our respondents' migration trajectories covered the whole of China, and a retrospective environmental assessment based on people's memories has been reported to be inaccurate, potentially inducing a measurement bias (Findlay & Li, 1999). This problem may also apply to our retrospective data on migration history, despite the efforts we made to restrict the recall errors by focusing on the occurrence of migration only. We suggest that future research should address these limitations by conducting longitudinal research using indicators that describe both pre- and post-environmental exposures and incorporate geographical analysis.

Several strengths also need to be highlighted. First, this research represents an initial effort to break migration down into individual sequences of movement. We utilized SAM to align similar migration trajectories into trajectory groups, something that has rarely been done. Second, our research bridges the life course and migration literature by acknowledging the importance of migration trajectories formed by the sequence of movements. Our finding on multiple migration experiences among internal migrants in China calls for attention in migration studies to such multiple experiences, an aspect that has so far been overlooked by scholars. Third, as we aligned different migration trajectory groups, different mental health performances across trajectory groups were explored for the first time.

### 3.6 Conclusions

Migration trajectories play a significant role in understanding migrants' mental health. In contrast to other studies, this paper provides evidence that migration, which is usually treated as a one point in time life course transition, should be seen as a trajectory involving sequential changes over time. This is particularly essential when multiple migration trips are considered. We showed through sequence analysis coupled with regressions that different migration trajectories are correlated with different mental health outcomes. People who had migrated due to job transfer or for educational purposes had better mental health than those who had stayed longer in their birthplaces and had migrated fewer times for work purposes. We suggest that scholars should pay more attention to migration trajectories formed by multiple migration journeys.

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Chapter

# 4

Using structural equation modeling to examine pathways between perceived residential green space and mental health among internal migrants in China

This chapter is based on the article: Yang, M., Dijst, M., Faber, J., & Helbich, M. (2020). 'Using structural equation modeling to examine pathways between perceived residential green space and mental health among internal migrants in China', *Environmental Research*. 183(January), p. 109121. doi: 10.1016/j.envres.2020.109121.

## Abstract

**Background:** Emerging evidence suggests that exposure to residential green space is beneficial for people's mental health along multiple pathways. It remains unknown, however, whether the complex pathways found for the general population also apply to internal migrants in China.

**Aim:** To examine the mediators of green space – mental health associations among migrants in the metropolis of Shenzhen, China.

**Methods:** We conducted a cross-sectional survey among 591 migrants aged between 18 and 68 years in January – April 2017 in Shenzhen, a city facing a considerable inflow of rural-urban migration. Migrants' mental health was assessed using the 12-item General Health Questionnaire (GHQ). Data on migrant's green space perception, migration characteristics, environmental disturbances, social cohesion, physical health, etc. were obtained through a questionnaire. Structural equation modeling (SEM) was used to analyze the mechanisms underlying the green space – mental health association.

**Results:** No direct effect of perceived green space on migrants' mental health was found. We did find, however, that perceived green space is significantly and indirectly related to mental health through reducing perceived environmental disturbance and enhancing social cohesion. Migrants' residential mobility presented a significant potential risk to migrants' physical health and might influence their mental health indirectly. A similar but only weakly significant health-threatening effect was found for migration frequency. Male and female respondents showed different patterns regarding their physical and mental health status. Migrants with higher personal incomes seemed to face a lower mental health risk.

**Conclusions:** Our findings suggest distinctive pathways through which residential green space could affect the mental health of internal migrants in China. Further studies in rapidly urbanizing areas are advised to evaluate green space – mental health relationships for specific population groups/subgroups with distinctive socioeconomic backgrounds.

*Keywords: Perceived green space; mental health; mediation; internal migrants; structural equation model*

## 4.1 Introduction

Mental diseases are a major public health issue in China (Mental Health Foundation, 2017) and make a significant contribution to the burden of disease (Vos et al., 2015). Migrants are particularly vulnerable to mental health problems because of their experience of leaving their hometowns, their relatively disadvantaged socioeconomic position in host places, the stress of acculturation, and social exclusion within host societies (Gong et al., 2011; Liu et al., 2015; Sirin et al., 2012; Yang et al., 2019). In 2015, more than 277 million internal migrants left their hometowns to live and work in urban areas, making migrants' mental health a particular concern in China (Yang et al., 2018).

Multiple studies suggest that residential outdoor green space is beneficial for people's mental health (Bratman et al., 2019; Nath et al., 2018; Tsai et al., 2018; van den Bosch and Ode Sang, 2017); however, evidence on the mechanisms between green space and mental health among migrants in general, and those in China in particular, are largely lacking (Helbich et al., 2019). It is also unclear whether findings from Western countries can be transferred to the Chinese context, and whether residential green space supports migrants' mental health in the way that it does for the general population. In addition, green space – mental health studies rarely consider multiple mediators simultaneously (Dzhambov et al., 2018a). Consequently, conflicting mediation effects have been reported across studies that used single mediator models (Dadvand et al., 2016; Dzhambov et al., 2018a; Krellenberg et al., 2014). Structural equation modeling (SEM), which is rarely used in green space research, may serve as an alternative, capturing multiple regression equations simultaneously (Hair et al., 2014).

The present research addressed these research gaps by examining residential green space – mental health pathways for internal migrants in China, accounting for multiple mediators by means of SEM. Our research questions were:

- *How is the perceived residential green space associated with the mental health of Chinese internal migrants?*
- *How does perceived residential green space affect internal migrants' mental health directly and indirectly through multiple mediators?*

This paper is structured as follows. Section 2 discusses the literature and introduces our theoretical framework. Section 3 introduces the research design, data, and methods. Section 4 summarizes the key results. Section 5 discusses our findings in the context of existing studies, and Section 6 presents some conclusions.

## 4.2 Conceptual framework

### 4.2.1 Green space – mental health pathways

Green space – mental health relationships have been widely studied (van den Bosch and Ode Sang, 2017) and various pathways have been suggested (Hartig et al., 2014). First, green space can reduce the disturbance caused by harmful exposures in urban environments such as air pollution and noise, both of which are posited to damage people's mental health (Dimitrova and Dzhambov, 2016; Dzhambov et al., 2018c; Wang et al., 2019). It is also posited that green space absorbs traffic-related air pollution (Su et al., 2011), while neighborhood green space could buffer the annoyance caused by traffic noise from busy roads (Van Renterghem and Botteldooren, 2016). Another study found that larger amounts of perceived residential green space could reduce the level of annoyance from air pollution and noise (Dzhambov et al., 2018b). Second, green space could enhance neighborhood social cohesion, which is considered to be protective against mental health problems (Akpinar, 2016; Gascon et al., 2018, 2015). Empirical studies have shown that green space enhances social cohesion by encouraging social interactions and leading to the development of social contacts during the active usage of green space (Hartig et al., 2014). Following the positive association between green space and social cohesion, the mediatory role of social cohesion between green space and mental health was verified across multiple studies (Ruijsbroek et al., 2017; van den Berg et al., 2017). For instance, a study (Sugiyama et al., 2008) found that social cohesion mediated the association between perceived green space and mental health. Apart from the single-mediator paths identified in earlier green space – mental health studies, some studies suggested serial indirect pathways where the relationship between mediators might be intertwined. Annoyance caused by traffic-related air pollution and noise was found to be negatively associated with neighborhood restorative quality (von Lindern et al., 2016), which may have impacts on residents' mental health. Others (Dzhambov et al., 2018b) presented serial pathways from green space and mental health where the indirect effect of perceived green space was connected to mental health through social cohesion, via perceived environmental annoyance from air pollution and noise.

However, the results concerning these mediatory pathways are partly contradictory. For instance, not all studies observed the mediating effect of social cohesion for green space – mental health association (Triguero-Mas et al., 2015). A possible reason for such inconsistent results is that factors such as frequency and duration of exposure when trying to address the association were not taken into consideration (Markevych et al., 2017). The actual frequency of use determines the extent to which the individual receives such benefits from green space (Krellenberg et al., 2014). In addition, the health benefits received from green space may vary according to the duration of a person's engagement with the natural environment (Musterd et al., 2012). In other words, more frequent visits to green space may lead to greater benefits being received from green space. Meanwhile, short-term exposure to green space may have different mental health effects compared to long-term exposure. Elsewhere (Dadvand et al., 2018) it was found that adolescents who spent more time in green space, reported a higher level of self-satisfaction. Similarly, longer visits to green space were associated with lower rates of depression, and more frequent visits to green space

were associated with improved social cohesion (Shanahan et al., 2016). Despite this evidence on the importance of the frequency and duration of exposure to green space (Silva et al., 2018), it remains unclear how these temporal factors are linked to mental health through mediators such as environmental disturbance and social cohesion.

Finally, benefits have been found for both mental and physical health (Gascon et al., 2016; Triguero-Mas et al., 2015; Twohig-Bennett and Jones, 2018). Physical and mental health are closely related: Better physical health seems to be correlated with better mental health (Dadvand et al., 2016). However, most studies only examined the health effect of green space on physical or mental health independently (Zhang et al., 2018), neglecting the fact that the physical and mental health outcomes from green space exposure could interact with each other.

#### **4.2.2 Migrants – green space – mental health pathways**

Although not yet examined, the green space – mental health correlations may be different for migrants than for the general population. Migrants from rural or urban areas may directly influence their mental health and affect their green space experience in host cities. In China, most migrants are rural-urban migrants driven by job opportunities and higher wages in cities (Chan, 2013). Some studies observed the “healthy migrants phenomenon”; that is, migrants from rural areas reported a better health status than urban non-migrants (Chen, 2011; Lu and Qin, 2014). However, the health advantage for rural migrants may decline the longer they stay in host cities, due to accumulated stress from social integration, poor housing quality, and limited access to health care (Chen, 2011; Kearns et al., 2017). In addition, considering the pronounced differences between urban and rural settings – including the quantity, quality, and accessibility of green space – rural migrants are forced to adapt to a new environment and re-engage with new types of green space, unlike urban migrants.

It is yet unknown whether migrants’ place of origin plays a role in understanding the green space – mental health relationship, despite its potential effect on green space perception and mental health outcomes. Another distinctive characteristic of migrants is their high level of mobility. Mobility health studies have shown that higher levels of residential mobility are associated with poor mental health and wellbeing (Oishi, 2010). By definition, being a migrant means that one has moved from one place to another. Mental health studies on migrants suggest that stressors caused by migration, including social exclusion and broken social connections, challenge migrants’ mental health in host cities (Li and Rose, 2017; Mao and Zhao, 2012). In addition, migrants also experience several residential moves after they settle in host cities. Studies have reported that migrants experience higher levels of residential mobility compared to locals, due to their lower starting points in local housing markets, and having less social and financial resources in host cities (Cui et al., 2015; Huang et al., 2017; Sun and Fan, 2011; Wang et al., 2010). However, no knowledge has been acquired concerning the effect of residential mobility on neighborhood green space exposure, and thus on mental health outcomes.

### 4.2.3 Conceptual model

We developed the conceptual model shown in Figure 4.1 based on the theoretical foundation of green space – migration – mental health relationships. The perceived green space exposure was measured from three dimensions: the perceived level of greenness in a neighborhood, the visit frequency to green space, and the duration of exposure to green space. We included multiple mediating pathways for the green space – mental health relationship and hypothesized that the beneficial effect of green space – including reducing environmental disturbance and enhancing social cohesion – may reduce the risk of mental health problems. In addition, we specified the green space – mental health pathways for migrants by incorporating migration characteristic (i.e., place of origin, residential mobility in host city, and migration frequency). The hypotheses were tested adjusting for numerous sociodemographic attributes (Lee and Maheswaran, 2011; Markevych et al., 2017). Finally, a reciprocal association was built between physical health and mental health to indicate their close interrelationship.

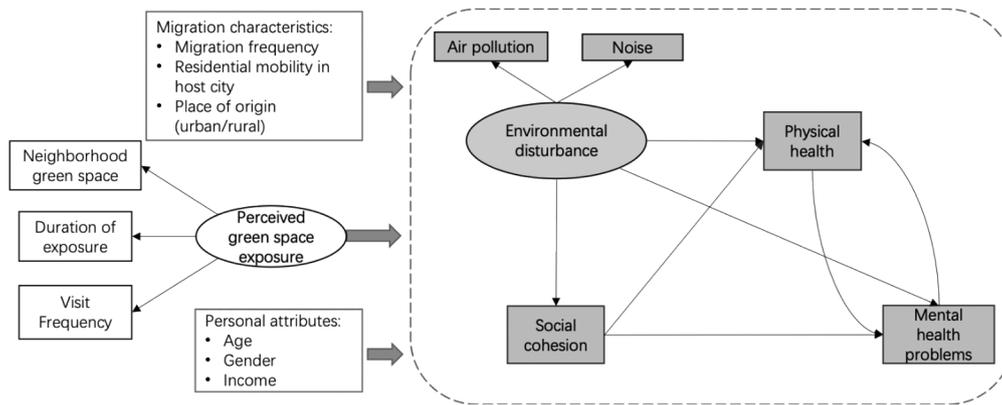


Figure 4.1 Conceptual model of green space–mental health pathways for migrants

## 4.3 Material and methods

### 4.3.1 Study area

Our study area was the megacity of Shenzhen, China. Known as a city of migrants, Shenzhen has a population of 11.37 million people, of whom 7.83 million do not hold a local hukou (i.e., the Chinese household registration system) (Yang et al., 2018). Thus, about 70% of Shenzhen’s population is considered “migrants”. Rapid urbanization has resulted not only in a growing number of urban migrants but also in challenges to the natural environment (i.e., green space). The high migration in-flow combined with the rapid urbanization made Shenzhen an ideal case to explore green space – migration – mental health correlations.

### 4.3.2 Research design and study population

This cross-sectional study was based on a mental health survey conducted in Shenzhen between January and April 2017. Shenzhen has a subtropical climate with sufficient sunshine and rainfall all year round. The temperature during January is between 12°C and 20°C and during April between 20°C and 26°C. Therefore, the weather condition plays only a small role in affecting people's green space perceptions. The participation eligibility criteria were that people were at least 18 years old and had lived in Shenzhen for more than 6 months (the latter criterion is used by the Chinese census department to define residents of the community (Johnson, 2003).

Multi-stage sampling design was applied. First, the respondents were sampled from Shenzhen's four administrative districts, namely two inner-city districts (Nanshan and Futian) and two suburban districts (Longgang and Baoan). Five types of neighborhoods with different functional uses – viz. work unit compound, inner-city village, commodity housing community (a private real estate development), social housing, and factory dormitory – were then identified in each administrative district based on differences in the neighborhoods' built environment and location, and the socioeconomic composition of their residents. Inner-city village, social housing, and factory dormitory areas were considered to have a poor neighborhood environment with a low amount of green space (Wu, 2016), whereas commodity housing and work unit compound areas have more green space (Gálvez and Cheshmehzangi, 2015). Finally, households were randomly sampled within the selected neighborhoods and the household heads were invited to complete a questionnaire.

We collected 855 completed questionnaires. The response rate was 7%. We excluded those completed by non-migrants (i.e., people born in Shenzhen, N=264) based on their birthplace. This enabled us to include migrants who had managed to transfer their hukous to Shenzhen after their arrival. This resulted in a final sample comprising 591 migrants. The study received approval from the Ethics Review Board of Utrecht University (FETC17-132-Helbich-Yang-Geo) and consent was obtained from all subjects.

### 4.3.3 Data

#### *Mental health outcome*

Migrant's mental health was assessed using the well-tested Chinese version (Ye, 2009) of the General Health Questionnaire (GHQ) (Goldberg et al., 1998). The GHQ-12 is a psychometric screener of 12-items dealing with people's emotions and daily functioning, such as self-confidence and losing sleep, their psychiatric condition (i.e., depression, anxiety), etc. The reliability of this instrument has been proven (Goldberg et al., 1997; Molina et al., 2006; Wan and Martin, 2006) and it has been widely used in other studies (e.g., (Dadvand et al., 2016; Dzhambov et al., 2018b; Gascon et al., 2015)). To assess whether a person is likely to suffer from mental problems, we employed the total GHQ-12 score as a continuous outcome by summing up the individual item scores. Values ranged between 0 (=lower severity of symptoms) and 12 (=higher severity of symptoms).

***Green space and mediators***

Information about the perceived amount of green space within the residential neighborhood was obtained through the questionnaire. We asked the respondents to evaluate the greenness of their neighborhoods by rating their opinions about the statement “There is sufficient green space (e.g., trees/plants) in my current residential neighborhood” on a 5-point Likert scale (1=strongly disagree; 5=strongly agree).

As suggested elsewhere (Markevych et al., 2017), the following mediators were operationalized. The level of perceived air quality and that of noise were assessed by the following statement: “I have good air quality in my current neighborhood” and “My current neighborhood is free from noise,” with answers ranging from 1 (=strongly disagree) to 5 (=strongly agree). The scores were then reverse-coded where higher scores indicated higher levels of perceived environmental problems. Cronbach’s alpha for the factor “environmental disturbance” composed by perceived air pollution and noise level was 0.830. Similar 5-point Likert scales were used to assess the frequency of visits to green space, and neighborhood social cohesion. Visit frequency was captured by the statement “I visit the green space in my neighborhood frequently” and social cohesion was captured by the statement “People in my neighborhood can be trusted.” Higher scores indicated more frequent visits to green space and better neighborhood social cohesion. The duration of exposure to neighborhood environments was measured through years of residence in the neighborhood (Sobngwi et al., 2004). Following others (Emerson and Llewellyn, 2008; Lu and Qin, 2014), self-rated physical health was also incorporated (1=poor, 5=excellent).

***Migration characteristics***

To assess people’s migration experiences, we asked whether the migrants originally came from an urban or a rural area, since previous environmental experiences may affect migrants’ initial mental health status, and how they cope with and adapt to the post-migration process (Gong et al., 2012; Peen et al., 2010). Information about migration frequency was obtained by asking how many times they had migrated. Data on respondents’ residential mobilities within Shenzhen were assessed on the basis of how many times respondents had relocated since their arrival in Shenzhen.

***Sociodemographic control variables***

We controlled for three sociodemographic attributes at the individual level (Lee and Maheswaran, 2011; Markevych et al., 2017): people’s age (in years), gender (0=female, 1=male), and personal monthly income (RMB/month).

**Table 4.1** Summary statistics of the study population (N=591)

Variable	Category	Mean (SD)	Percentage
<b>GHQ-12</b>		1.28 (1.44)	
<b>Physical health</b>	Poor or fair		35.03%
	Good		30.63%
	Very good		21.83%
	Excellent		12.52%
<b>Age (years)</b>		31.37 (7.91)	
<b>Gender</b>	Female		43.99%
	Male		56.01%
<b>Personal income (RMB/month)</b>	≤ 3000		23.01%
	3001 – 6000		35.19%
	6001 – 9000		20.47%
	> 9000		21.32%
<b>Times of migration</b>		3.66 (1.57)	
<b>Residential mobility in Shenzhen</b>		1.86 (1.85)	
<b>Migrant's origin</b>	Rural		62.27%
	Urban		37.73%
<b>Perceived neighborhood greenness</b>	Very little green		7.30%
	Little green		14.00%
	Normal		32.30%
	Green		23.20%
	Very green		23.20%
<b>Duration of exposure (years)</b>		5.36 (4.45)	
<b>Frequency of visit</b>	Very low		6.80%
	Low		10.30%
	Normal		31.80%
	High		25.00%
	Very high		26.10%
<b>Perceived air pollution</b>	Heavy air pollution		20.10%
	Some air pollution		26.20%
	Normal		38.90%
	Little air pollution		10.20%
	No pollution at all		4.60%
<b>Perceived noise level</b>	Heavy noise		15.90%
	Some noise		22.00%
	Normal		33.20%
	Little noise		16.40%
	No noise at all		12.50%
<b>Perceived neighborhood social cohesion</b>	Very low		10.80%
	Low		16.80%
	Normal		40.60%
	High		16.60%
	Very high		15.20%

#### 4.3.4 Statistical analyses

SEM was chosen over other multivariate analysis methods because it can accommodate multiple dependent variables within one single model while accounting for mediating effects specified between interrelated dependent variables (Hair et al., 2014). In addition, it also allows the direct inclusion of latent constructs (i.e., factor analysis models) in the linear relations specified among various latent and observed constructs.

We analyzed the effects of neighborhood-based green space on the risk of mental health problems mediated by: 1) perceived environmental disturbance, which is a latent variable measured on the self-reported levels of neighborhood air pollution and neighborhood noise disturbance; 2) neighborhood social cohesion; and 3) self-rated physical health. The mental health and mediators mentioned above were the dependent variables. In accordance with Figure 4.1, the model also controlled for contextual factors, including migration and sociodemographic characteristics. As the variables in Table 4.1 are categorical variables measured on a dichotomous or ordinal scale and continuous variables measured on an interval or ratio scale, the effects specified were estimated as standardized linear regression coefficients from a Pearson correlation matrix by means of the maximum likelihood method.

Each correlation in the input matrix was estimated as a polychoric correlation between two categorical variables (Olsson, 1979), a polyserial correlation between a categorical and a continuous variable (Olsson et al., 1982), or a (standard) product – moment correlation between two continuous variables (Wonnacott and Wonnacott, 1982). The polychoric and polyserial correlations are the product – moment correlations of the standardized normally distributed latent variables underlying the observed categorical variables as their empirical expressions. Following the suggestions of others (Iacobucci, 2010), the model goodness-of-fit was assessed by the following multiple indicators: goodness of fit index (GFI > 0.95), adjusted goodness of fit index (AGFI > 0.90), comparative fit index (CFI > 0.95), root mean square error of approximation (RMSEA < 0.05), Parsimony Normed Fit Index (PNFI > 0.50), and Parsimony Goodness of Fit Index (PGFI > 0.50). Note that values given in brackets refer to a good fit.

The maximum likelihood methods to estimate the polychoric, polyserial, and product – moment correlations were programmed in PRELIS2 (Jöreskog and Sörbom, 1996). The matrix containing these correlations was used as the input matrix in LISREL8 (Jöreskog and Sörbom, 1992) in order to also estimate the standardized regression coefficients in the model by means of the maximum likelihood method.

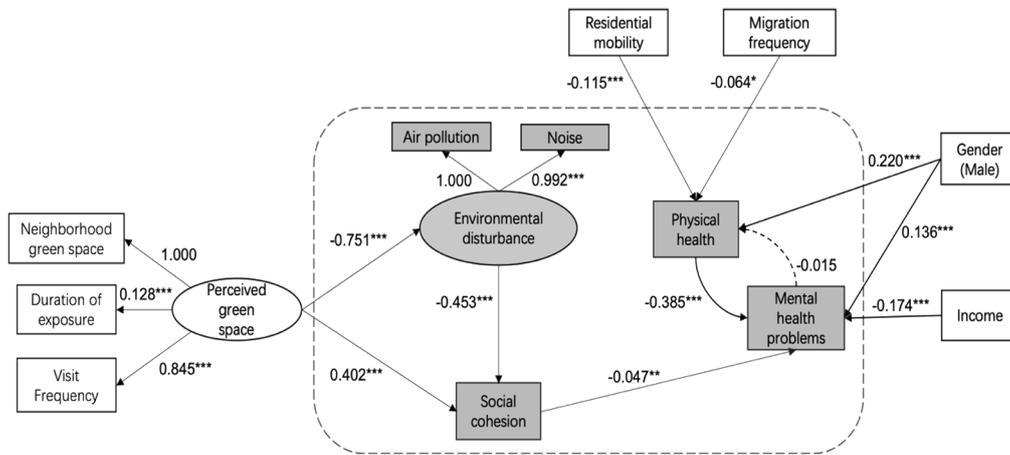
As the initial model had a relative poor fit to the data (RMSEA=0.0925, the CFI=1.000, the GFI=0.998, the AGFI=0.983) and the parsimonious fit indices suggested less favorable parsimony, (PNFI=0.132, and PGFI=0.114), several insignificant causal paths were removed from the initial model based on their t-values ( $t < 1.645$ ). Finally, marginally significant effects ( $p < 0.1$ ) are also reported but should be interpreted with caution. In total, we tested seven models (see supplementary materials).

## 4.4 Results

Table 4.1 presents the summary statistics of the study population. The average age of our sample was 31.37 years; about 44% were female. On average, the age and gender distribution of our sample was similar to Shenzhen's general population in 2016 (mean age of 32.5 years, 46.4% female). The final model in Figure 4.2 (Model 7A in the supplementary materials) shows an improved overall model fit than the initial model: RMSEA=0.0469; CFI=1.000; GFI=0.994; AGFI=0.988; PNFI = 0.626; and PGFI = 0.539. Tables 4.2 and 4.3 present the pathways from green space and other variables to mental health. We did not find a significant direct path from perceived green space exposure to mental health. However, two indirect pathways were identified from the model. First, we found a significant negative indirect effect of perceived green space on mental health via facilitating social cohesion. Second, we found the serial mediatory pathway between perceived green space and mental health via environmental disturbance and social cohesion. The total indirect effect of perceived green space on mental health was -0.035 and significant ( $p < 0.05$ ). Apart from perceived green space and the identified mediators, we found a positive direct effect from physical health to mental health. No reciprocal association between physical health and mental health were found. The effect of mental health to physical health is weak and not significant.

In addition, we found that migration characteristics also affect migrants' mental health problems indirectly through the channel of physical health. Residential mobility has a significant ( $p < 0.05$ ) indirect effect on mental health problems, mediated by physical health. A higher residential mobility level reduces people's self-rated physical health and thereby increases the risk of mental health problems. The same mediatory pathway was found between migration frequency and migrants' mental health problems, but its significance level is questionable ( $p < 0.1$ ). No effects were identified between the place of origin and migrants' level of mental health.

Finally, we investigated the effects of sociodemographic characteristics on mental health, and found that income has a direct effect on mental health: A higher income contributes to a lower level of mental health problems. Gender difference effects were also found on both mental and physical health: Males were found to be less mentally healthy than females but to have better physical health than females. This may explain the insignificant total effect of gender on mental health, as the significantly higher risk of mental health problems for males is mitigated by their significantly better physical health.



**Figure 4.2** Final SEM model describing the direct effects between variables (significance levels: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ ).

**Table 4.2** Unstandardized direct, indirect, and total effect of perceived green space on mental health

Pathways	Direct effect	Indirect effect	Total effect
Perceived green space → Social cohesion → Mental health problems	—	-0.019***	—
Perceived green space → Environmental disturbance → Social cohesion → Mental health problems	—	-0.016**	—
Perceived green space → Mental health problems	—	-0.035**	-0.035**

Significance levels: \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

**Table 4.3** Unstandardized direct, indirect, and total effect of other variables on mental health

Pathways	Direct effect	Indirect effect	Total effect
Environmental disturbance → Social cohesion → Mental health problems	—	0.022*	0.022*
Social cohesion → Mental health problems	-0.047**	—	-0.047**
Physical health → Mental health problems	-0.385***	-0.002***	-0.387***
Residential mobility → Physical health → Mental health problems	—	0.047**	0.047**
Migration frequency → Physical health → Mental health problems	—	0.025*	0.025*
Gender → Physical health → Mental health problems	—	-0.084**	—
Gender → Mental health problems	0.136***	-0.084**	0.052
Income → Mental health problems	-0.174***	—	-0.174***

Significance levels: \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

## 4.5 Discussion

### 4.5.1 Green space and mental health

In this study on Chinese internal migrants, we identified a minor indirect effect of neighborhood green space on migrants' mental health. The mediatory path contributing to this effect is through social cohesion, and a serial mediatory via environmental disturbance to social cohesion. This suggests that social cohesion is an important mediator between perceived green space and mental health for Chinese migrants, as it mediates two pathways. First, in line with our hypothesis based on previous studies (De Vries et al., 2013; Liu et al., 2019; Markevych et al., 2017), we found a positive relationship between perceived green space and social cohesion, which in turn was associated with better mental health. However, the other hypothesized mediator through environmental disturbance composed by perceived air pollution and noise level, was not found to be directly associated with mental health problems. This result is in contrast to our hypothesis and the findings of other studies (Dzhambov et al., 2018c, 2018b; von Lindern et al., 2016). Possible reasons for the null effect of environmental disturbance on mental health problems in our study could be related to the measurement of perceived air pollution and noise level we used, the specific focus on migrants, and the adjustment of other mediators that reduced the importance of environmental disturbance on mental health. Yet, we were able to identify an indirect path linking environmental disturbance to mental health problems through social cohesion. Our finding suggests that a higher level of perceived environmental disturbance is associated with lower-rated neighborhood cohesion. Empirical studies suggest that a higher level of exposure to air pollution and noise may reduce neighborhood restorative quality (von Lindern et al., 2016), which may reduce the level of social cohesion (Dzhambov et al., 2017). Echoing findings elsewhere (Gascon et al., 2018; Van Renterghem and Botteldooren, 2016), our study also confirms that even at only the perceptual level, neighborhood green space could mitigate the negative effects of air pollution and noise. Although no direct effect on perceived green space on mental health was found, the mediatory pathways are in line with previous studies (Dzhambov et al., 2018b). We therefore conclude, with some caution, that higher levels of perceived neighborhood green space could reduce migrants' mental health problems. More green space may also reduce environmental disturbances and may enhance neighborhood social cohesion. The weaker direct and indirect paths between perceived green space and mental health may be due to a relatively short length of exposure to the neighborhood environment. As suggested, migrants may not have been sufficiently exposed to their current neighborhood's natural environment due to their high residential mobility levels. This may partly explain why we did not observe a direct effect of perceived neighborhood green space on mental health. Perhaps a more extended exposure duration would reveal such an effect.

Our results reveal different green space – mental health paths for internal migrants in China compared to Western studies [e.g., 11,67,68]. Our novel results concerning the green space – mental health relationship suggest the importance of specific knowledge construction for different demographics and social groups regarding the pronounced differences in health performance and behavior across groups (Pearce, 2018). The following section therefore discusses the role of migration experience

and migrants' sociodemographic attributes in understanding the green space–mental health relationship in our specific context.

#### **4.5.2 Green space – mental health paths for migrants**

By incorporating migration characteristics, we believe that the analysis provides a more nuanced view on the relationship between green space and mental health. We found that migrants who reported higher residential mobility rates in Shenzhen were likely to experience poorer physical health, and therefore poorer mental health. This finding confirms a hypothesis that we formulated based on mobility – health studies, namely that residential mobility is associated with an increased risk of poor health performance (Oishi and Schimmack, 2010). Migrants are found to be more residentially mobile than non-migrants in host cities due to hukou restrictions, a lack of financial resources and support, and a relatively low starting point in the housing market (Cui et al., 2016; Huang et al., 2014). In this respect, migrants are at greater risk for mental health problems. Migration is regarded as a special form of residential mobility that takes place less frequently but usually involves long-distance movements (Tolbert et al., 2009). Our results suggest that a frequent migration experience may also have negative impacts on migrants' physical health, although the significance level of the effect is questionable.

Concerning sociodemographic characteristics, our results indicate that male migrants are physically healthier but mentally less healthy than female migrants. Previous studies in China reported that male migrants perceive a higher level of discrimination compared to female migrants (Lin et al., 2011), resulting in considerably more mental health issues among male migrants. Further, we found that higher income levels reduce the level of mental health problems and contribute to physical health. People with more financial resources can spend more on leisure and entertainment activities, both of which contribute to physical and mental wellbeing (Cummins, 2000). Male migrants and migrants on low incomes experience more stress in their urban lives, resulting in poorer mental health.

#### **4.5.3 Strengths, limitations, and future research**

This study addressed the limitations of many green space – mental health studies (Dzhambov et al., 2018a) by using SEM to test multiple mediatory pathways. In addition, this study is among the first to explore the green space – mental health pathways in the context of internal migrants in China (for exceptions, see (Helbich et al., 2019; Liu et al., 2019)). Our model has yielded novel results concerning the green space – mental health relationship for these migrants, by taking into account their distinctive socioeconomic background. We hope that by addressing the complex green space – mental health relationship for a specific population group, we will stimulate a discussion on context-specific research.

Our study had some limitations. First, we only measured perceived neighborhood green space based on the respondents' subjective experiences, considering their high residential mobility level in host cities. Yet, we cannot rule out that our findings also hold for objective green space measures, such as the normalized difference vegetation index (Helbich, 2019). Second, this study specified

the pathways between perceived green space and mental health for migrants only. However, the pathways might differ among non-migrant groups in Shenzhen. Third, the low response rate in the study limits the generalization of our findings. Finally, reverse causalities cannot be excluded due to the cross-sectional nature of this study, and the mediation effect might be overestimated.

We suggest that future research should build upon our findings by, for example, conducting comparison studies in different contexts (e.g., migrants in Europe), comparing models between migrant and non-migrant groups, incorporating objectively measured green space and other potential mediators, and accounting for the role of blue space. There is also need for qualitative studies to understand how migrants experience urban green space in host cities and how green space-mental health pathways differ between migrants and local residents.

## 4.6 Conclusions

This study examined the green space – mental health relationship for internal migrants in China through multiple mediators. Although the contribution of green space to good mental health was minor and only through indirect pathways, we found that perceived neighborhood green space played a beneficial role in terms of reducing environmental disturbance from air pollution and noise and promoting neighborhood social cohesion. Our results suggest that the association between perceived green space exposure and mental health for Chinese internal migrants forms distinctive mediatory paths comparing to different population groups suggested by others. Policymakers are advised to ensure a stable residential experience for migrants in host cities, to reduce the risks for migrants' physical and mental health.

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# Chapter 5

Effect of pre- and post-migration  
neighborhood environment on migrants'  
mental health: the case of Shenzhen, China

This chapter is based on a manuscript under review for a peer-reviewed journal.  
Co-authors: Martin Dijst, Jan Faber and Marco Helbich

## Abstract

Existing mental health studies failed to incorporate people's neighborhood experiences in the past, which may have long-lasting mental health effects. This may particularly be true for migrants. To assess how the perceived pre- and post-migration neighborhood environment shapes migrants' mental health later on in life, a survey among migrants was conducted in Shenzhen, China (N=591). The risk of poor mental health was screened with the General Health Questionnaire (GHQ). Perceptions of the pre- and post-migration neighborhood environment were collected retrospectively. Structural equation modeling was used for data analysis. The results showed that the direct path between the perceived post-migration neighborhood environment and migrants' mental health was significant. No direct association was observed between the pre-migration neighborhood environment and mental health. The indirect path between the pre-migration neighborhood environment and mental health was significantly mediated by the post-migration neighborhood environment. Migrants' pre- and post-migration socioeconomic status was directly associated with mental health; income appeared to be most influential. Our findings suggest that the pre-migration neighborhood plays a crucial role in migrants' mental health. This confirms a path dependency on migrants' neighborhood environment throughout their migrations. Future mental health studies are advised to incorporate neighborhood characteristics along migrants' residential histories.

*Keywords: Perceived neighborhood environment; mental health; migration; structural equation model; path dependency; China*

## 5.1 Introduction

China, the world's largest developing country, faces a massive flow of internal migration (Hu et al., 2011). Since 2017, approximately 286.5 million people have left their homes to live and work elsewhere in urban China (Yang et al., 2018). A concern aroused by the growing number of internal migrants is their mental health (Zhong et al., 2015). A migrant's mental health in the host city is frequently challenged by their disadvantaged socioeconomic position, social exclusion from the host society, and housing stress (Li and Liu, 2018; Li and Rose, 2017; Lin et al., 2011).

Evidence is mounting that a neighborhood's physical and social environments are among the determinants of mental health, independent of people's demographic, behavioral, and socioeconomic predispositions (Helbich et al., 2020; Kawachi and Berkman, 2009; Van Dyck et al., 2015). Previous studies have examined migrants' mental health in relation to their residential neighborhood in host cities (Hilario et al., 2015; Wen et al., 2010; Xiao et al., 2018). It was found that a less desirable neighborhood physical environment – such as safety concerns, poor accessibility, a lack of facilities, and unpleasant aesthetics – was negatively associated with residents' mental health (Gao et al., 2016; Guo et al., 2020; Meyer et al., 2014). Negative experiences may increase stress and discourage residents from engaging in social interactions and physical activities (Smith et al., 2015), which may be correlated with mental illness. In contrast, neighborhood green space has been suggested to have beneficial effects on residents' mental health (Hartig et al., 2014; Houlden et al., 2018; van den Berg et al., 2015) by mitigating harmful exposures (e.g., air pollutants), stress restoration, and encouraging physical activities (Markevych et al., 2017). Likewise, a neighborhood's social environment – such as social support, trust, and social cohesion – also plays a role in shaping mental health outcomes (Erdem et al., 2015). People who live in neighborhoods with a low sense of community and trust reported poorer mental health (Erdem et al., 2015), because people find it difficult to maintain their social contacts and receive social support in such neighborhoods (Veling et al., 2015). On the contrary, neighborhoods with more social cohesion and support among neighbors seem to support mental health (Van Dyck et al., 2015; Ward Thompson et al., 2016). However, findings such as these are not consistent across studies and differ across population groups (Rautio et al., 2018; Yen et al., 2009)

One possible reason for contradictory findings is that the migrants' new neighborhood environment was only captured at a single point in time (Wen et al., 2010; Xiao et al., 2018). Such an approach disregards the pre-migration neighborhood environment, which may have long-lasting protective or health-threatening effects on people's mental health (Helbich, 2018). A lack of knowledge of pre-migration neighborhood characteristics could lead to a misconceptualization of the health-influencing spatial context, since migrants are likely to experience differences in the socio-spatial context in places before and after they migrate (Li and Rose, 2017).

To incorporate both the past and the current residential neighborhood, life-course epidemiology (Kuh et al., 2003) provides a theoretical framework to assess how migrants' mental health

depends on varying neighborhood environments over time, namely before and after moving. Two hypothesis have been put forward (Kuh et al., 2003). First, the latency model suggests a time lag between an exposure and its mental health effect (Lynch and Smith, 2005). Therefore, the model assumes that early neighborhood experience may directly influence people's mental health later on in life (Barr, 2018). Following this assumption, studies found that conditions in previous residential neighborhoods have an independent effect on people's health conditions later on in life, after controlling for individual factors (Dundas et al., 2014; Jivraj et al., 2019; Pearce et al., 2018). Second, the pathway model proposes a mediation pathway between early exposures and later health outcomes (Lyu and Burr, 2016). The mediation assumption allows the incorporation of temporal sequences of the neighborhood environment where previous adverse environments may increase the risk of adverse experiences later on in life, which in turn links to poor mental health (Coulter et al., 2015); and vice versa. For instance, the earlier neighborhood environment was correlated with the neighborhood environment they experience later on in their lives (South et al., 2016). The pathway model also accommodates a chain of exposures, suggesting that an adverse experience might lead to another risk exposure (Ben-Shlomo and Kuh, 2002). For instance, poor early socioeconomic status (SES) seems to be associated with adverse neighborhood exposures in early life (Hedman et al., 2015), which may increase the chance of living in poor neighborhoods later on in life (Asah et al., 2012; Thompson et al., 2008), which in turn raises the risk of a poor mental health later on in life. However, empirical evidence assessing the latency and pathway models in the context of mental health research is scarce.

The present study addressed this knowledge gap by assessing how both the old and the new neighborhood environment are associated with migrants' mental health in Shenzhen, China. To capture people's environmental perceptions, we used retrospective measures of the pre- and the post-migration neighborhood environment, as such measures have been found to be particularly suitable for life-course-oriented studies because they entail only minor recall bias (Osypuk et al., 2015). The pathways were examined by means of structural equation modeling (SEM) (Hair et al., 2014).

## 5.2 Material and methods

### 5.2.1 Research design and study population

This study used survey data from Shenzhen, China, collected between January and April 2017. More than 70% of Shenzhen's population of 11.37 million people are migrants (Shenzhen Municipal Bureau of Statistics, 2018), which made this city an ideal site to conduct our study.

Participants were sampled using a multi-stage sampling design. First, two inner-city districts (i.e., Nanshan and Futian) and two suburban districts (i.e., Longgang and Baoan) were chosen as sampling areas. Second, we identified five neighborhood types per sampling area based on their physical environment and the socioeconomic composition of their residents. The identified neighborhood

types are work unit compound, inner-city village, commodity housing community (i.e., a private real-estate development), social housing, and factory dormitory. We then took a random sample of the selected households within the selected neighborhoods. The following eligibility criteria were set for participants: Older than 18 years and lived in Shenzhen for at least 6 months. In total, we collected 855 completed questionnaires. After removing non-migrants (i.e., people born in Shenzhen, N=264), the final sample comprised 591 migrants.

### 5.2.2 Mental health as outcome variable

The mental health status of migrants in the host city was captured using the General Health Questionnaire-12 (GHQ-12) (Goldberg et al., 1997), a well-established psychometric screener used to assess people's non-specific mental health status. The GHQ-12 is based on 12 items that assess people's emotions and daily functioning in the previous four weeks. Both the reliability and the validity of the GHQ-12 have been confirmed (Goldberg et al., 1997; Molina et al., 2006; Wan and Martin, 2006). We used the Chinese version (Ye, 2009). The GHQ-12 score ranges from 0 (=excellent mental health) to 12 (=poor mental health). As done elsewhere (Dzhambov et al., 2018; Yang et al., 2020), we summed the individual item scores to obtain an overall outcome measure.

### 5.2.3 Perceived pre- and post-migration neighborhood environment

We used the perceived neighborhood environment rather than objective measures because people's perceptions were found to be more formative for mental health (Wen et al., 2006). We used retrospective questions to measure the migrants' neighborhood perceptions, because such questions have been proven to be a valid, reliable, and cost-effective way to ascertain people's neighborhood experiences over time (Osypuk et al., 2015). Here, the pre-migration neighborhood environment referred to the last place of residence where a person had lived for at least 6 months.

Questions about migrants' perceptions of the physical neighborhood were operationalized through the short version of the Neighborhood Environment Walkability Scale (NEWS-A) (Cerin et al., 2006). Respondents rated their agreement to several statements on a 5-point Likert scale ranging from 1 (=strongly disagree) to 5 (=strongly agree). We used 13 of the 54 NEWS-A items to represent neighborhood facilities and accessibility, neighborhood aesthetics, safety, and availability of green space.

The neighborhood social environment was assessed based on four items covering six aspects (Roberts and Stephen, 2012). We asked migrants to assess the level of shared values, trust, helpfulness between neighbors, and neighborhood organization in their neighborhood before and after they moved to Shenzhen. These items were rated on a 5-point Likert scale. Higher scores indicate better perceived neighborhood social environments. Table S1 in the supplementary materials summarizes the statements concerning neighborhood physical and social environments.

The measurements for neighborhood physical and social environments were then combined as a single construct representing the perceived neighborhood environment (Schulz et al. 2013).

The combined physical and social attributes provide an overall assessment of the neighborhood environment, since they both serve an important role in shaping people's mental health (Rautio et al., 2018). In addition, using the combined factor of perceived neighborhood environment obviated an overly complex model specification with respect to our sample size and the pathways to be fitted. Cronbach's alpha confirmed good internal consistency for our perceived neighborhood environment measure (Cortina, 1993): It was 0.94 for before migration and 0.951 for after migration.

#### **5.2.4 Pre- and post-migration socioeconomic status**

Individual-level SES is a potential risk factor for poor mental health across life stages (Gilman et al., 2002; Milanovic et al., 2017; Wheaton and Clarke, 2003). We integrated migrants' pre- and post-migration SES into the analysis by means of people's highest completed educational level, monthly personal income (CNY/month), and monthly household income (CNY/month).

#### **5.2.5 Control variables**

Following previous studies (Dong and Qin, 2017; Gao et al., 2016), data on migrants' age and gender were collected via the questionnaire. We also adjusted for their residential mobility level; that is, we distinguished between inter-city migration and intra-city residential mobility within Shenzhen. Respondents reported the number of migration trips they had made (i.e., migration frequency) before moving to Shenzhen. Residential mobility within Shenzhen was measured by the number of residential moves made after arrival in Shenzhen. The effects of the control variables were accounted for by specifying the relations between the control variables and all the dependent variables.

#### **5.2.6 Statistical analysis**

SEM was chosen over other multivariate modeling techniques for two reasons. First, SEM enabled us to specify factorial models as latent constructions and regress them to other variables (Hair et al., 2014). Our model had two latent variables, namely pre- and post-migration neighborhood environment, each measured through 19 items. Second, apart from numerous independent variables, we also had multiple dependent variables, including the GHQ-12 score, pre- and post-migration neighborhood environment, and post-migration SES. Unlike regular regression methods, SEM accommodates multiple dependent variables in one model and allows interactions between dependent variables (Ullman and Bentler, 2013).

Two theoretically guided hypotheses were tested: a) The pre-migration neighborhood environment has a direct negative effect on the GHQ-12 score; and b) the pre-migration neighborhood environment has an indirect negative effect on the GHQ-12 score, mediated by the post-migration neighborhood. Migrants' pre- and post-migration SES were examined in relation to pre- and post-migration neighborhood environment, and in relation to their mental health. Our SEM was adjusted for migrants' current age, gender, residential mobility, and pre-migration SES. Figure 5.1 summarizes our conceptual model.

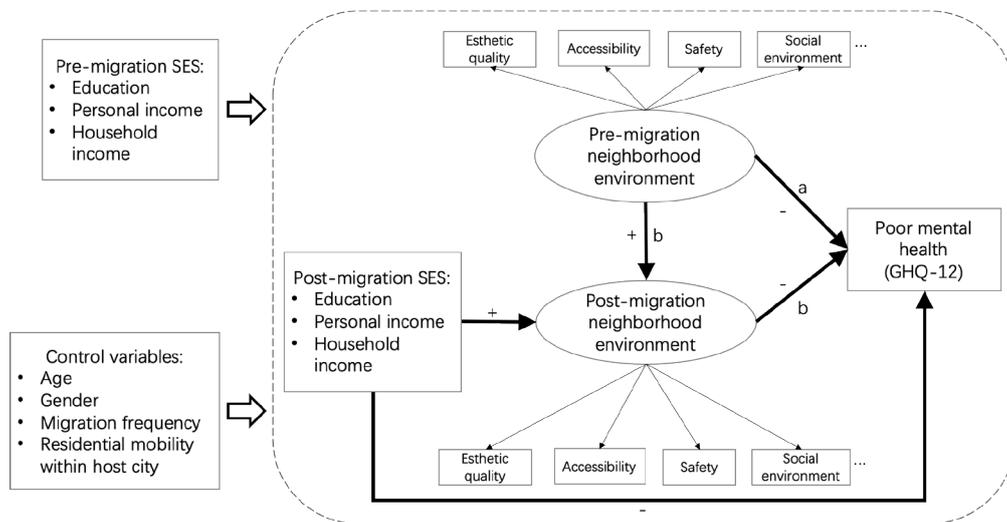


Figure 5.1 Conceptual model

All specified relations were estimated as standardized linear relations by means of the maximum likelihood method based on ordinary Pearson correlations. These correlations are estimated for pairs of ordinal/categorical variables as polychoric correlations (Olsson, 1979), for pairs of an ordinal/categorical variable and a continuous interval/ratio variable as polyserial correlation (Olsson et al., 1982), and for pairs of continuous variables as Pearson correlations (Wonnacott and Wonnacott, 1982).

The model's goodness-of-fit was assessed by multiple indicators (Iacobucci, 2010), namely goodness-of-fit index (GFI > 0.95), adjusted goodness-of-fit index (AGFI > 0.90), comparative fit index (CFI > 0.95), and root mean square residual (RMR < 0.08). The initial SEM was fitted strictly according to the conceptual model (Figure 5.1). As the model fit suggested poor model fit to the data, we adjusted the model by introducing plausible paths and removing insignificant paths step by step, following the indications from modification indices (Jöreskog and Sörbom, 1992).

## 5.3 Results

### 5.3.1 Descriptive statistics

The respondents' mean age was 31 years, with a standard deviation (SD) of 7.91, and 44% of them were female. Our sample closely matches the demographic composition of the city of Shenzhen: In 2018, the average age of the permanent residents of Shenzhen was 32.5 years and 46% were female (Statistics Bureau of Shenzhen Municipality, 2019).

**Table 5.1** Summary statistics for study population (N=591)

Variable	Category	Pre-migration			Post-migration		
		%	Mean	SD	%	Mean	SD
<b>Educational level</b>	Primary school and lower	3.38%			0.51%		
	Secondary school	7.78%			6.77%		
	High school or secondary technical school	26.73%			24.53%		
	Bachelor's degree	57.53%			62.10%		
	Master's degree or above	4.57%			6.09%		
<b>Personal income</b>	< 1,000 yuan	25.04%			2.71%		
	1,001 – 2,000 yuan	9.81%			1.02%		
	2,001 – 3,000 yuan	12.86%			4.91%		
	3,001 – 4,000 yuan	16.75%			14.21%		
	4,001 – 5,000 yuan	12.18%			15.23%		
	5,001 – 6,000 yuan	6.94%			11.00%		
	6,001 – 7,000 yuan	4.91%			8.80%		
	7,001 – 8,000 yuan	2.71%			7.95%		
	8,001 – 9,000 yuan	2.03%			5.92%		
	9,001 – 10,000 yuan	2.20%			6.77%		
> 10,001 yuan	4.57%			21.49%			
<b>Household income</b>	< 2,000 yuan	11.84%			1.86%		
	2,001 – 4,000 yuan	18.27%			5.92%		
	4,001 – 6,000 yuan	18.61%			9.31%		
	6,001 – 8,000 yuan	13.03%			9.81%		
	8,001 – 10,000 yuan	9.31%			10.66%		
	10,001 – 12,000 yuan	10.49%			11.34%		
	12,001 – 14,000 yuan	4.06%			11.17%		
	14,001 – 16,000 yuan	1.69%			6.60%		
	16,001 – 18,000 yuan	2.37%			4.06%		
	18,001 – 20,000 yuan	3.21%			7.78%		
> 20,001 yuan	7.11%			21.32%			
<b>Neighborhood environment</b>	Litter-free		3.29	1.15		3.43	1.44
	Good air quality		3.59	1.10		3.47	1.06
	Free from noise		3.32	1.23		3.13	1.23
	Attractive architecture		2.92	1.15		2.98	1.18
	Safe from crime		3.58	1.09		3.59	1.02
	Safe from traffic		3.62	1.08		3.58	1.04
	Do shopping in neighborhood		3.95	1.04		3.91	1.05
	Shops within walking distance		3.97	1.09		3.95	1.05
	Facilities within walking distance		3.74	1.18		3.79	1.15
	Public transportation within walking distance		3.53	1.22		3.72	1.13

Variable	Category	Pre-migration			Post-migration		
		%	Mean	SD	%	Mean	SD
	Parks and open spaces near by		3.55	1.24		3.72	1.13
	Sufficient trees and plants in neighborhood		3.41	1.23		3.41	1.19
	Attractive natural sights in neighborhood		2.99	1.31		3.07	1.29
	People are willing to help each other		3.41	1.10		3.28	1.12
	Helpful neighborhood organization		2.96	1.13		3.1	1.15
	Utilizing neighborhood organization		2.91	1.19		3.07	1.18
	Residents share same values		3.1	1.14		3.11	1.14
	Close-knit neighborhood		3.1	1.14		3.08	1.17
	People in the neighborhood can be trusted		3.18	1.12		3.13	1.14

The GHQ-12 scores ranged from 0 to 12, with a mean score of 5.22 (SD=2.88). Descriptives of the sample's pre- and post-migration attributes are given in Table 5.1. In general, the migrants' educational level and personal and household income improved after migration. The average scores on litter-free neighborhood, access to facilities and public transportation, helpfulness between neighbors, and utilization of neighborhood organization were higher in neighborhoods after migration; the scores on the other indicators increased only slightly or decreased.

### 5.3.2 Measurement model for the neighborhood environment

Table 5.2 shows the factor loadings measuring the pre- and the post-migration neighborhood environment. For the pre-migration neighborhood, the factor loadings were between 0.602 and 0.840. Factors measuring the post-migration neighborhood environment ranged from 0.667 to 0.833. Because all factor loadings were greater than 0.5 ( $p < 0.05$ ), we consider the convergent validity for both factors to be acceptable (Anderson and Gerbing, 1988). The composite reliability (CR), which measures the construction quality of the measurement model (Ahmad et al., 2016), suggested good composite reliability for both latent variables with CR values of 0.953 and 0.966, respectively (Raykov, 1997).

### 5.3.3 Structural model

The SEM overall model fit was good with GFI ( $> 0.95$ )=0.963; AGFI ( $> 0.90$ )=0.959; CFI ( $> 0.90$ )=1.000; RMR ( $< 0.08$ )=0.077. Details of the estimated total, direct, and indirect effects are given in Tables 5.3 and 5.4. The post-migration neighborhood environment had a significant direct effect on GHQ-12, whereby a better perceived neighborhood was associated with better mental health. The pre-migration neighborhood environment had a negative indirect relationship with GHQ-12, mediated by the post-migration neighborhood environment. Among the pre- and post-migration SES variables, the SEM results showed that personal income and household income were more essential for the perception of neighborhood environment and for mental health outcomes than for education. Higher personal pre- and post-migration income levels were directly associated with better mental health (Table 5.3). Higher pre- and post-migration household income levels

were indirectly associated with better mental health via influencing migrants' perceived pre- and post-migration neighborhood environment. In addition, we found higher pre-migration personal income to be linked to a better rated post-migration neighborhood environment, which contributes indirectly to better mental health.

**Table 5.2** *Estimates of the standardized factor loadings of the perceived pre- and post-migration neighborhood environment*

Items	Pre-migration neighborhood environment		Post-migration neighborhood environment	
	Factor loading	R <sup>2</sup>	Factor loading	R <sup>2</sup>
Litter-free	0.602	0.363	0.705	0.497
Good air quality	0.672	0.452	0.810	0.657
Free from noise	0.647	0.419	0.748	0.560
Attractive architecture	0.673	0.452	0.781	0.610
Safe from crime	0.717	0.514	0.797	0.635
Safe from traffic	0.769	0.591	0.817	0.667
Do shopping in neighborhood	0.647	0.419	0.688	0.473
Shops within walking distance	0.619	0.383	0.667	0.445
Facilities within walking distance	0.695	0.483	0.739	0.547
Public transportation within walking distance	0.614	0.377	0.676	0.458
Parks and open spaces near by	0.633	0.401	0.786	0.618
Sufficient trees and plants in neighborhood	0.718	0.515	0.801	0.642
Attractive natural sights in neighborhood	0.732	0.537	0.768	0.589
People are willing to help each other	0.776	0.602	0.808	0.654
Helpful neighborhood organization	0.839	0.704	0.812	0.659
Utilizing neighborhood organization	0.791	0.626	0.799	0.639
Residents share same values	0.814	0.663	0.813	0.660
Close-knit neighborhood	0.824	0.680	0.809	0.655
People in that neighborhood can be trusted	0.840	0.705	0.833	0.694
<b>CR value</b>	<b>0.953</b>		<b>0.966</b>	

The control variables indicated that women and younger people were mentally healthier than men and the elderly. Only indirect effects of mobility variables on mental health were found: Frequent migration contributes to poorer mental health by negatively affecting a migrant's neighborhood environment after migration, while high residential mobility in Shenzhen contributes to slightly better mental health through associated improved personal income after migration. Figure 5.2 shows the overall paths between migrants' SES, the neighborhood environment, and mental health.

**Table 5.3** Total effects, direct effects, and indirect effects of the variables on GHQ-12, post-migration neighborhood environment, and pre-migration neighborhood environment

From	To	GHQ-12			Post-migration neighborhood environment			Pre-migration neighborhood environment		
		Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect
<b>Dependent variables</b>										
Post-migration neighborhood environment		-0.325***	-0.325***	—	—	—	—	—	—	—
Pre-migration neighborhood environment		-0.235***	—	-0.235***	0.671***	0.664***	0.008***	—	—	—
Post-migration education		-0.069***	—	-0.069***	0.028***	—	0.028***	—	—	—
Post-migration personal income		-0.179***	-0.155***	-0.023***	0.071***	—	0.071***	—	—	—
Post-migration household income		-0.034***	—	-0.034***	0.103***	0.103***	—	—	—	—
<b>Independent variables</b>										
Age		-0.081***	—	-0.081***	0.135***	0.064***	0.071***	0.08***	0.08***	—
Gender (ref=Male)		-0.014**	—	-0.014**	0.08***	0.043***	0.038***	0.065***	0.065***	—
Pre-migration education		-0.021**	—	-0.021**	-0.084**	-0.106***	0.022**	—	—	—
Pre-migration personal income		-0.159***	-0.105***	-0.054***	0.046***	0.065***	-0.019***	—	—	—
Pre-migration household income		-0.056***	—	-0.056***	0.136***	—	0.136***	0.11***	0.11***	—
Migration frequency		0.015***	—	0.015***	-0.046***	-0.046***	—	—	—	—
Residential mobility		-0.053***	—	-0.053***	0.021***	—	0.021***	—	—	—
Model fit		GFI (> 0.95)=0.963; AGFI (> 0.90)=0.959; CFI (> 0.90)=1.000; RMR (< 0.08)=0.077								

Significance levels: \*p < 0.10, \*\*p < 0.05, \*\*\*p < 0.01. "—": unidentified effect

Table 5.4 Total effects, direct effects, and indirect effects of the variables on post-migration SES (e.g., education, personal income)

From	To			Post-migration education			Post-migration personal income			Post-migration household income		
	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect
<b>Dependent variables</b>												
Post-migration neighborhood environment	—	—	—	—	—	—	—	—	—	—	—	—
Pre-migration neighborhood environment	0.168**	0.168**	—	0.108***	0.108***	—	0.075***	0.108***	—	0.075***	—	0.075***
Post-migration education	—	—	—	0.386***	0.368***	—	0.267***	0.368***	—	0.267***	—	0.267***
Post-migration personal income	—	—	—	—	—	—	0.692***	—	—	0.692***	—	—
Post-migration household income	—	—	—	—	—	—	—	—	—	—	—	—
<b>Independent variables</b>												
Age	0.134***	0.134***	—	0.24***	0.179***	0.061***	0.166**	0.179***	0.061***	0.166**	—	0.166***
Gender (ref=Male)	—	—	—	-0.081***	-0.088***	0.007***	-0.056***	-0.088***	0.007***	-0.056***	—	-0.056***
Pre-migration education	0.804***	0.804***	—	0.31***	—	0.31***	0.215***	—	0.31***	0.215***	—	0.215***
Pre-migration personal income	-0.265***	-0.265***	—	0.25***	0.352***	-0.102***	-0.185***	0.352***	-0.102***	-0.185***	—	0.173***
Pre-migration household income	0.175***	0.175***	—	0.079***	—	0.079***	0.609***	—	0.079***	0.609***	—	0.055***
Migration frequency	—	—	—	—	—	—	—	—	—	—	—	—
Residential mobility	—	—	—	0.296***	0.296***	—	0.205***	0.296***	—	0.205***	—	0.205***
Model fit	GFI (> 0.95)=0.963; AGFI (> 0.90)=0.959; CFI (> 0.90)=1.000; RMR (< 0.08)=0.077											

Significance levels: \*p &lt; 0.10, \*\*p &lt; 0.05, \*\*\*p &lt; 0.01. "—": unidentified effect

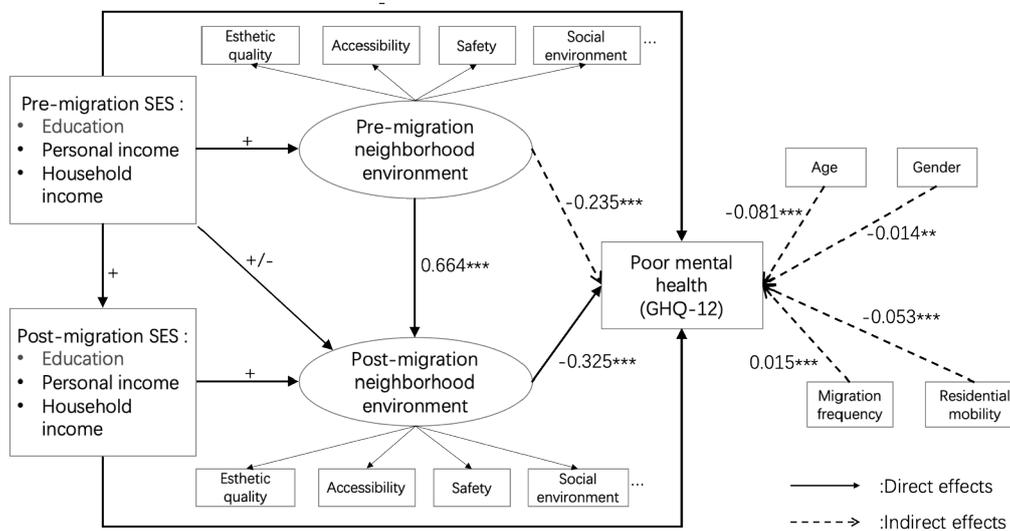


Figure 5.2 Overall paths between migrants' SES, neighborhood environment, and GHQ-12

## 5.4 Discussion

This study examined how the neighborhood perception and mental health of internal Chinese migrants are correlated when taking into account their pre- and their post-migration neighborhood experience. Incorporating the pre-migration neighborhood provided a measurement of the migrants' neighborhood experience that is closer to reality, enabling a better understanding of the neighborhood – mental health relationship for migrants.

### 5.4.1 Pre- and post-migration neighborhood environment and mental health

Our results show that both the pre- and the post-migration neighborhood environment influenced the migrants' mental health after they had migrated to Shenzhen. In general, a better perceived pre- and post-migration neighborhood environment was associated with better mental health, which is in line with earlier studies (Li and Liu, 2018; Truong and Ma, 2006; Wen et al., 2006; Xiao et al., 2018). However, we did not find the significant direct path from perceived pre-migration neighborhood environment to mental health that we hypothesized based on the latency model. Debates about the latency effect of early life exposure are linked to the timing of exposure, suggesting that there are critical life stages (i.e., early childhood, adolescence, and early adulthood) during which people are more vulnerable to risk exposures than at other stages (Kuh et al., 2003; Mishra et al., 2010). We expect that the insignificant direct effect of the pre-migration neighborhood environment on mental health in our SEM, was partly due to the fact that we could not specify the specific life stages of the exposures due to the cross-sectional design.

Our modeling results suggests that the mediatory path, as given in the pathway model, better explains the relationship between perceived pre-migration neighborhood environment and mental health. The positive relationship between pre- and post-neighborhood environment suggests a path dependence of migrants' residential experiences. Studies have found that people who lived in a socially deprived neighborhood early on in life are more likely to live in neighborhoods with similar conditions later on in life (Hedman et al., 2015). The disadvantaged residential trajectory will then contribute to poorer mental health, as the risk exposures may cumulate and reinforce each other (Clarke et al., 2014). Early experiences in an advantaged or disadvantaged neighborhood are associated with corresponding social, financial, and human capital, which has profound implications for geographic moves to neighborhoods later in life (South et al., 2016). In our case, the migrants' pre-migration neighborhood experience could have a long-term impact on their mental health by influencing their choice of post-migration neighborhood in Shenzhen.

#### **5.4.2 Migrants' SES and mental health**

When accounting for the pre- and post-migration SES, the SEM showed the full social pathway linking migrants' lives before migration to their mental health after migration. The available evidence suggests that individual SES is closely related to people's mental health development over their life course (Colman and Ataullahjan, 2010; Gilman et al., 2002; Lyu and Burr, 2016). In line with this, our model indicated that pre-migration SES – specifically the pre-migration personal and household income – has direct negative effects on post-migration mental health. Low SES is considered a stressor for mental health (Baum et al., 1999), since it is closely linked to people's social and environmental conditions. Earlier research reported that income is a predictor of depression; that is, low income is associated with a higher risk of depression (Beard et al., 2008; Colman and Ataullahjan, 2010). Besides the direct effect, the mediatory paths also showed that migrants' pre-migration SES has a lasting impact on their post-migration mental health by influencing their choice of neighborhood at different time points. This finding echoes prior conclusions based on the capability approach, in which people's choice of neighborhood is enabled or constrained by their capabilities for utilizing resources (Sen, 2007; Shinn, 2015). Individual SES could be seen as a person's human and financial capital, which could influence their choice of neighborhoods, and therefore have an impact on their mental health (Wang et al., 2010).

#### **5.4.3 Mobility level – mental health pathways for migrants**

Our results evidenced that mobility at different geographical scales (e.g., inter-city migration vs. intra-city residential move) are associated with mental health in different ways. First, more frequent inter-city migration had an indirect and positive effect on the GHQ-12 score, mediated by a reduced perception of the post-migration neighborhood environment. This finding confirms previous studies that related a higher mobility level to poorer mental health (Moore et al., 2018; Oishi, 2010; Oishi and Schimmack, 2010). Second, a higher level of intra-city residential mobility was indirectly and negatively correlated with the GHQ-12 score. Studies have suggested that the decision to move is associated with the desire to improve the neighborhood quality (Baker et al., 2016). Migrants could benefit from the improvement of the neighborhood environment throughout their residential

mobilities within Shenzhen, which contributes to better mental health outcomes. This relationship is also supported by our results, as we identified a positive indirect effect of residential mobility on perceived post-migration neighborhood environment.

#### 5.4.4 Strengths and limitations

This study is among the first to examine the association between past neighborhood experience and mental health later on in life for a specific social group, namely internal migrants. The theoretical contribution of this paper is based on the incorporation of migrants' experience of their pre-migration neighborhood in the analysis of neighborhood – mental health associations. Our conceptual model provides a more comprehensive way to understand the neighborhood – mental health relationship by taking into account people's neighborhood experiences in the past (Helbich, 2018). In addition, SEM enabled us to examine the paths simultaneously and to identify direct and mediatory associations between migrants' SES, neighborhood environment, and mental health. Our SEM stressed the interplay between migrants' SES and their neighborhood experience pre-/post-migration and identified complex pathways connecting them to migrants' mental health, which has rarely been discussed in previous studies.

This study also had some limitations. First, our research employed cross-sectional data, which limited the examination of the impact of early life exposures on mental health and does not permit statements regarding causalities. Second, although the perceived neighborhood environment was repeatedly found to be closely linked to residents' mental health (Zhang et al., 2019), we cannot rule out the potential impact of objectively measured neighborhood exposures. Third, our results are likely to have been affected by recall bias due to the retrospective data collection, although the level of bias is judged to be minor (Osypuk et al., 2015).

#### 5.5 Conclusion

This study examined the pathways linking neighborhood environments and mental health, while accounting for changes in perceived neighborhood environment due to migration. Our SEM results for Shenzhen, China, suggest that migrants' experience of their previous neighborhood plays a significant role in their mental health in the host city. Migrants' neighborhood trajectories seem to follow a path dependency and are influenced by pre- and post-migration SES. Although frequent migration is correlated with poorer mental health, intra-city residential mobility is correlated with better mental health with the possibility of improving residential environments. We advise future studies to consider different contextual settings longitudinally, including the neighborhood environment along the residential trajectory.

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# Chapter 6

Assessing the changes in neighborhood  
physical and social environments and how  
they are associated with Chinese migrants'  
mental health

This chapter is based on a manuscript under review for a peer-reviewed journal.  
Co-authors: Martin Dijkstra, Julian Hagenauer and Marco Helbich

## Abstract

Migrants experience substantial changes in their neighborhood physical and social environments along their migration journeys, but little is known about how such changes correlate with their mental health. Our aim was to examine the associations between changes in the perceived neighborhood environments and migrants' mental health. We used cross-sectional data on 591 migrants in Shenzhen, China. The risk of mental illness was assessed by the General Health Questionnaire (GHQ). Neighborhood perceptions were collected retrospectively pre- and post-migration. We used random forests to analyze possible associations between GHQ scores and neighborhood environment changes, variable importance, and variable interactions. Changes in neighborhood aesthetics, safety, and green space were non-linearly associated with migrants' mental health: A decline in these characteristics was associated with poor mental health, while improvements in them were unrelated to mental health benefits. Variable importance showed that change in safety was the most important neighborhood characteristic, although individual-level characteristics – such as physical health, personal income, and hukou – appeared to be more important and strongly interacted with other variables. Our findings suggest degradations in the physical environment may worsen migrants' mental health, but replication of our findings in longitudinal settings is needed.

*Keywords: Migrants; neighborhood changes; mental health; machine learning; random forest*

## 6.1 Background

Between 1979 and 2019, China's urban population increased from 17% to 60% (Knoema, 2019). In parallel, between 2005 and 2013, the country's annual economic burden caused by mental disorders quadrupled from \$21.0 billion to \$88.8 billion (Xu et al., 2016). Internal migrants contributed significantly to China's growing urban population, and they are particularly vulnerable to mental illness resulting from changes in their social and physical living environments (Li and Rose, 2017; Li et al., 2006; Wong et al., 2008).

Evidence is mounting that risk factors for mental illness in host cities are different for migrants compared to non-migrants; for example, migrants tend to have a low socioeconomic status, are separated from their families, and are socially excluded from their host societies (Chen et al., 2019; Hu et al., 2008; Wang et al., 2010; Zhang et al., 2018). Furthermore, hukou (the Chinese household registration system) prevents migrants from accessing social and medical benefits in host cities. Failure to transfer their hukous to host cities puts migrants at additional mental health risk because of the associated social welfare and healthcare inequalities (Yang et al., 2018).

Studies have shown that good neighborhood physical and social environments contribute to mental health among the general population (Diez Roux and Mair, 2010); in this, the social environment seems to play a more important role (Helbich et al., 2020). For example, noise (Ma et al., 2018), air pollution (Dzhambov et al., 2018), lack of essential neighborhood facilities (e.g., lighting, benches, etc.) (Bird, 2012), and safety concerns (R. Wang et al., 2019) were found to threaten mental health. In contrast, neighborhood social cohesion and social support (Li and Liu, 2018) may contribute to better mental health. The physical environment in the form of green space may also promote mental health (Liu et al., 2019).

Previous studies on neighborhood – mental health relationships were limited in two ways. First, it remains unclear whether such associations hold for migrants experiencing changes in their living environment due to moving. This concern echoes criticism put forward elsewhere (Helbich, 2018) that neighborhood environments are measured at a single point in time (Dawson et al., 2019; Liu et al., 2017; Ruoyu Wang et al., 2019), which may lead to over-emphasizing the role of the neighborhood in which people currently live. Only a few studies have incorporated neighborhood experiences at multiple stages of people's lives (Barr, 2018; Cherrie et al., 2018; Jivraj et al., 2019). It is plausible that migrants' mental health is shaped by both the previous and the actual neighborhood environment (Coulter et al., 2015; Helbich, 2018; Pearce et al., 2018). For example, a US study showed that moving away from an impoverished neighborhood resulted in improved mental health (Brazil and Clark, 2017).

Second, some studies (i.e., Chen and Chen, 2015; Dong and Qin, 2017; Ruijsbroek et al., 2017) have a methodological deficit because they were mainly based on inflexible regression analyses assuming that neighborhood – mental health correlations are linear. While there is no plausible reason for

such a simplification, this may at least partly contribute to inconsistent results across studies (Rautio et al., 2018). To overcome these constraints, others have promoted the application of more flexible machine learning approaches to uncover complex and possibly non-linear associations (Helbich et al., 2020). Non-linearities make intuitive sense, because people's mental health might not respond in the same way to an improvement or deterioration of the neighborhood environment. Meanwhile, several machine learning models (e.g., random forests) have demonstrated their analytical advantages by routinely assessing the importance of explanatory variables and modeling variable interactions (Breiman, 2001), which supports our understanding concerning the mechanisms underlying how neighborhood characteristics correlate with mental health.

To address these limitations, the present study used random forests to examine associations between changes in neighborhood physical and social environments pre- and post-migration and migrants' mental health in the host city of Shenzhen, China. Three research questions were formulated:

1. *How are changes in neighborhood characteristic associated with migrants' mental health in the host city?*
2. *Which neighborhood changes are most influential for migrants' mental health?*
3. *How do migrants' individual-level characteristics interact with neighborhood-level characteristics?*

## 6.2 Methods

### 6.2.1 Study area and study design

A cross-sectional observational study was conducted in the city of Shenzhen, China. Shenzhen has a population of 11.37 million people, 70% of whom are migrants (Shenzhen Municipal Bureau of Statistics, 2018), which made it an ideal site for our study.

Data were collected by means of a survey carried out between January and April 2017. We selected participants using a multi-stage sampling approach. First, two inner-city districts (Nanshan and Futian) and two suburban districts (Longgang and Baoan) were chosen as sampling areas. Second, five neighborhood types per sampling area were identified based on the neighborhood physical environment and the socioeconomic composition of the residents. The identified neighborhood types were work unit compound, inner-city village, commodity housing community (i.e., a private real-estate development), social housing, and factory dormitory. Finally, we took a random sample of people per selected neighborhood. Eligible to participate were people older than 18 years who had lived in Shenzhen for at least 6 months. In total, our sample included 855 respondents. After removing non-migrants (i.e., people born in Shenzhen,  $N=264$ ), the final sample comprised 591 people.

### 6.2.2 Data

#### ***Mental health as outcome variable***

Migrant's mental health was assessed using the well-tested Chinese version (Ye, 2009) of the 12-item General Health Questionnaire (GHQ-12) (Goldberg et al., 1998). The GHQ-12 is a psychometric screener dealing with people's emotions and daily functioning in the 4 weeks prior to the survey. The items address respondents' experience of self-confidence, losing sleep, and other psychiatric conditions. Each item was scored on a 4-point Likert scale ranging from 0 (not at all) to 3 (yes/always). The 12 individual scores were summed, leading to a total score that served as our outcome variable. The GHQ-12 in our sample ranged from 0 (good mental health) to 30 (poor mental health). A Cronbach's alpha of 0.821 indicated the good internal consistency of the GHQ-12 in our sample.

#### ***Perceptions of the residential neighborhood pre- and post-migration***

We assessed the physical and the social dimension of migrants' residential neighborhoods. Respondents were asked to assess both their current and their pre-migration neighborhood environment. This approach has the advantage that it captures migrants' neighborhood experiences along their migration trajectory efficiently and with minor recall bias (Osypuk et al., 2015).

The neighborhoods' physical characteristics were measured by means of the short version of the Neighborhood Environment Walkability Scale (NEWS-A) (Cerin et al., 2006). We used 13 of the 54 NEWS-A items to represent neighborhood facilities and their accessibility (4 items), aesthetics (4 items), safety (2 items), and the availability of green space (3 items). Respondents were asked to assess their neighborhoods by means of a 5-point Likert scale. The items for each attribute were then summed, with higher scores indicating better perceived neighborhood characteristics.

The neighborhood social environment was assessed by social cohesion, which was operationalized by asking respondents to rate the following statements on a 5-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree): "People in the neighborhood are willing to help their neighbors," "The neighborhood organization is very helpful," "People in the neighborhood share the same values," "The neighborhood is close-knit," "People in the neighborhood can be trusted" (Roberts and Stephen, 2012). The scores were summed, with higher scores indicating better perceived neighborhood social environments.

Changes in the perceived neighborhood environment were operationalized by subtracting the scores of the previous neighborhood from those of the current neighborhood. Values below 0 indicate a decline in a specific neighborhood attribute post-migration, while values above 0 indicate an improvement.

#### ***Individual-level covariates***

Following the recommendation by Helbich et al. (2020), Huang et al. (2017), and Yang et al. (2018), the following personal characteristics were included: age (measured in years), gender (male, female), education (high school or lower; bachelor's degree; master's or higher degree), personal

monthly income (in RMB<sup>3</sup>/month), employment status (employed or unemployed), hukou type (a dummy variable referring to holding or not holding a Shenzhen hukou), and a variable representing the migration context (intra- or inter-province migration). We also considered physical health, as earlier studies suggested a relation between physical and mental health (Scott and Happell, 2011; Yang et al., 2018). Physical health was measured on a 5-point self-rated scale from poor to excellent (Lu and Qin, 2014).

### 6.2.3 Machine learning-based analyses

Summary statistics were used to describe the study population. We applied a random forest model (Breiman, 2001) to assess the associations between GHQ-12 scores and environmental changes between migrants' previous and current neighborhoods. A random forest has the advantage that it models non-linear associations, includes interactions between variables, is not grounded on statistical assumptions, and is robust against overfitting (Fox et al., 2017). While there are numerous machine learning algorithms, studies have shown that random forests are highly competitive in their performance compared to other state-of-the-art machine learning models (Fernández-Delgado et al., 2014; Helbich et al., 2020).

Briefly, a random forest is an ensemble of decision trees, each of which is built using a random bootstrap sample (i.e., sampling with replacement) of the data. To further reduce correlations between the predictions of the individual trees, at each split only a fixed number of randomly selected variables are considered. The prediction of a random forest is the mean of the predictions of the individual decision trees.

Four approaches were used to obtain an in-depth model understanding. First, we assessed the variable importance by measuring how much, on average, each variable decreases the variance when the trees are grown. Second, we used partial dependence plots – which show the change in the average predicted value as one or more variables vary over their marginal distribution (Goldstein et al., 2015) – to investigate the directions and shape of the associations. Third, we quantified the total interaction of one variable with the other variables by means of the H statistic (Friedman and Popescu, 2008). Values close to zero indicate no variable interactions, while values close to 1 indicate that the entire variance is explained by the partial dependence functions. Fourth, we visualized the interactions of selected variables (i.e., those having a high H statistic) using bivariate partial dependence plots. The analyses were carried out in R software (R Development Core Team, 2011) using the ranger package (Wright and Ziegler, 2017).

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<sup>3</sup> 1 RMB=0.14 USD

## 6.3 Results

Table 6.1 presents the descriptive statistics of the study population. Our sample had a mean ( $\mu$ ) GHQ-12 score of 6.61 with a standard deviation (SD) of  $\pm 4.070$ . The changes in neighborhood conditions showed that, on average, the respondents experienced a slight decline in neighborhood quality post-migration in terms of aesthetics ( $\mu = -0.132$ ,  $SD \pm 4.070$ ), safety ( $\mu = -0.029$ ,  $SD \pm 1.866$ ), and social cohesion ( $\mu = -0.052$ ,  $SD \pm 4.681$ ). The neighborhood facilities and accessibility ( $\mu = 0.174$ ,  $SD \pm 3.986$ ) and green space ( $\mu = 0.240$ ,  $SD \pm 3.092$ ) improved post-migration.

The average age of our respondents was 31.374 years ( $SD \pm 7.911$ ) and 44% were female. Both age and gender distributions of our sample matched closely the demographic profile of people in Shenzhen in 2018, when the mean age of the permanent residents was 32.5 years and 46% of the permanent residents were female (Statistics Bureau of Shenzhen Municipality, 2019). Because only a few respondents reported "poor" physical health, we merged the "poor" and the "fair" group into a "fair/poor" group, which accounted for 35% of the sample. Well over half (66%) of the respondents had at least good physical health. Over two thirds (69%) of the respondents were currently living in Shenzhen without a Shenzhen hukou, and 68% of these respondents had migrated from places outside the province (Guangdong).

### 6.3.1 Variable importance

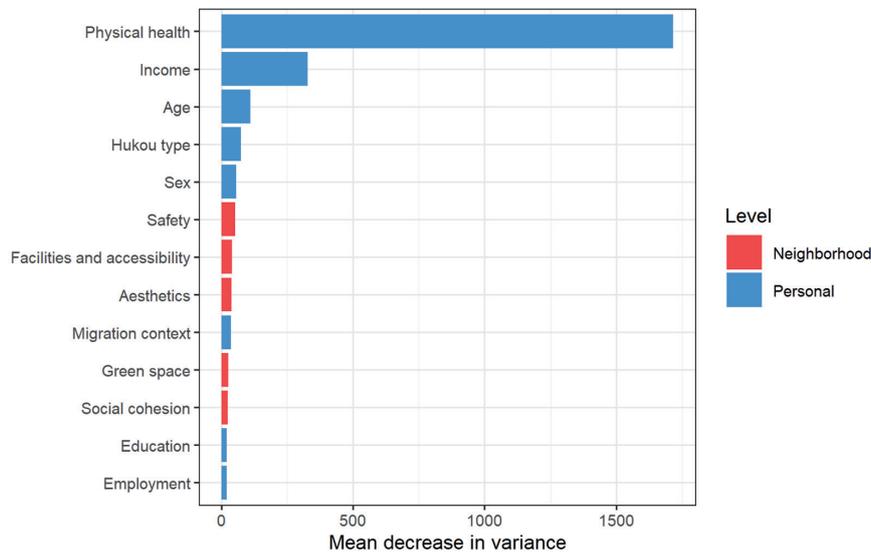
Figure 6.1 shows the variable importance for predicting migrants' GHQ-12 scores. Physical health, income, and age were found to be the most important variables correlating with GHQ-12, followed by migrants' hukou type and sex. Perceived changes in neighborhood characteristics were less important in explaining migrants' mental health in the host city. The most irrelevant variables were education and employment status.

**Table 6.1** Descriptive statistics of the study population

Variable	Category	Minimum	Maximum	Mean	SD	Percentage
GHQ-12 scores						
		0.000	30.000	6.613	4.070	
<b>Changes in neighborhood characteristics</b>						
Aesthetics		-16.000	20.000	-0.132	4.073	
Safety		-8.000	8.000	-0.029	1.855	
Facilities and accessibility		-16.000	16.000	0.174	3.986	
Green space		-12.000	12.000	0.240	3.092	
Social cohesion		-20.000	20.000	-0.052	4.681	
<b>Individual-level characteristics</b>						
Physical health	Fair/poor					35%
	Good					31%
	Very good					22%
	Excellent					13%
Hukou type	Non-Shenzhen					69%
	Shenzhen					31%
Migration context	Intra-province					32%
	Inter-province					68%
Age		17.000	68.000	31.374	7.911	
Gender	Female					44%
	Male					56%
Education	High school or lower					32%
	Bachelor's					62%
	Master's and higher					6%
Income	≤ 4,000 CNY					23%
	4,001 – 8,000 CNY					43%
	> 8,000 CNY					34%
Employment	Unemployed					23%
	Employed					77%

### 6.3.2 Correlation analysis

Figure 6.2 shows the correlations between the GHQ-12 scores and the covariates as partial dependence plots. A decrease in a migrant's perception of safety was associated with a higher GHQ-12 score (meaning poorer mental health), while an increase was not associated with a lower GHQ-12 score (meaning better mental health). A similar pattern was found for changes in neighborhood green space and aesthetics, where a reduction in the experiences of green space and aesthetics were associated with higher GHQ-12 scores. A decrease in GHQ-12 scores was observed for respondents with improvements (above 5) in green space. A decline in the perceived social cohesion post-migration was associated with higher GHQ-12 scores, and an increase with lower GHQ-12 scores.



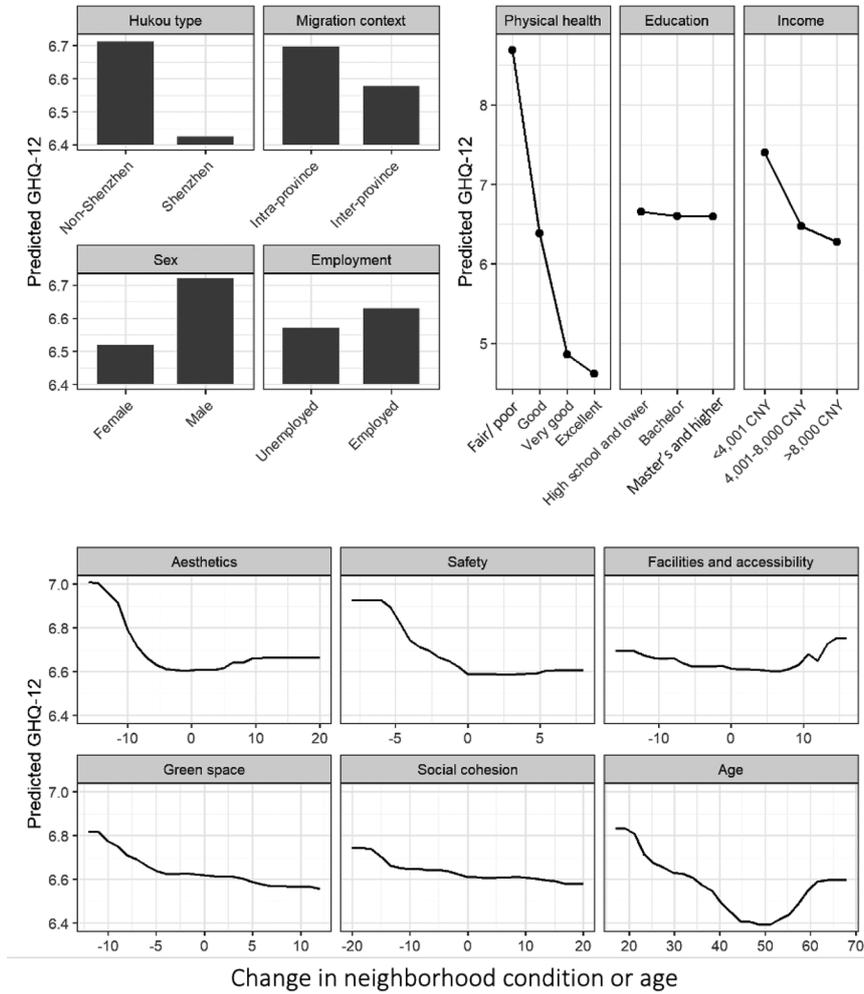
**Figure 6.1** Variable importance of the individual-level and neighborhood-level characteristics. The higher the mean decrease in variance, the more important the variable.

As for individual-level characteristics, migrants with a Shenzhen hukou had lower GHQ-12 scores than those without a Shenzhen hukou. Inter-province migrants also had better mental health than inter-province migrants. Male migrants had higher GHQ-12 scores than female migrants. The overall trend indicated that better physical health was associated with lower GHQ-12 scores. There was a substantial drop in GHQ-12 scores between migrants who assessed their physical health as “fair/poor” and migrants who reported “very good” physical health. In contrast, the GHQ-12 difference between “very good” and “excellent” physical health was minor. A similar trend was found for income, whereby higher income levels were associated with lower GHQ-12 scores; the GHQ-12 score difference between the low- and the middle-income group was greater than that between the middle- and the high-income group.

6

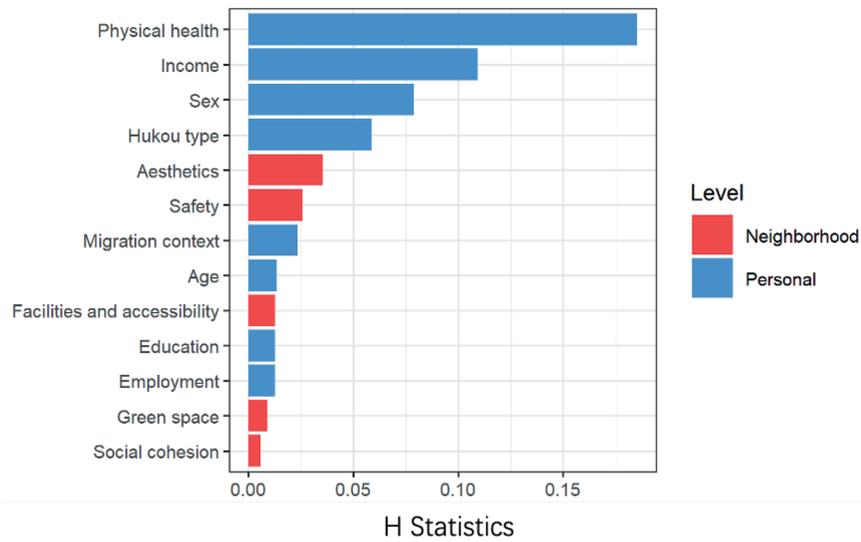
### 6.3.3 Variable interactions

Figure 6.3 shows the H statistics for the variables used to evaluate variable interactions. Physical health, income, hukou type, and sex had pronounced overall interaction. The remaining variables, including all neighborhood characteristics, showed moderate to little interaction. To investigate the most important interactions among variables, we calculated bivariate partial dependence plots for those with high overall interaction (i.e., physical health, income, hukou type, and sex) (Figure 6.4).

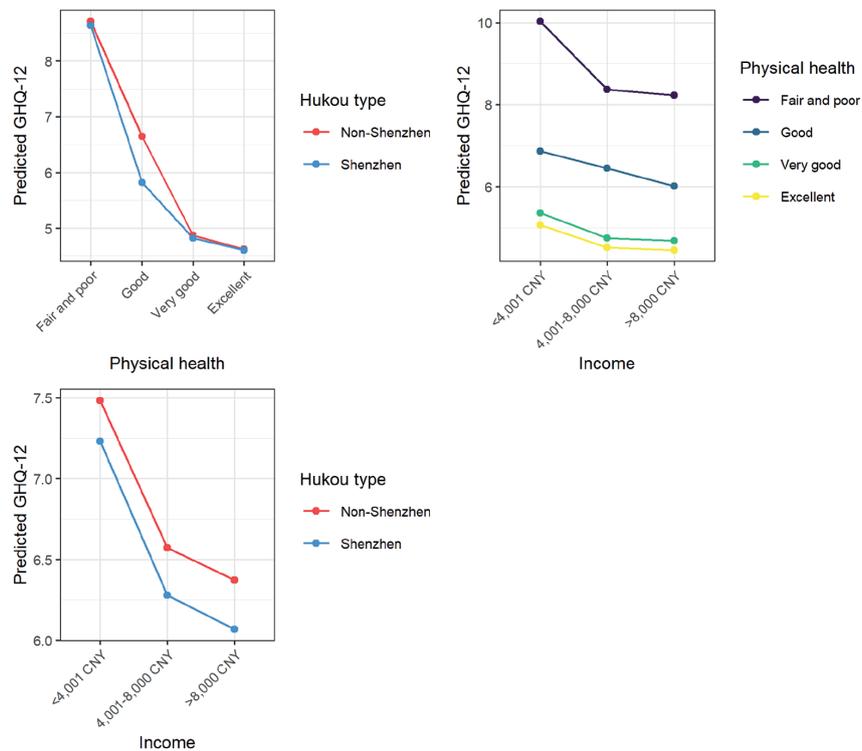


**Figure 6.2** Partial dependence plots relating each predictor to the GHQ-12 scores.

The association between hukou type and GHQ-12 scores varied by the level of income, whereby migrants with a Shenzhen hukou scored lower on GHQ-12 than those with a non-Shenzhen hukou. The difference in GHQ-12 scores between hukou types was more noticeable for the middle- and high-income groups than for the low-income group. The relationship between hukou type and GHQ-12 also varied by physical health. Among those who rated their physical health as good, non-Shenzhen hukou holders had higher GHQ-12 scores than hukou holders; there was little difference for other physical health levels.

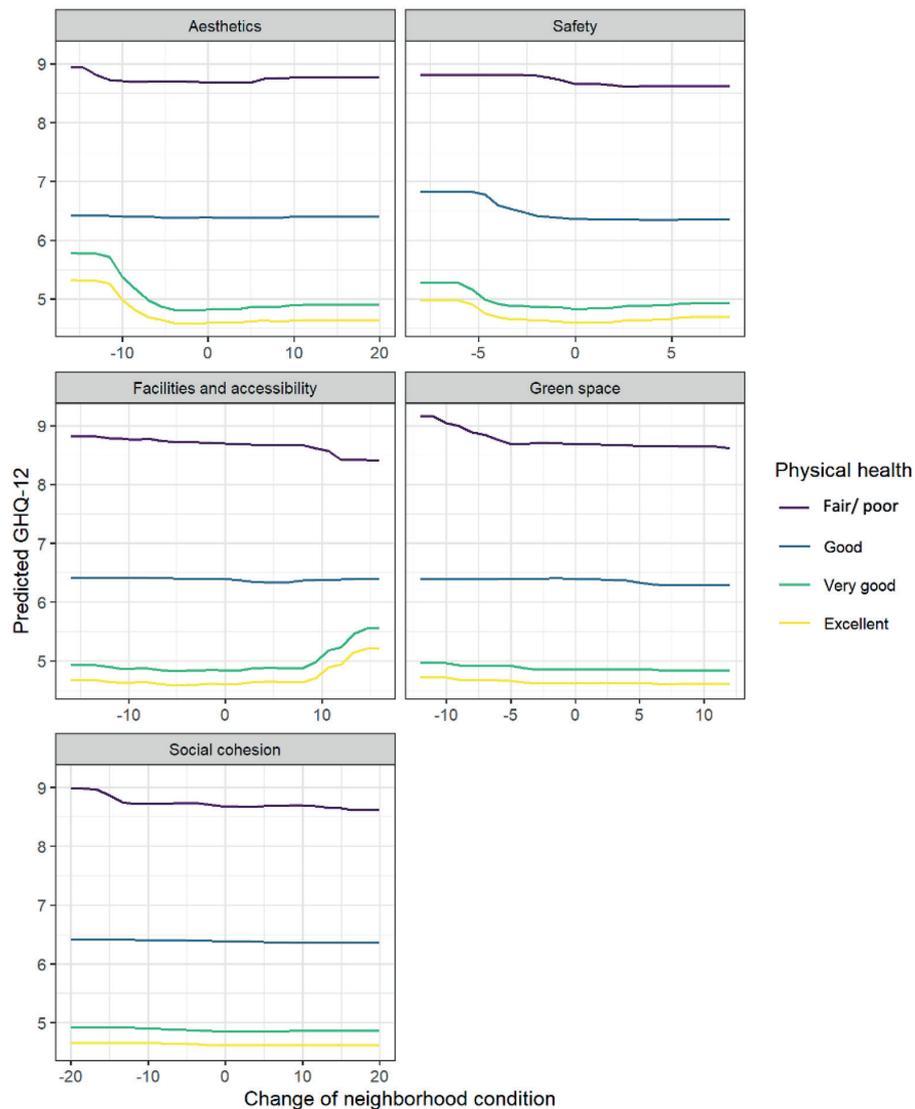


**Figure 6.3** Overall variable interactions of the individual-level and changes in neighborhood characteristics. The higher the H statistic, the stronger a variable's interaction with the other variables.



**Figure 6.4** Bivariate partial dependence plots of income, hukou, and physical health

6



**Figure 6.5** *Bivariate partial dependence plots of physical health and neighborhood characteristics*

The association between income level and GHQ-12 showed different patterns across physical health levels. A sharp drop in GHQ-12 scores between the low- and the middle-income group was found for migrants who rated their physical health as fair or poor. The pronounced negative association between income and GHQ-12 scores were flattened for migrants who rated their physical health as better than fair/poor.

Even though changes in neighborhood characteristics were not strongly related to migrants' GHQ-12 scores (Figure 6.1), the associations varied across different physical health levels. Figure 6.5 shows

the associations between changes in perceived neighborhood characteristics and GHQ-12 scores for migrants with different physical health levels. Respondents who rated their physical health as very good or excellent showed a sharper increase in GHQ-12 scores when they experienced a decline in neighborhood aesthetics and safety post-migration. A similar trend appeared between changes in perceived safety and GHQ-12 for migrants with good physical health. Yet, for migrants with fair/poor physical health, their GHQ-12 scores remained high regardless of whether changes in aesthetics and safety were experienced. In addition, we observed a sharp increase in GHQ-12 scores when migrants with very good or excellent physical health experienced a substantial improvement (above 10) in neighborhood facilities and accessibility. As for changes in green space and social cohesion, those who rated their physical health as fair/poor showed a more pronounced negative association between neighborhood changes and GHQ-12 scores compared to other physical health groups.

## 6.4 Discussion

In the present study, we applied a machine learning-based analysis to examine the associations between changes in multiple neighborhood physical and social environmental characteristics pre- and post-migration and migrants' mental health in Shenzhen, a metropolis whose population is largely composed of migrants. We also addressed how important changes in neighborhood characteristics are related to individual-level characteristics, including their level of interactions across variables – an issue that has rarely been examined.

### 6.4.1 Experience of environmental neighborhood change

We found that, in general, migrants experienced a decline in neighborhood aesthetics, safety, and social cohesion post-migration. This result supports studies that have reported that migrants are likely to end up in less desirable neighborhoods due to their disadvantaged position in the local housing market (Zheng et al., 2009). Unaffordable housing prices in Shenzhen (Sun, 2020), combined with a lack of family support, social capital, and financial capital, contributed to migrants' higher level of housing stress and poorer neighborhood choice in Shenzhen (Cui et al., 2016). Meanwhile, migrants' social integration may negatively affect their perception of social aspects of the neighborhood environment (Li and Liu, 2018), contributing to their reduced perceptions of neighborhood social cohesion in the host city.

In addition to the experienced decline in neighborhood aesthetics, safety, and social cohesion, our respondents also reported an improvement in neighborhood facilities and accessibility and in green space in Shenzhen. Since the majority of internal migration flows in China are rural to urban and/or from less developed cities to metropolitan areas (Sun and Fan, 2011), migrants may experience an overall improvement in urban infrastructure provision at their destination in Shenzhen. The increased green space perception in Shenzhen could be attributed to the city's subtropical climate, which makes it greener than most other Chinese cities, especially northern cities: In 2018, the

green coverage rate of Shenzhen's the built-up area was 45.1%, making it a top-ranking ecological environment among Chinese cities (Tao and Yuan, 2019).

#### **6.4.2 Neighborhood change and mental health**

Our results suggest that post-migration, migrants moved to less safe neighborhoods and had poorer mental health. However, an improvement in neighborhood safety was not associated with mental health benefits. Similarly, non-linear associations with mental health were also found for neighborhood aesthetic quality and green space, where only the association between a decline in neighborhood characteristics and poor mental health was identified. Empirical studies have suggested that neighborhood safety, aesthetic quality, and green space contribute to residents' mental health (Gao et al., 2016; Markevych et al., 2017; Wang et al., 2019). Therefore, it is reasonable to conclude that a decline in such neighborhood characteristics may contribute to mental illness. Furthermore, due to institutional barriers caused by hukou, and a lack of social support in the host city, migrants struggle to maintain their neighborhood quality in the host city (Huang et al., 2014), which may induce additional stress as a result of ending up in deprived neighborhoods, putting them at risk for mental illness (Li and Liu, 2018).

For neighborhood social cohesion, we found that a perceived decline in such cohesion is associated with poor mental health, and that a perceived improvement is associated with better mental health. Previous research has shown positive effects of perceived neighborhood social cohesion in terms of improving residents' life satisfaction (Maas et al., 2016) and enhancing their social contact and support (O'Campo et al., 2009), which contribute to good mental health.

A somewhat unexpected finding was that people who moved to neighborhoods with better facilities and accessibility post-migration reported poorer mental health. This result is contradictory to that of other studies (Gao et al., 2016; Matheson et al., 2006). However, some studies did find an association, albeit an insignificant one, between mental health and access to neighborhood facilities and services (Kubzansky et al., 2005; O'Campo et al., 2015; Wen et al., 2010). Similarly, a UK panel data-based study (Tunstall et al., 2014) on internal migrants found that moving to a less deprived physical environment was associated with poor mental health. In fact, most evidence on the health-promoting role of neighborhood facilities and accessibilities concerns residents' physical (rather than mental) health, which is promoted by encouraging physical activities and more active traveling modes, such as walking and cycling (Humpel et al., 2002; Renalds et al., 2010; Tan et al., 2014). Considering the limited and mixed results linking neighborhood facilities and accessibilities to mental health, we speculate that while better neighborhood facilities and accessibility may indirectly contribute to residents' mental health by improving their physical health, there are potential stressors that may offset the effect. For instance, neighborhoods with better facilities and accessibility may attract more visitors, increasing the density and crowdedness of the neighborhood, which will have negative impacts on mental health (Gong et al., 2016). In sum, our results suggest that neighborhood changes and mental health have a complex, non-linear relationship. The mechanisms behind the patterns require more in-depth and context-specific investigations.

In line with an earlier study concerning the general population (Helbich et al., 2020), the variable importance showed that, in general, neighborhood characteristics were less important in explaining migrants' mental health outcomes compared to their individual-level characteristics (e.g., physical health, income, and hukou). A reason for this could be that individual-level characteristics, such as income and hukou, may not only serve as influential factors for migrants' mental health (Beard et al., 2008; Yang et al., 2018), but also enable or constrain people's selection of neighborhood types (Weden et al., 2008). Among the perceived neighborhood characteristics, it turned out that neighborhood safety in the host city was essential. This result is congruent with earlier work that reported that safety in the living environment is related more strongly to migrants' reduced psychological stress level in the host city than any other neighborhood physical characteristic (Gu et al., 2015).

#### **6.4.3 The importance of physical health**

Physical health is often strongly related to migrants' mental health, as it is for general populations (Ohrnberger et al., 2017a; Yang et al., 2018). Poor physical health may limit people's physical activity (Ohrnberger et al., 2017a), which increases the risk for mental illness (Meyer et al., 2014). In addition, in our models we found striking interactions between physical health and income, hukou, and three neighborhood characteristics (green space, aesthetics, and safety). For instance, people with poor physical health were at greater risk for mental illness if they had a low personal income compared to those with better physical health. Similarly, the relationships between changed neighborhood-level characteristics and mental health varied across physical health groups. Specifically, migrants with fair/poor physical health were more sensitive to a decrease in perceived neighborhood green space.

Our results also showed that poorer mental health was associated with worsening perceived neighborhood aesthetics and safety only for those with at least very good physical health. Such differences across physical health groups may be due to the fact that physical health status may influence people's perception of their neighborhood environment (Wen et al., 2006). Physical health conditions were also found to be related to the way and frequency with which people interact with their neighborhood environment (Roh et al., 2011). For example, physically healthier people tend to go out more frequently than less healthy people, and thus their mental health response could be more sensitive to a decline in neighborhood aesthetics and safety.

#### **6.4.4 Other individual-level characteristics: income and hukou**

Income and hukou type were also found to be important for migrants' mental health in the host city. Several studies have suggested an income – health gradient, whereby a high personal income is associated with better mental health (Gresenz et al., 2001; Ohrnberger et al., 2017b). A positive association between income, life satisfaction, and mental health may be especially important for migrants, because they mainly move to cities to earn higher incomes (Chen et al., 2019). In our study, hukou was also of central importance for migrants' mental health, as highlighted in other Chinese studies (Li and Rose, 2017; Qiu et al., 2011). Hukou is strongly related to social welfare, health services, and the provision of other public services (Gong et al., 2012). The difference between local

hukou and non-local hukou holders regarding health insurance and social welfare indicates great health inequality in cities like Shenzhen (Lam and Johnston, 2012). Migrants frequently suffer from such inequality due to difficulties in transferring their hukous to the host city (Yang et al., 2018).

#### **6.4.5 Strengths and limitations**

Our study had numerous strengths. First, we focused on neighborhood changes pre- and post-migration, something that has rarely been done. Second, we incorporated multiple neighborhood characteristics rather than focus on a single one. This approach took into account that different neighborhood characteristics are likely to co-vary and influence each other. Third, in order to be methodologically innovative, we employed a data-driven random forest to assess the variable importance of neighborhood characteristics and their interactions, while going beyond linear relations.

Our study also had a number of limitations. First, the cross-sectional nature of the research design did not allow for causal statements. Second, although the perceived neighborhood characteristics have been found to be more influential for mental health than objective measures (Zhang et al., 2019), we cannot rule out that people's perceptions vary, so their retrospective neighborhood assessments might have been prone to recall bias. Finally, due to a lack of data on migrants' mental health conditions prior to moving to Shenzhen, we were not able to realize longitudinal analyses. Given these limitations, we encourage future studies to employ longitudinal designs that incorporate both objective and perceived neighborhood characteristics, while measuring changes in mental health over time.

### **6.5 Conclusions**

This study was among the first to examine changes in the perceived physical and social residential environments on migrants' mental health. We found that a reduction in neighborhood aesthetics, safety, green space, and social cohesion pre- and post-migration to Shenzhen were associated with poor mental health post-migration. Yet, the impact of neighborhood environment changes on migrants' mental health was minor. Three individual-level characteristics—namely physical health, income, and hukou – were among the most important factors associated with migrants' mental health. In addition, physical health interacted strongly with other variables (e.g., income and hukou) when correlating with mental health. While replication in a longitudinal setting is required, an actionable target to promote mental health among migrants in the Chinese context could be the prioritizing of individual-level characteristics rather than focusing solely on neighborhood characteristics.

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Chapter

7

Discussion and conclusions

## 7.1 Introduction

In recent years, an increasing number of studies have focused on the promotion of the mental health of migrants in urban China. These studies have revealed a series of risk and protective factors for migrants' mental health at both the individual and the neighborhood level. For instance, income, hukou status, and physical health are significant individual characteristics that are closely related to migrants' mental health (Cummins, 2000; Li and Rose, 2017; Ohrnberger et al., 2017a). At the neighborhood level, neighborhood safety, green space, and the social environment have been found to have positive impacts on migrants' mental health (Gu et al., 2015; Liu et al., 2019; Wen et al., 2010).

However, the existing knowledge has several limitations. The current understanding of "migration" in studies on the mental health of Chinese internal migrants results in: 1) Limited knowledge of the implications of defining migrants by hukou or by birthplace. 2) Neglecting the possibility of multiple migrations and their relationship to migrants' mental health. 3) Limited knowledge of the mental health benefits of green space and the potential pathways for migrants in China. 4) Overlooking residential history when analyzing the neighborhood – mental health relationship for migrants in China. 5) A lack of understanding of how differences between pre- and post-migration neighborhoods are related to migrant's mental health in host cities

The research underlying this thesis addressed the above research limitations. By incorporating a life-course-oriented framework in understanding migration as a sequence of moves and neighborhood changes associated with the move, the research examined migrants' mental health in relation to their migration trajectories and neighborhood environments along the migration journey. This chapter presents the main findings of this research and discusses the theoretical implications and empirical findings on the migration – mental health relationship.

## 7.2 Main findings

Five research questions were presented in the introduction to this thesis. This section summarizes and interprets the main findings discussed in Chapters 2 through 6, which provided answers to these research questions.

1. *What is the impact of defining migration by hukou or by birthplace on the migration – mental health relationship?*

Previous studies on the mental health of migrants in China primarily focused on rural – urban migrants who lacked local hukous in host cities. However, using the hukou-based definition does not capture the whole group of migrants, since a considerable number manage to transfer their hukous

to host cities (Sun and Fan, 2011). Chapter 2 defined migrants by both hukou and birthplace, and compared the impacts on the results when examining migrants' mental health.

The results suggest that defining migrants by birthplace rather than hukou captures a larger group of migrants. The regression analysis showed migration to be significantly associated with the prevalence of mental health problems among internal migrants in China. We found that in Shenzhen, migrants defined by hukou were more likely to have mental health problems than non-migrants. However, when migrants were defined by birthplace, migrants were found to be mentally healthier and less likely to have mental health problems than non-migrants. In addition, physical health and personal incomes were found to be significantly related to migrants' mental health using both definitions. This suggests that physical health and personal income are strongly related to people's mental health, independent of their migration status (Lund, 2012; Ohrnberger et al., 2017b). The findings suggest that birthplace serves as a better definition of migrants because the hukou-based definition may lead to overestimating the negative impact of hukou on migrants' mental health. However, hukou still plays a crucial role in understanding the mental health of migrants in China, because not holding a local hukou leads to a mental health inequality between local hukou holders and non-local hukou holders in host cities in terms of mental health risk levels, healthcare accessibility and utilization, and social support (Li and Rose, 2017; Qiu et al., 2011).

## *2. How do migration trajectories differ from one another, and how are these trajectories associated with migrants' mental health?*

Chapter 3 investigated migrants' mental health in relation to their migration trajectories. It contributes to the mental health literature as previous studies often disregarded migration histories over people's life courses (Li et al., 2014). By adopting sequence alignment methods (SAM), we were able to analyze migrants' migration trajectories quantitatively and identify eight types of migration trajectory.

The results show that migrants in general had conducted multiple migration trips over the course of their lives. By analyzing migration trajectories based on when and why the migration trips took place throughout a person's life course, we identified eight types of migration trajectory, namely "college graduates," "educational movers," "family movers," "job transfer movers," "work-related movers," "new job movers," "marriage movers," and "old movers," each group exhibiting distinct migration patterns over time. The regression analysis showed that compared to the college graduates, old movers are at greater risk of having mental health problems. In contrast, educational movers and job transfer movers were less likely to have mental health problems than college graduates when controlling for other individual characteristics.

In sum, simplifying migration as a one-time event could lead to the misinterpretation of the effect of migration on mental health. Migrants differ in terms of socio-demographics (Yang et al., 2018), place of origin (Chen, 2011), and sociocultural background (Yang et al., 2012), and these characteristics

have been analyzed in relation to migrants' mental health in previous studies. However, people's migration experiences differ as they are formed along migrants' moves through space and time. Such differences were captured and represented by the migration trajectories, as presented in Chapter 3. Analyzing migration trajectories can help us to better understand migrants' experiences throughout their journeys and the mental health implications of these experiences.

*3. What are the pathways linking neighborhood green space exposure to migrants' mental health in the host city?*

Evidence on the beneficial impact of neighborhood green space on residents' mental health has been mounting in recent years. While several mediating pathways between green space and mental health have been identified, what remained unknown is whether these pathways have the same effect for migrants and how the mediators interact simultaneously. Chapter 4 addressed this research gap by utilizing structural equation modeling (SEM) and accounting for migrants' individual characteristics.

The results suggest only a minor indirect pathway between neighborhood green space and migrants' mental health, mediated by perceived social cohesion in the residential neighborhood. Although no direct effect was found between green space and mental health for migrants, we did find the suggested effect of green space in terms of reducing harmful exposures to air pollution and noise and promoting social cohesion (Markevych et al., 2017). We speculate that the high mobility rate and relatively short exposure period may explain the missing direct link between neighborhood green space and the mental health of migrants.

*4. How are migrants' pre- and post-migration neighborhoods associated with their mental health in the host city?*

Chapter 5 explored the role of migrants' pre- and post-migration neighborhood environments on their mental health in the host city. Inspired by analytical models from life-course epidemiology, we hypothesized two pathways linking migrants' pre-migration environment to their mental health, namely a direct pathway based on the latency model and an indirect pathway mediated by post-migration neighborhood, based on the pathway model.

Results suggest there is no direct pathway from pre-migration neighborhood to mental health. The pathway model was supported as we found an indirect pathway between pre-migration neighborhood and mental health via the post-migration neighborhood. The results show that migrants' pre- and post-neighborhood environments follow a pathway dependency over migrants' residential trajectories, where the original neighborhood environments serve as strong predictors of neighborhood environments in the future (Zwiers et al., 2017). In addition, both pre- and post-migration SES were directly and indirectly linked to migrants' mental health. As suggested by literature, individual SES, including education and income, could influence people's mental health

through health awareness and risk behaviors, the affordability of health services, and stress arising from poverty (Beard et al., 2008; Hoffmann et al., 2018; Silva et al., 2016). The mediatory pathways also showed that migrants' pre-migration SES has a lasting impact on their post-migration mental health by influencing their choice of neighborhood at different points in time.

5. *How are changes in neighborhood characteristics associated with migrants' mental health in the host city, and which neighborhood changes have the most influence on migrants' mental health?*

Chapter 6 examined the relationship between perceived neighborhood changes due to migration and migrants' mental health in the host city. A machine learning-based analysis was used to accommodate non-linear relationships between variables and provide the relative importance of individual- and neighborhood-level variables in explaining migrants' mental health.

The results show that changed neighborhood environments were non-linearly associated with migrants' mental health in the host city. A reduction in neighborhood aesthetics, safety, green space, and social cohesion pre- and post-migration to Shenzhen were associated with poor mental health post-migration. However, the influence of changed neighborhood environment on migrants' mental health is minor. Individual-level factors – such as physical health, income, and hukou—were the most important variables associated with migrants' mental health. Of the neighborhood-level factors, the change in neighborhood safety was the most important factor impacting migrants' mental health. These findings suggest that individual-level characteristics should be prioritized when trying to promote the mental health of migrants. Research in a Dutch setting also found individual characteristics to be more important for depression severity compared to neighborhood characteristics (Helbich et al., 2020).

### 7.3 Theoretical implications

The insights from the empirical analyses on the relationship between migration, migrants' residential experience, and migrants' mental health have a number of implications for current theoretical discussions on mobility and the effect of neighborhood on mental health, as well as for mental health research in general.

First, this thesis suggests conceptualizing migration as a dynamic process that involves people's experiences over space and time. When linking migration to mental health outcomes, previous studies often recognized migration as an individual characteristic. Thus, the major body of studies on migrants' mental health operationalized migration as an independent variable and/or made migrant/non-migrant mental health comparisons (Hu et al., 2007; Keung Wong et al., 2007; Stillman et al., 2009). In the Chinese context, what first comes to mind when people hear the word "migration" is usually the image of rural migrant workers who lack urban hukous and work as manual laborers in cities (Liang et al., 2014; Zhong et al., 2016). However, migration is more

complex than an individual characteristic or a hukou. This thesis presents empirical evidence for the substantial relationship between the experience of migration (including migration trajectories triggered by life events and residential environments in pre- and post-migration neighborhoods) and mental health, and has demonstrated that migration is a combination of life events at different life stages and change of residences over time. These changes at the individual and the neighborhood level can better explain migrants' mental health compared to treating migration as an individual characteristic. Data on migration in China suffer from great complications, making the tracing of migrants a major challenge when investigating migrants' mental health. The number of migrants varies across administrative sources, since sources vary in their choice of migration criteria and capture different parts of this population group (Wong et al., 2015). Consequently, the definition of migrants influences the results on the migration – mental health relationship (Chapter 2). By shifting the focus from migrants as an individual identity to the whole experience over space and time, we avoided inconsistent results regarding the migration – mental health relationship (e.g., (Yang et al., 2018; Zhong et al., 2015)). Instead, we were able to explain the complex relationship based on varied migration experiences between each migrant.

Whereas many studies on the neighborhood environment and mental health focused on the objectively measured environment (e.g., these are the examples of objectively measured environment mentioned before) street connectivity, residential density, land-use mix, and green space) (Roe et al., 2013; Saarloos et al., 2011; van den Berg et al., 2010), the present research focused on exploring the neighborhood environment and migrants' mental health from a subjective perspective. The focus on subjectively measured neighborhood environments allowed us to further investigate the neighborhood – mental health effect by, first, recognizing the diversity of the neighborhood experiences of people from different sociodemographic backgrounds. Kwan (2018) pointed out that the neighborhood effect is idiosyncratic based on how individuals perceive and react to specific environments; therefore the health behaviors and outcomes may vary across people's specific attributes. For instance, age and gender difference have been observed in relation to how people perceive and make use of certain spaces (Musterd et al., 2012; Shigematsu et al., 2009). To take a step further, people's perceptions of neighborhood environments and their consequential health effects can also vary across people's life courses. Studies have reported differences between young and old people regarding how they perceive and utilize neighborhood facilities (Murry and Isaacowitz, 2017; Shigematsu et al., 2009).

Second, by conceiving the effects of neighborhood environment as a wide range of subjective experiences over space and time (e.g., pre- and post-migration neighborhoods) and measuring the perceived neighborhood environment in both pre- and post-migration places, we were able to identify the pathways linking early life neighborhood experience to migrants' mental health. It might be argued that migrants' mental health is affected by the combination of neighborhood experiences throughout their migration trajectories. By integrating insights from life-course epidemiology and environmental psychology, we have shown that migrants' mental health is related to perceptions of the neighborhood environment in both the pre- and the post-migration stage.

Moreover, the relationship between neighborhood green space and mental health appears to be mediated by perceived social cohesion, in the sense that a higher level of perceived green space promotes better perceived social cohesion in the neighborhood, and therefore reduces the risk of mental health problems for migrants. Similar mediation pathways between neighborhood green space and mental health were found in another Chinese study (Liu et al., 2019).

These findings provide novel insights into expanding the debate on migration, neighborhood perceptions, and mental health (e.g., Gu et al. 2015; Li and Rose 2017; Xiao et al. 2018), which is currently largely investigated without considering the role of pre-migration neighborhood and the interplay between neighborhood physical and social environments. As many studies have suggested that a pleasant neighborhood environment contributes to better mental health (Dong and Qin, 2017; Gao et al., 2016; Truong and Ma, 2006), it may even be said that neglecting the role of early life neighborhood experience could lead to spurious associations between the neighborhood environment and mental health (Helbich, 2018). Including the pre-migration neighborhood could contribute to a more nuanced and inclusive picture of neighborhood environment and mental health, especially when considered in the context of changing residence for migrants.

This research also contributes to our knowledge of the complex relationships between changed residential experience throughout migration and migrants' mental health. Few studies have investigated the dynamic residential experience along people's residential mobility. Specifically, little is known about how differences in certain neighborhood characteristics between the pre- and the post-migration neighborhood are related to migrants' mental health. There is, however, evidence suggesting that migrants are likely to end up in less desirable neighborhoods in host cities, due to their lower SES and to housing inequalities caused by hukou barriers (Li and Liu, 2018; Liu et al., 2015). Our investigation revealed non-linear relationship between changed neighborhood experience and mental health and adds to the literature a new way of analyzing people's residential experience in relation to their mental health.

#### **7.4 Limitations and recommendations for future research**

Although this thesis provides empirical evidence for the importance of analyzing the migration trajectory and the residential experience along that trajectory in relation to migrants' mental health in China, there is room for further research to build upon the findings of the present research from different perspectives. First, as demonstrated in Chapter 3, migrants conduct multiple migration trips over their life courses. However, our investigation into the neighborhood trajectory was limited to places before and after people migrated to Shenzhen (Chapter 5). Although the choice was made to minimize recall bias and ensure the survey reliability by restricting the burden on respondents, it did limit our interpretation of migrants' residential history and their mental health. Therefore, future studies could incorporate the environmental exposures from the birthplace to the host city

to provide a comprehensive residential trajectory. This would improve the model quality of linking residential history to mental health in later life.

In addition, the present research measured migrants' environmental exposure over time at a perceptual level. Analyzing the neighborhood environment at a perceptual level takes into account the diversity of people's experience of and interactions with the environment based on their individual backgrounds. However, the lack of objective environmental information was a limitation of this research. Empirical evidence suggests that perceived neighborhood environment has a closer relationship with residents' mental health and mediates the relationship between objective environment and mental health (Dzhambov et al., 2018). Future studies could extend the present research by including in the framework the objective neighborhood environment along migrants' residential trajectories. In addition, future studies could incorporate the spatial – temporal trajectory that people follow throughout their migration, as is done in studies on daily mobility (Kawase and Ito, 2016). This would enable the tracking of migrants' footprints over space and time by including historical spatial information, which would help to improve our understanding of the relationship between migration, residential trajectory, and mental health.

Moreover, future studies on international migration and mobility studies in general could also benefit from the conceptualization of migration used in this thesis. International migration, especially refugee migration, also entails multiple transit points before people reach their final destinations (Schwarz, 2018). Similarly, people may make multiple residential moves during their life courses. Studies as such could gain deeper insights into the meaning of migration/mobility based on the theoretical and analytical approach on migration and residential trajectory. Furthermore, the analysis of people's spatial trajectories could also be extended beyond the residential environment. Most contextual studies in epidemiology have ignored exposure to activity spaces outside of the residential environment (Chaix, 2009). For instance, people may not be constantly exposed to air pollution from traffic in their neighborhood, but only on their way to work. A healthy diet can also be related to people's access to healthy food at school and the workplace. The characteristics of the non-residential environment that people visit in their everyday lives may mitigate or exacerbate the disadvantage they experience in their residential neighborhood (Kwan, 2015). With the help of GPS, it is possible to establish not only when, where, and for how long people conduct their activities, but also the route they take to reach where they conduct those activities, as well their travel behavior throughout the day (Kerr, et al., 2011). This provides an opportunity to further investigate individuals' environmental exposures outside of their residential neighborhoods.

## 7.5 Policy implications

This research revealed several individual- and neighborhood-level factors that are related to migrants' mental health while they reside in Shenzhen. This section provides suggestions on how this knowledge can be translated into policies and interventions to promote migrants' mental health in urban China.

As suggested in Chapter 2, hukou may not be an adequate definition for migrants, yet it is still a significant institutional barrier preventing migrants from accessing public healthcare services and social benefits in the host city, thus contributing to health inequalities between the holders of local hukous and non-local hukous. The institutional barrier for migrants has been broadly discussed in relation to social and health inequalities in urban China (Keung Wong et al., 2007; Liu, 2005; Qiu et al., 2011). The lack of local hukous means that migrants are unable to access public education and healthcare resources and are excluded from subsidies and welfare in host cities (Mackenzie, 2002). Chapter 6 also stressed that hukou is one of the most important individual-level factors affecting migrants' mental health. We can therefore expect that minimizing gaps between the hukou types will lead to noticeable mental health benefits. Although it might be unrealistic to abandon the hukou system in the short term, some measures could be taken to reduce the social gap between different hukou types. For instance, municipalities could consider extending medical insurance to non-local hukou holders. In addition, policymakers could provide subsidies for uninsured migrants to access basic public healthcare services in cities. Such approaches could encourage migrants to utilize the health resources in host cities, thereby reducing their risk of physical and mental health problems (Lam and Johnston, 2012).

In addition, interventions promoting mental health at the individual level could be focused on improving migrants' physical health. Our results stress the close relationship between migrants' physical and mental health. It has been suggested that migrants in general have better initial physical health than non-migrants in host cities (Lu and Qin, 2014). The challenge is to maintain migrants' physical health advantage during their residence in host cities. The negative effects of urban environments – such as higher air pollution and noise exposure – may have impacts on migrants' physical and mental health over time. The results presented in Chapter 4 show that perceived neighborhood green space could significantly reduce the distress caused by perceived air pollution and noise in the neighborhood. Thus, urban planners are advised to ensure access to large amounts of green space in neighborhoods, especially in inner-city villages and factory dorms where migrants are concentrated, and the residential environment is poor. In addition, although some of the effects of green space did not seem to be related to migrants' mental health, the beneficial role of green space in facilitating social cohesion was proven in our study. We believe that the positive mental health effect for migrants will gradually build up the longer they remain in the host city. Therefore, green space still plays a curtail role in promoting migrants' mental health in urban areas.

Chapter 6 suggests that migrants experience an overall decrease in the quality of the neighborhood environment post-migration. Therefore, housing policies should ensure that migrants have access to good quality housing and neighborhoods in host cities in order to improve their starting point in the housing market. Due to increasing housing prices in metropolitan areas like Shenzhen, policies impose severe restrictions on the purchase of commodity housing by non-local hukou holders. Therefore, cities like Shenzhen should not only increase the share of social housing and public rentals in their existing housing markets, but also provide a certain quota of public rental housing for migrants to ensure their access to rental housing in the highly competitive rental market. Municipalities should also improve migrants' access to information by putting more advertisements on line, on TV, and in paper publications, providing guidance for migrants concerning both public and private rental markets, and regulating rental agencies to ensure healthy landlord-tenant relationships and protect tenants' legal rights.

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# Appendix

## Supplementary materials

### Using structural equation modeling to examine pathways between perceived residential green space and mental health among internal migrants in China

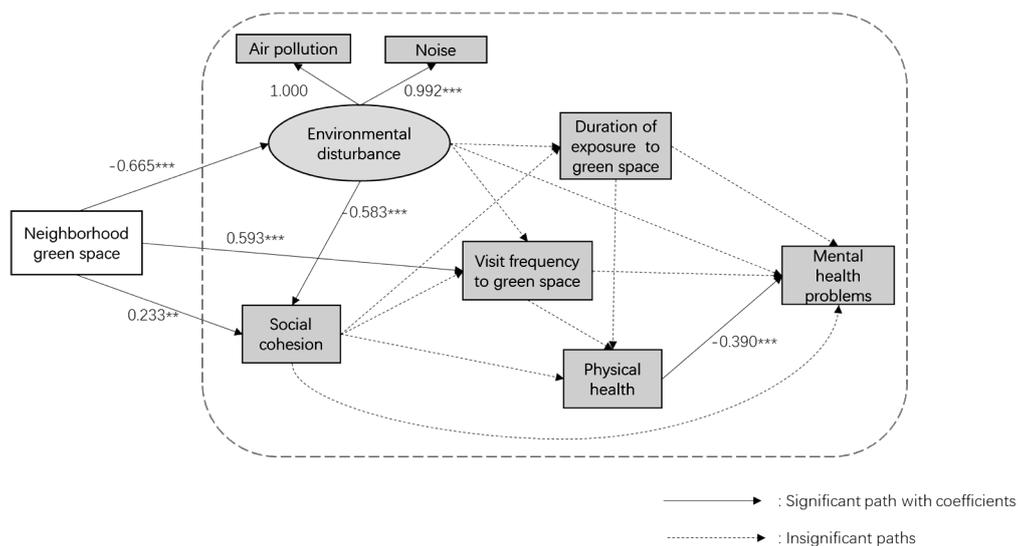
Below we summarize the structural equation modeling results for seven alternative models and outlines how we reached our final model (Model A7) reported in the paper. The significance levels for all tables and figures : \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

The correlation matrix of key variables is provided at the end of the file (Table A8).

#### 1. Model A1 with insignificant theoretical paths.

For the readability of Figure A1, we only show the paths between greenspace-related variables and mental health. We do not show the coefficients of insignificant paths. As can be seen, by doing so the situation regarding the significance of indirect relations via those insignificant direct relations turns out to become worse than before. Even less significant indirect pathways appear because of the dispersion of indirect effects over more indirect pathways possible. As Table A1-2 suggests, none of the green space-related variables had significant indirect effects to mental health. Table A1-3 shows only the total effects from income, residential mobility, and physical health were significant.

Goodness of Fit Statistics: GFI=0.998; AGFI=0.983; CFI=1.000; RMSEA=0.0925; PGFI=0.114; Model AIC=258.595



**Figure A1** SEM model keeping all insignificant paths

Appendix

Table A1-1 *Unstandardized direct effects from estimated model*

<b>From</b> \ <b>To</b>	<b>Mental health</b>	<b>Physical health</b>	<b>Duration of exposure</b>	<b>Visit frequency</b>	<b>Social cohesion</b>	<b>Environmental disturbance</b>
<b>Dependent variables</b>						
Physical health	-0.390***	—	—	—	—	—
Duration of exposure	0.036	0.062	—	—	—	—
Visit frequency	-0.068	-0.077	—	—	—	—
Social cohesion	-0.025	-0.037	0.052	0.155	—	—
Environmental disturbance	0.134	0.006	0.096	-0.063	-0.583***	—
<b>Independent variables</b>						
Perceived green space	0.172	0.113	0.146	0.593***	0.233*	-0.665***
Age	-0.053	0.032	0.015	-0.012	0.002	-0.013
Gender (Male)	0.150**	0.220***	0.016	0.074*	-0.022	-0.031
Income	-0.145**	0.053	-0.048	-0.031	0.023	-0.015
Origin place (Urban)	0.029	0.075*	-0.047	0.032	0.010	-0.003
Migration frequency	-0.009	-0.077*	0.032	-0.035	-0.015	-0.021
Residential mobility	0.057	-0.107**	-0.085*	0.011	-0.054	0.017

Table A1-2 *indirect effects from estimated model*

<b>From</b> \ <b>To</b>	<b>Mental health</b>	<b>Physical health</b>	<b>Duration of exposure</b>	<b>Visit frequency</b>	<b>Social cohesion</b>	<b>Environmental disturbance</b>
<b>Dependent variables</b>						
Physical health	-0.024	—	—	—	—	—
Duration of exposure	0.030	—	—	—	—	—
Visit frequency	0.009	-0.009	—	—	—	—
Social cohesion	0.010	0.037	-0.030	-0.090	—	—
Environmental disturbance	—	—	—	—	—	—
<b>Independent variables</b>						
Perceived green space	-0.164	-0.076	-0.032	0.138*	0.388***	—
Age	-0.014	0.001	-0.001	0.002	0.008	—
Gender (Male)	-0.092***	-0.005	-0.003	0.001	0.018	—
Income	-0.023	-0.002	0.000	0.006	0.009	—
Origin place (Urban)	-0.031*	-0.006	0.000	0.002	0.002	—
Migration frequency	0.029*	0.004	-0.002	0.001	0.012	—
Residential mobility	0.043**	-0.003	-0.002	-0.011	-0.010	—

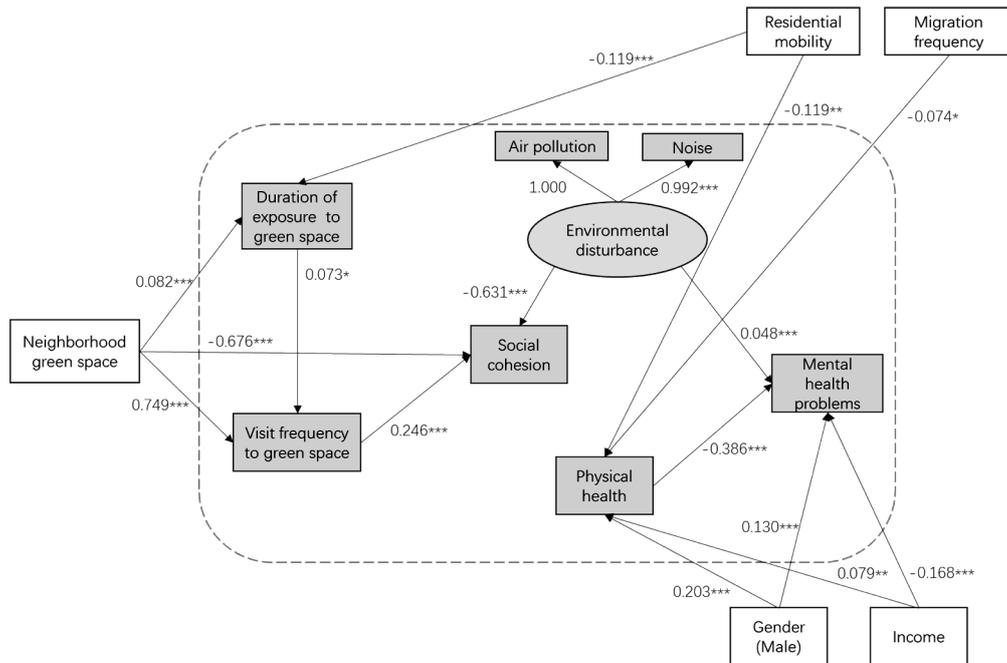
**Table A1-3** *Unstandardized total effects from estimated model*

<b>From</b>	<b>To</b>	<b>Mental health</b>	<b>Physical health</b>	<b>Duration of exposure</b>	<b>Visit frequency</b>	<b>Social cohesion</b>	<b>Environmental disturbance</b>
<b>Dependent variables</b>							
Physical health		-0.390***	—	—	—	—	—
Duration of exposure		0.012	0.062	—	—	—	—
Visit frequency		-0.037	-0.077	—	—	—	—
Social cohesion		-0.016	-0.045	0.052	0.155	—	—
Environmental disturbance		0.144	0.043	0.066	-0.153	-0.583***	—
<b>Independent variables</b>							
Perceived green space		0.007	0.037	0.114***	0.731***	0.621***	-0.665***
Age		-0.067	0.034	0.015	-0.010	0.010	-0.013
Gender (Male)		0.058	0.215***	0.013	0.075*	-0.004	-0.031
Income		-0.168***	0.051	-0.048	-0.025	0.032	-0.015
Origin place (Urban)		-0.002	0.069*	-0.046	0.034	0.011	-0.003
Migration frequency		0.020	-0.073*	0.030	-0.035	-0.003	-0.021
Residential mobility		0.101**	-0.110**	-0.087*	0.001	-0.064	0.017

**2. Model A2 with reverse path directions from visit frequency and exposure duration to environmental disturbance and social cohesion.**

This specification did not contribute any additional explanation concerning the presence of mental health problems among urban migrators. Neither a significant effect of social cohesion on mental health problems appeared nor were changes in other effects noticeable. Current green space, environmental problems, visiting frequency, social cohesion, and to a minor extent the exposure time were associated with one another; however, not with the mental and physical health conditions of the respondents.

Goodness of Fit Statistics: GFI=0.995; AGFI=0.990; CFI=1.000; RMSEA=0.0509; PGFI=0.502; Model AIC=237.958



**Figure A2** SEM model with reversed paths from visit frequency and duration to social cohesion and environmental disturbance

**Table A2-1** *Unstandardized direct effects from estimated model*

<b>From</b> \ <b>To</b>	<b>Mental health</b>	<b>Physical health</b>	<b>Duration of exposure</b>	<b>Visit frequency</b>	<b>Social cohesion</b>	<b>Environmental disturbance</b>
<b>Dependent variables</b>						
Mental health	—	—	—	—	—	—
Physical health	-0.386***	—	—	—	—	—
Duration of exposure	—	—	—	0.073	—	—
Visit frequency	—	—	—	—	0.246***	—
Social cohesion	—	—	—	—	—	—
Environmental disturbance	0.048**	—	—	—	-0.631***	—
<b>Independent variables</b>						
Perceived green space	—	—	0.082***	0.749***	—	-0.676***
Age	—	—	—	—	—	—
Gender (Male)	0.13**	0.203***	—	—	—	—
Income	-0.168***	0.079**	—	—	—	—
Origin place (Urban)	—	—	—	—	—	—
Migration frequency	—	-0.074*	—	—	—	—
Residential mobility	—	-0.119***	-0.119***	—	—	—

**Table A2-2** *Unstandardized indirect effects from estimated model*

<b>From</b> \ <b>To</b>	<b>Mental health</b>	<b>Physical health</b>	<b>Duration of exposure</b>	<b>Visit frequency</b>	<b>Social cohesion</b>	<b>Environmental disturbance</b>
<b>Dependent variables</b>						
Mental health	—	—	—	—	—	—
Physical health	—	—	—	—	—	—
Duration of exposure	—	—	—	—	0.018	—
Visit frequency	—	—	—	—	—	—
Social cohesion	—	—	—	—	—	—
Environmental disturbance	—	—	—	—	—	—
<b>Independent variables</b>						
Perceived green space	-0.032**	—	—	0.006*	0.612***	—
Age	—	—	—	—	—	—
Gender (Male)	-0.078***	—	—	—	—	—
Income	-0.03**	—	—	—	—	—
Origin place (Urban)	—	—	—	—	—	—
Migration frequency	0.028*	—	—	—	—	—
Residential mobility	0.046***	—	—	-0.009	-0.002	—

**Table A2-3** *Unstandardized total effects from estimated model*

<b>From</b>	<b>To</b>	<b>Mental health</b>	<b>Physical health</b>	<b>Duration of exposure</b>	<b>Visit frequency</b>	<b>Social cohesion</b>	<b>Environmental disturbance</b>
<b>Dependent variables</b>							
Mental health		—	—	—	—	—	—
Physical health		-0.386***	—	—	—	—	—
Duration of exposure		—	—	—	0.073*	0.018	—
Visit frequency		—	—	—	—	0.246***	—
Social cohesion		—	—	—	—	—	—
Environmental disturbance		0.048**	—	—	—	-0.631***	—
<b>Independent variables</b>							
Perceived green space		-0.032**	—	0.082***	0.755***	0.612***	-0.676***
Age		—	—	—	—	—	—
Gender (Male)		0.051	0.203***	—	—	—	—
Income		-0.198***	0.079**	—	—	—	—
Origin place (Urban)		—	—	—	—	—	—
Migration frequency		0.028*	-0.074*	—	—	—	—
Residential mobility		0.046**	-0.119***	-0.119***	-0.009	-0.002	—

### 3. Model A3 without the variable physical health.

The explained variance of mental health problems dropped from 18% to less than 3%. The estimated associations were hardly affected by dropping the variable physical health from the model. This implies that physical health plays an important role in explaining the variance of the outcome variable.

Goodness of Fit Statistics: GFI=0.995; AGFI=0.990; CFI=1.000; RMSEA=0.0472; PGFI=0.503; Model AIC=196.405

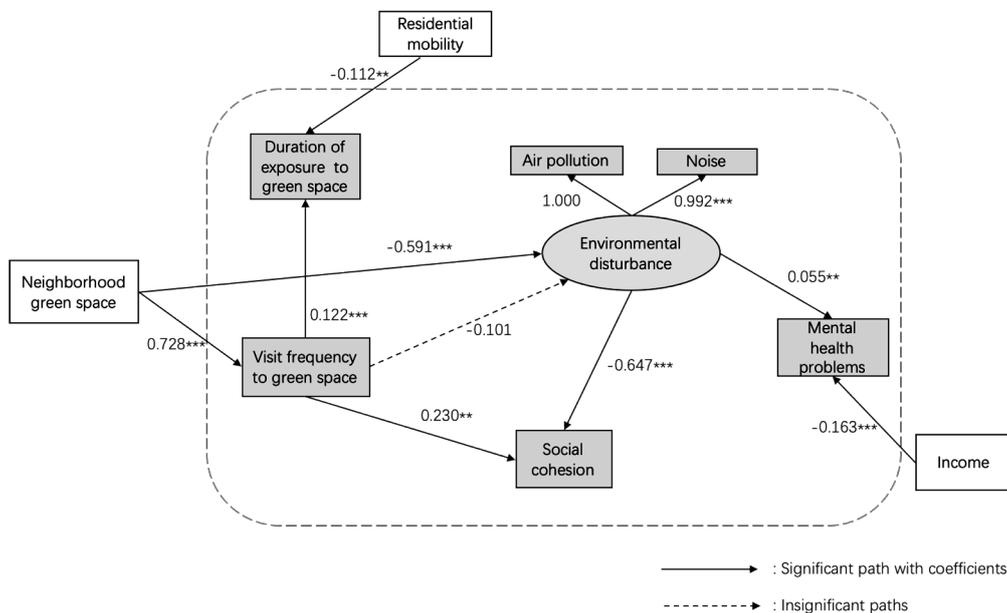


Figure A3 SEM model without physical health

**Table A3-1** *Unstandardized direct effects from estimated model*

	To	Mental health	Duration of exposure	Visit frequency	Social cohesion	Environmental disturbance
From						
<b>Dependent variables</b>						
Mental health	—	—	—	—	—	—
Duration of exposure	—	—	—	—	—	—
Visit frequency	—	0.122***	—	—	0.230**	-0.101
Social cohesion	—	—	—	—	—	—
Environmental disturbance	0.055**	—	—	—	-0.647***	—
<b>Independent variables</b>						
Perceived green space	—	—	—	0.728***	—	-0.591***
Age	—	—	—	—	—	—
Gender (Male)	—	—	—	—	—	—
Income	-0.163***	—	—	—	—	—
Origin place (Urban)	—	—	—	—	—	—
Migration frequency	—	—	—	—	—	—
Residential mobility	—	-0.112***	—	—	—	—

**Table A3-2** *Unstandardized indirect effects from estimated model*

	To	Mental health	Duration of exposure	Visit frequency	Social cohesion	Environmental disturbance
From						
<b>Dependent variables</b>						
Mental health	—	—	—	—	—	—
Duration of exposure	—	—	—	—	—	—
Visit frequency	-0.006	—	—	—	0.065	—
Social cohesion	—	—	—	—	—	—
Environmental disturbance	—	—	—	—	—	—
<b>Independent variables</b>						
Perceived green space	-0.036**	0.089***	—	—	0.597***	-0.073
Age	—	—	—	—	—	—
Gender (Male)	—	—	—	—	—	—
Income	—	—	—	—	—	—
Origin place (Urban)	—	—	—	—	—	—
Migration frequency	—	—	—	—	—	—
Residential mobility	—	—	—	—	—	—

**Table A3-3** *Unstandardized total effects from estimated model*

From \ To	Mental health	Duration of exposure	Visit frequency	Social cohesion	Environmental disturbance
<b>Dependent variables</b>					
Mental health	—	—	—	—	—
Duration of exposure	—	—	—	—	—
Visit frequency	-0.006	0.122***	—	0.295***	-0.101
Social cohesion	—	—	—	—	—
Environmental disturbance	0.055**	—	—	-0.647***	—
<b>Independent variables</b>					
Perceived green space	-0.036**	0.089***	0.728***	0.597***	-0.665***
Age	—	—	—	—	—
Gender (Male)	—	—	—	—	—
Income	-0.163***	—	—	—	—
Origin place (Urban)	—	—	—	—	—
Migration frequency	—	—	—	—	—
Residential mobility	—	-0.112***	—	—	—

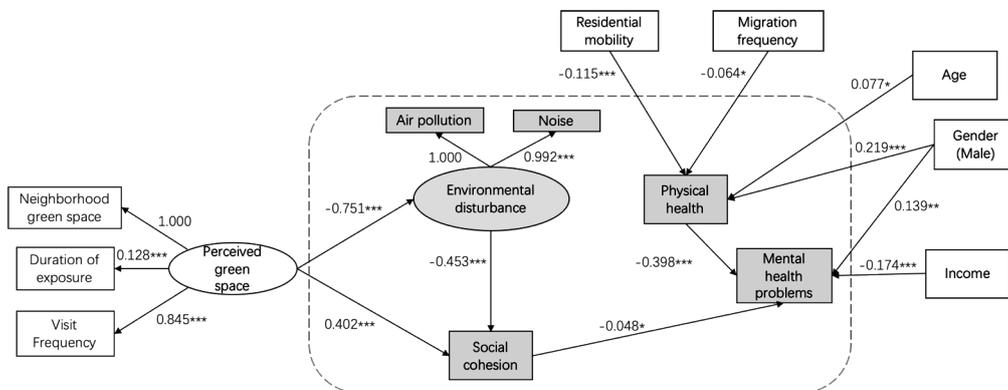
**4. Model A4 included a reciprocal association between mental health problems and physical health.**

We were not able to reach a solution in LISERAL with this model specification. The model did not converge (after 5,000 iterations) and resulted in (mathematical) model identification problems.

**5. Model A5 with a latent variable for perceived green space (i.e., current green space, visiting frequency and exposure time).**

From the model A5 we found that social cohesion was weakly and significantly associated with the presence of mental health problems. Perceived green space exposure, environmental disturbance and social cohesion were, as expected, strongly associated with each other. The explained variance of the outcome variable mental health problems was 18.3% while Model A7 explained 18.8%.

Goodness of Fit Statistics: GFI=0.994; AGFI=0.988; CFI=1.000; RMSEA=0.0469; PGFI=0.539; Model AIC=226.825



**Figure A5** SEM model with latent variable for perceived green space

**Table A5-1** *Unstandardized direct effects from estimated model*

From \ To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>Dependent variables</b>				
Mental health	—	—	—	—
Physical health	-0.398***	—	—	—
Social cohesion	-0.048*	—	—	—
Environmental disturbance	—	—	-0.453***	—
Perceived green space exposure	—	—	0.402***	-0.751***
<b>Independent variables</b>				
Age	—	0.077*	—	—
Gender (Male)	0.139**	0.219***	—	—
Income	-0.175***	—	—	—
Origin place (Urban)	—	—	—	—
Migration frequency	—	-0.064*	—	—
Residential mobility	—	-0.115***	—	—

**Table A5-2** *Unstandardized indirect effects from estimated model*

From \ To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>Dependent variables</b>				
Mental health	—	—	—	—
Physical health	—	—	—	—
Social cohesion	0.022*	—	—	—
Environmental disturbance	-0.035*	—	0.340***	—
Perceived green space exposure	—	—	—	—
<b>Independent variables</b>				
Age	-0.031*	—	—	—
Gender (Male)	-0.087***	—	—	—
Income	0.002	—	-0.036*	0.037**
Origin place (Urban)	—	—	—	—
Migration frequency	0.025*	—	—	—
Residential mobility	0.048***	—	-0.056***	0.057***

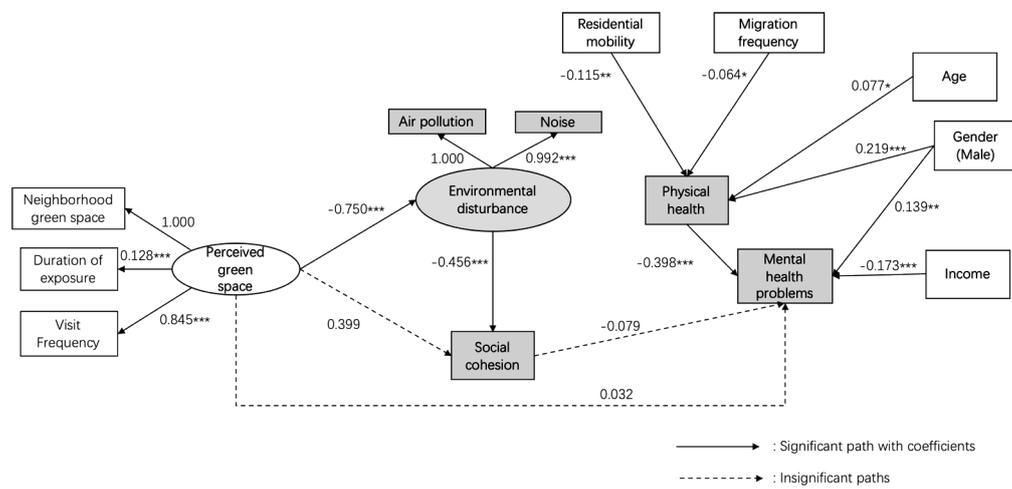
**Table A5-3** *Unstandardized total effects from estimated model*

From \ To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>Dependent variables</b>				
Mental health	—	—	—	—
Physical health	-0.398***	—	—	—
Social cohesion	-0.048*	—	—	—
Environmental disturbance	0.022	—	-0.453***	—
Perceived green space exposure	-0.035*	—	0.742***	-0.751***
<b>Independent variables</b>				
Age	-0.031*	0.077*	—	—
Gender (Male)	0.052	0.219***	—	—
Income	-0.173***	—	-0.036**	0.037**
Origin place (Urban)	—	—	—	—
Migration frequency	0.025*	-0.064*	—	—
Residential mobility	0.048***	-0.115***	-0.056***	0.057***

**6. Model A6 included the path from perceived green space exposure (i.e., the latent variable) to mental health problems, regardless its significance.**

As seen from figure A6, including this insignificant path attenuated the significance of some identified paths from Model A5 (i.e., from perceived green space to social cohesion and from social cohesion to mental health problems). Consequently, less significant indirect effects could be identified from this model(see table A6-2).

Goodness of Fit Statistics: GFI=0.994; AGFI=0.988; CFI=1.000; RMSEA=0.0463; PGFI=0.539; Model AIC=225.068



**Figure A6** SEM model with latent variable for perceived green space and keep the insignificant path from perceived green space to mental health problems

**Table A6-1** *Unstandardized direct effects from estimated model*

	To	Mental health	Physical health	Social cohesion	Environmental disturbance
From					
<b>Dependent variables</b>					
Mental health	—	—	—	—	—
Physical health	-0.398***	—	—	—	—
Social cohesion	-0.079	—	—	—	—
Environmental disturbance	—	—	-0.456***	—	—
Perceived green space exposure	0.032	—	0.399	-0.750***	—
<b>Independent variables</b>					
Age	—	0.077*	—	—	—
Gender (Male)	0.139***	0.219***	—	—	—
Income	-0.173***	—	—	—	—
Origin place (Urban)	—	—	—	—	—
Migration frequency	—	-0.064*	—	—	—
Residential mobility	—	-0.115**	—	—	—

**Table A6-2** *Unstandardized indirect effects from estimated model*

	To	Mental health	Physical health	Social cohesion	Environmental disturbance
From					
<b>Dependent variables</b>					
Mental health	—	—	—	—	—
Physical health	—	—	—	—	—
Social cohesion	—	—	—	—	—
Environmental disturbance	0.036	—	—	—	—
Perceived green space exposure	-0.058	—	0.342***	—	—
<b>Independent variables</b>					
Age	-0.031*	—	—	—	—
Gender (Male)	-0.087***	—	—	—	—
Income	0.001	—	-0.036**	0.036**	—
Origin place (Urban)	—	—	—	—	—
Migration frequency	0.025*	—	—	—	—
Residential mobility	0.048**	—	-0.056***	0.057***	—

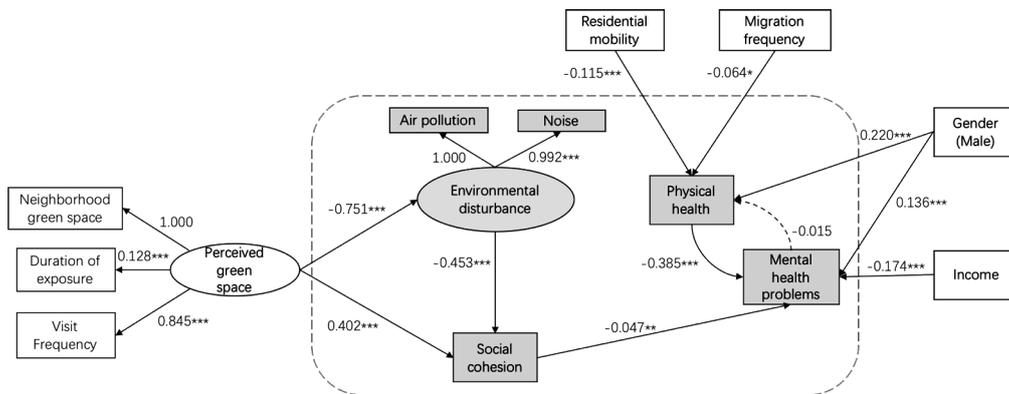
**Table A6-3** *Unstandardized total effects from estimated model*

From \ To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>Dependent variables</b>				
Mental health	—	—	—	—
Physical health	-0.398***	—	—	—
Social cohesion	-0.079	—	—	—
Environmental disturbance	0.036	—	-0.456***	—
Perceived green space exposure	-0.026	—	0.741***	-0.750***
<b>Independent variables</b>				
Age	-0.031*	0.077*	—	—
Gender (Male)	0.052	0.219***	—	—
Income	-0.172***	—	-0.036**	0.036**
Origin place (Urban)	—	—	—	—
Migration frequency	0.025*	-0.064*	—	—
Residential mobility	0.048**	-0.115**	-0.056***	0.057***

**7. Model A7 added a reciprocal association between mental health problems and physical health to Model 5**

This was the finally chosen model which is reported in the paper. Reasons for selecting this model were of both theoretical and statistical nature.

Goodness of Fit Statistics: GFI=0.994; AGFI=0.988; CFI=1.000; RMSEA=0.0469; PGFI=0.539; Model AIC=226.825



**Figure A7** SEM model presented in manuscript – latent variable for perceived green space and with reciprocal association between mental health problems and physical health

**Table A7-1** *Unstandardized direct effects from estimated model*

	To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>From</b>					
<b>Dependent variables</b>					
Mental health	—	—	-0.015	—	—
Physical health	—	-0.385**	—	—	—
Social cohesion	—	-0.047*	—	—	—
Environmental disturbance	—	—	—	-0.453***	—
Perceived green space exposure	—	—	—	0.402***	-0.751***
<b>Independent variables</b>					
Age	—	—	0.075	—	—
Gender (Male)	—	0.136**	0.220**	—	—
Income	—	-0.174**	—	—	—
Origin place (Urban)	—	—	—	—	—
Migration frequency	—	—	-0.064*	—	—
Residential mobility	—	—	-0.115***	—	—

**Table A7-2** *Unstandardized indirect effects from estimated model*

	To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>From</b>					
<b>Dependent variables</b>					
Mental health	—	0.006	0.000	—	—
Physical health	—	-0.002	0.006	—	—
Social cohesion	—	0.000	0.001	—	—
Environmental disturbance	—	0.022*	0.000	—	—
Perceived green space exposure	—	-0.035**	0.001	0.340***	—
<b>Independent variables</b>					
Age	—	-0.029	0.000	—	—
Gender (Male)	—	-0.084*	-0.001	—	—
Income	—	0.001	0.003	-0.036**	0.037**
Origin place (Urban)	—	—	—	—	—
Migration frequency	—	0.025	0.000	—	—
Residential mobility	—	0.047*	-0.001	-0.056***	0.057***

**Table A7-3** *Unstandardized total effects from estimated model*

From \ To	Mental health	Physical health	Social cohesion	Environmental disturbance
<b>Dependent variables</b>				
Mental health	0.006	-0.015	—	—
Physical health	-0.387***	0.006	—	—
Social cohesion	-0.048*	0.001	—	—
Environmental disturbance	0.022	0.000	-0.453***	—
Perceived green space exposure	-0.035**	0.001	0.742***	-0.751***
<b>Independent variables</b>				
Age	-0.029	0.075*	—	—
Gender (Male)	0.052	0.219***	—	—
Income	-0.174***	0.003	-0.036**	0.037**
Origin place (Urban)	—	—	—	—
Migration frequency	0.025	-0.065*	—	—
Residential mobility	0.047*	-0.115***	-0.056***	0.057***

Table A8 Correlation matrix of key variables

Correlation Matrix														
	SUMGHQ	PhHealth	SocCohes	AirPol	Noise	CurGreen	ExpTime	FreqVis	Age	Gender	Income	OrigUrb	MigrFr	ResMobil
SUMGHQ	1.000													
PhHealth	-0.367	1.000												
SocCohes	-0.039	-0.005	1.000											
AirPol	0.005	0.000	-0.576	1.000										
Noise	0.086	-0.025	-0.649	0.779	1.000									
CurGreen	0.011	0.028	0.625	-0.688	-0.627	1.000								
ExpTime	0.019	0.067	0.084	-0.033	-0.082	0.094	1.000							
FreqVis	-0.010	-0.002	0.558	-0.545	-0.529	0.722	0.137	1.000						
Age	-0.114	0.037	-0.021	-0.010	0.040	-0.047	-0.032	-0.053	1.000					
Gender	0.029	0.215	-0.038	0.008	0.008	-0.067	0.003	0.016	0.032	1.000				
Income	-0.165	0.067	-0.025	0.008	0.045	-0.075	-0.064	-0.073	0.430	0.145	1.000			
OrigUrb	-0.001	0.059	0.009	-0.014	0.004	0.004	-0.056	0.037	0.020	-0.010	0.035	1.000		
MigrFr	0.015	-0.039	-0.017	0.031	-0.047	-0.027	0.025	-0.047	-0.009	0.138	0.087	0.013	1.000	
ResMobil	0.045	-0.098	-0.100	0.006	0.113	-0.073	-0.107	-0.058	0.239	-0.046	0.213	0.086	0.003	1.000

## Supplementary materials

### Effect of pre- and post-migration neighborhood environment on migrants' mental health: the case of Shenzhen, China

**Table S1** *The respondents agreed or disagreed with the following statements in relation to 1) the pre-migration neighborhood and 2) the post-migration neighborhood*

	The neighborhood is litter-free
	There air in the neighborhood is clean
	The neighborhood is free from noise
	The architecture in the neighborhood is attractive and pleasant
	The neighborhood is safe as regards crime
	The neighborhood is safe as regards traffic
<b>Neighborhood physical environment</b>	It is possible to do most of one's shopping at local stores in the neighborhood
	Stores are within easy walking distance in the neighborhood
	There are many places within easy walking distance of the neighborhood
	There is always a nearby transit stop (bus, train) in the neighborhood
	There are parks/open spaces nearby for recreational activities
	There are sufficient trees/plants in the neighborhood
	There are many attractive natural sights in the neighborhood (such as landscaping and views)
	People around in the neighborhood are willing to help their neighbors
	The neighborhood organization is very helpful
<b>Neighborhood social environment</b>	I always contact the neighborhood organization for help
	People in the neighborhood share the same values
	It is a close-knit neighborhood
	People in the neighborhood can be trusted

## Summary

Mental health issues are a global concern. It is suggested that more than half of the population of middle- and high-income countries will be affected by at least one mental health problem in the course of their lives. Urban environments are stressors for mental health in the form of environmental pollution, overcrowding, and unhealthy lifestyles. China, which is experiencing rapid economic growth and urbanization, is facing the challenge of mental health problems in urban areas. It is thought that 17.5% of Chinese people suffer from mental health problems. However, the figure could be twice that, since the World Health Organization reported that only 50% of mental illnesses are recorded worldwide. Considering China's huge population, the number of Chinese people suffering from mental health problems could therefore be more than 400 million.

In China, internal migrants have contributed to half of the growth of the urban population. They left their homes to seek better job and life opportunities in urban areas and thus improve their quality of life. However, they face various difficulties in their urban lives – including socioeconomic disadvantages, social exclusion, and most importantly, the institutional barriers created by the Chinese hukou (household registration) system – which constantly challenge their quality of life and mental health. While studies have identified a number of mental health protective and threatening factors for migrants in China, many studies have implicitly assumed that migration is a personal characteristic represented by hukou status. Because of this assumption, studies in China have focused on examining the relationship between migration status and mental health, or on comparing mental health status between migrants and non-migrants, and have suffered from inconsistent results. One of the limitations is that studies neglected migrants' experience during their migration journeys over space and time, such as the experience of geographical and social environment differences in places before and after migration.

To fill this gap, the research underlying this dissertation adopted a systematic approach to investigate the individual and environmental determinants of mental health for Chinese migrants. Based on survey data collected between January and April 2017 in Shenzhen, this dissertation provides evidence determinants such as sociodemographics and neighborhood physical and social environment have an impact on migrants' mental health. In addition, the migration experience represented by the migration trajectory, as well as neighborhood experiences in pre-and post-migration places, is associated with migrants' mental health in their host cities.

Since this dissertation is all about the experience of migration and how it is related to migrants' mental health, the definition of "migrant" needed to be chosen carefully. **Chapter 2** examined two definitions of migrants, namely according hukou and according to birthplace, and compared the migration – mental health relationship using the two definitions. The results suggest that defining migrants according to birthplace can capture a larger share of the migrant population, because although it is difficult to achieve, some migrants manage to transfer their hukous to their host

cities after migration. The results also show that migrants defined according to hukou were more likely to have mental health problems than non-migrants, but that migrants defined according to birthplace were mentally healthier than non-migrants. We conclude that defining migrants according to birthplace is more appropriate when investigating the migration experience in relation to mental health, while hukou remains a significant risk factor for migrants' mental health since it may contribute to social and spatial inequalities between migrants and non-migrants in host cities.

**Chapter 3** investigated the heterogeneity of the migration experience by examining migration trajectories using sequence alignment methods (SAMs) and identifying associations between different migration trajectories and mental health status. The results show that in general, migrants experience more than one migration in their lifetimes. Multiple migrations is a general experience among internal migrants in China, and we identified eight different migration trajectory types from the data using SAMs. Furthermore, different migration trajectories were found to be differently associated with migrants' mental health. The results suggest that conceptualizing migration as a one-time occurrence has limited our understanding of the heterogeneity of migration, and made us overlook the impact of events and experiences that happened during the migration journey on migrants' mental health.

**Chapter 4** shifted the focus from the determinants of migrants' mental health from the individual to the neighborhood level. Although studies suggest that neighborhood green space serves as a protective factor for residents' mental health in various contextual settings, studies are lacking concerning the beneficial role of neighborhood green space for migrants' mental health with respect to migrants' distinctive sociodemographics and high residential mobility rate. The results did not reveal any direct associations between neighborhood green space and migrants' mental health; only indirect pathways were identified. We speculate that the missing direct pathway between green space and mental health is partially due to migrants' relatively short exposure.

Existing knowledge about the neighborhood – mental health relationship is mainly based on examining the neighborhood environment where people currently live, neglecting the role of residential history in shaping people's mental health over time. **Chapter 5** fills this gap by examining the neighborhood environment in pre- and post-migration places and relating them to migrants' mental health. Although we did not find a direct path from pre-migration neighborhood to mental health (latency effect), we did find a mediatory path from pre-migration neighborhood to mental health via the post-migration neighborhood. The results suggest that accounting for people's residential history can help improve our understanding of how the neighborhood environment is related to people's mental health over space and time.

**Chapter 6** further considered the difference between pre- and post-migration neighborhoods and how the perceived changes in neighborhood environment are related to migrants' mental health. A random forest was used to assess the potential non-linear association between perceived neighborhood changes and migrants' mental health. In addition, the variable "importance" in

predicting migrants' mental health was assessed, as were the interactions between variables. The results show that individual-level characteristics – including physical health, personal income, and hukou – are the most important variables relating to migrants' mental health status. At the neighborhood level, changes in neighborhood safety was the most important variable associated with migrants' mental health. Non-linear associations were found between perceived neighborhood changes and mental health.

This dissertation has several theoretical implications that future research could build upon. It re-conceptualizes migration as a series of residential moves associated with life events over space and time. Acknowledging multiple migrations and analyzing the migration trajectories quantitatively provides opportunities for migration studies to capture more detailed, meaningful information on migration experiences and examine their impacts on migrants' mental health. There is room for future research to account for spatiotemporal trajectories of migration over the life course and investigate their implications for migrants' mental health. In addition, while this dissertation provides evidence on the role of pre- and post-migration neighborhoods in shaping migrants' mental health, residential histories were obtained through a cross-sectional survey. Without longitudinal data, our research is limited in terms of interpretable causal relationships between neighborhood environment and mental health, and in terms of identifying the critical period of risk environmental exposures for mental health development over time. Future studies could extend our work by using longitudinal designs to identify the latency and mediatory effect of past neighborhood exposures on people's mental health outcomes later in life.



## Samenvatting

Geestelijke gezondheidsproblemen zijn een wereldwijde bron van zorg. Er wordt wel gesuggereerd dat ruim de helft van de bevolking van midden- en hoge-inkomenslanden in de loop van hun leven zullen worden getroffen door ten minste één geestelijk gezondheidsprobleem. Stedelijke omgevingen zetten de geestelijke gezondheid onder druk als gevolg van milieuvervuiling, overbevolking en ongezonde leefstijlen. China, dat momenteel snelle economische groei en verstedelijking doormaakt, heeft te kampen met de uitdaging van geestelijke gezondheidsproblemen in stedelijke gebieden. Gedacht wordt dat 17,5% van de Chinese bevolking last heeft van geestelijke gezondheidsproblemen. Dat percentage is echter mogelijk twee keer zo hoog, aangezien volgens de Wereldgezondheidsorganisatie wereldwijd slechts 50% van alle psychische aandoeningen wordt geregistreerd. Gezien de enorme bevolking van China betekent dat dat het aantal Chinezen dat geestelijke gezondheidsproblemen ondervindt meer dan 400 miljoen bedraagt.

In China zijn interne migranten goed geweest voor de helft van de groei van de stedelijke bevolking. Zij hebben hun woonplaats achter zich gelaten op zoek naar beter werk en betere kansen in stedelijke gebieden, om zo hun levenskwaliteit te verbeteren. Zij krijgen in hun stedelijke bestaan echter te maken met verschillende moeilijkheden – zoals sociaal-economische achterstelling, sociale uitsluiting en vooral de institutionele barrières die worden opgeworpen door het Chinese systeem van hukou (huishoudensregistratie) – die hun levenskwaliteit en geestelijke gezondheid voortdurend onder druk zetten. Hoewel in onderzoeken verschillende factoren zijn geïdentificeerd die de geestelijke gezondheid van migranten in China beschermen dan wel bedreigen, is men er bij veel onderzoek impliciet van uitgegaan dat migratie een persoonlijk kenmerk is dat wordt vertegenwoordigd door iemands hukou-status. Als gevolg van dit uitgangspunt zijn onderzoeken in China vooral gericht geweest op de relatie tussen migratiestatus en geestelijke gezondheid, of op het vergelijken van de geestelijke-gezondheidsstatus van migranten met die van non-migranten, en hebben deze inconsistente resultaten opgeleverd. Een van de beperkingen is dat bij onderzoek geen aandacht is besteed aan de ervaringen van migranten tijdens hun migratiereis door ruimte en tijd, zoals bijvoorbeeld de ervaring van verschillen in geografische en sociale omgevingen op locaties vóór en na hun migratie.

Om die lacune aan te vullen is voor het onderzoek dat ten grondslag ligt aan dit proefschrift een systematische benadering gehanteerd voor het onderzoeken van de individuele en omgevingsgerelateerde determinanten van de geestelijke gezondheid van Chinese migranten. Op basis van enquêtegegevens die tussen januari en april 2017 in Shenzhen zijn verzameld levert dit proefschrift bewijs dat determinanten zoals sociaal-demografische factoren en de fysieke en sociale omstandigheden in iemands leefomgeving van invloed zijn op de geestelijke gezondheid van migranten. Daarnaast is er een verband tussen enerzijds de migratie-ervaring zoals die wordt vertegenwoordigd door het migratietraject en de ervaring in de leefomgevingen van vóór en na de migratie, en anderzijds de geestelijke gezondheid van migranten in hun gaststeden.

Aangezien in dit proefschrift de migratie-ervaring en het verband daarvan met de geestelijke gezondheid van migranten wordt behandeld, is het van belang dat het begrip ‘migrant’ zorgvuldig wordt gedefinieerd. In **hoofdstuk 2** worden twee definities van migrant onderzocht – één gebaseerd op hukou en één gebaseerd op geboorteplaats – en wordt het verband tussen migratie en geestelijke gezondheid op basis van deze twee definities onderzocht. De resultaten wijzen erop dat het definiëren van migranten op basis van geboorteplaats een groter deel van de migrantenpopulatie in kaart kan brengen, want hoewel dit lastig is om te bewerkstelligen, slagen sommige migranten erin om hun hukou na hun migratie over te zetten naar hun gaststad. Daarnaast laten de resultaten zien dat migranten gedefinieerd op basis van hukou een grotere kans maakten op geestelijke gezondheidsproblemen dan niet-migranten, maar dat migranten gedefinieerd op basis van geboorteplaats geestelijk gezonder waren dan niet-migranten. Wij concluderen dat migranten definiëren op basis van geboorteplaats toepasselijker is bij het onderzoeken van de relatie tussen de migratie-ervaring en geestelijke gezondheid, terwijl de hukou een significante risicofactor voor de geestelijke gezondheid van migranten blijft, aangezien deze in gaststeden kan bijdragen aan sociale en ruimtelijke ongelijkheden tussen migranten en niet-migranten.

In **hoofdstuk 3** wordt onderzoek gedaan naar de heterogeniteit van migratie-ervaringen door migratietrajecten te onderzoeken door middel van ‘sequence alignment’-methodes (SAM’s) en verbanden te identificeren tussen verschillende migratietrajecten en geestelijke-gezondheidsstatus. De resultaten laten zien dat migranten over het algemeen in hun leven meer dan één migratie doormaken. Meerdere migraties doormaken is een algemeen voorkomende ervaring onder interne migranten in China, en wij hebben op basis van de gegevens door middel van SAM’s acht verschillende types migratietraject geïdentificeerd. Daarnaast bleken verschillende migratietrajecten verschillende verbanden te vertonen met de geestelijke gezondheid van migranten. De resultaten wijzen erop dat het conceptualiseren van migratie als eenmalige gebeurtenis het inzicht in de heterogeniteit van migratie heeft beperkt en ertoe heeft geleid dat er onvoldoende aandacht is besteed aan de invloed van gebeurtenissen en ervaringen tijdens de migratiereis op de geestelijke gezondheid van migranten.

In **hoofdstuk 4** wordt de nadruk met betrekking tot de determinanten van de geestelijke gezondheid van migranten verlegd van het individu naar de leefomgeving. Hoewel onderzoek erop wijst dat groene ruimtes in de leefomgeving in verschillende contexten fungeren als beschermende factor voor de geestelijke gezondheid van migranten, is er onvoldoende onderzoek voorhanden naar de gunstige invloed van groene ruimtes op de geestelijke gezondheid van migranten met betrekking tot de specifieke sociaaldemografische kenmerken van migranten en een hoge mate van mobiliteit wat betreft woonplaats. De resultaten brachten geen directe verbanden aan het licht tussen groene ruimtes in de leefomgeving en de geestelijke gezondheid van migranten; er werden uitsluitend indirecte verbanden geïdentificeerd. Wij speculeren dat het ontbreken van een direct verband tussen groene ruimte en geestelijke gezondheid deels het gevolg is van de relatief korte blootstelling van migranten hieraan.

De bestaande kennis over het verband tussen leefomgeving en geestelijke gezondheid is voornamelijk gebaseerd op onderzoek naar de omgeving waar mensen op dat moment leven, waarbij niet wordt gekeken naar de invloed van eerdere leefomgevingen op de ontwikkeling van de geestelijke gezondheid van mensen in de loop van de tijd. In **hoofdstuk 5** wordt deze lacune opgevuld door onderzoek naar de leefomgeving op locaties van vóór en na migratie en het verband hiervan met de geestelijke gezondheid van migranten. Hoewel we geen direct verband hebben gevonden tussen de leefomgeving van voor de migratie en geestelijke gezondheid (vertragingseffect), hebben we wel een verband gevonden tussen de leefomgeving van voor de migratie en geestelijke gezondheid met de leefomgeving van na de migratie als tussenstap. De resultaten wijzen erop dat rekening houden met de woongeschiedenis van mensen ons inzicht in de aard van het verband tussen de leefomgeving en de geestelijke gezondheid van mensen in ruimte en tijd kan verbeteren.

In **hoofdstuk 6** is verdere aandacht besteed aan het verschil tussen de leefomgevingen van voor en na de migratie en hoe de waargenomen verbanden in de leefomgeving verband houden met de geestelijke gezondheid van migranten. Er is een willekeurig gekozen bos gebruikt om het mogelijke non-lineaire verband te beoordelen tussen waargenomen veranderingen in de leefomgeving en de geestelijke gezondheid van migranten. Daarnaast is de variabele 'belang' bij het voorspellen van de geestelijke gezondheid van migranten beoordeeld, evenals de wisselwerking tussen variabelen. De resultaten laten zien dat kenmerken op individueel niveau – waaronder fysieke gezondheid, persoonlijk inkomen en hukou – de belangrijkste variabelen zijn voor de geestelijke-gezondheidsstatus van migranten. Op het niveau van de leefomgeving waren veranderingen in de veiligheid in de leefomgeving de belangrijkste variabele met betrekking tot de geestelijke gezondheid van migranten. Er zijn non-lineaire verbanden aangetroffen tussen waargenomen veranderingen in de leefomgeving en geestelijke gezondheid.

Dit proefschrift heeft diverse theoretische implicaties waarop bij verder onderzoek kan worden voortgebouwd. Migratie wordt hier opnieuw geconceptualiseerd als een reeks veranderingen van woonomgeving die verband houdt met levensgebeurtenissen in de ruimte en tijd. Rekening houden met meerdere migraties en kwantitatieve analyse van migratietrajecten bieden bij migratieonderzoek mogelijkheden om meer gedetailleerde en betekenisvolle informatie vast te leggen over migratie-ervaringen en de gevolgen daarvan voor de geestelijke gezondheid van migranten te onderzoeken. Bij toekomstig onderzoek zou rekening kunnen worden gehouden met de spatiotemporele trajecten die migratie in de loop van een leven volgt en zouden de gevolgen daarvan voor de geestelijke gezondheid van migranten kunnen worden onderzocht. En hoewel dit proefschrift bewijs aanvoert voor de invloed van de leefomgevingen van voor en na de migratie op de geestelijke gezondheid van migranten, zijn de woongeschiedenissen verkregen door middel van een transversale enquête. Zonder longitudinale gegevens is ons onderzoek beperkt wat betreft interpreteerbare causale verbanden tussen leefomgevingen en geestelijke gezondheid en wat betreft de identificatie van de kritieke periode van blootstelling aan risico-omgevingen voor de ontwikkeling van de geestelijke gezondheid in de loop van de tijd. Toekomstig onderzoek zou op ons werk kunnen voortbouwen

door aan de hand van een longitudinale opzet de vertraging- en bemiddelings-effecten van eerdere blootstellingen aan omgevingen op de geestelijke gezondheid van mensen later in hun leven te identificeren.

## Curriculum Vitae

Min Yang was born on 14 January 1989 in Shandong province, China. She got her bachelor's degree in Public Utilities Management in 2011 from North China Electric Power University (Beijing). After that, she obtained her first master's degree from Institute for Housing and Urban Development Studies (IHS) of Erasmus University Rotterdam in 2012. She then enrolled in the research master program in Human Geography and Planning at Faculty of Geosciences, Utrecht University (2013 – 2015). In 2015, she started her PhD research on residential experience, life course mobility and mental health in urban China in the department of Human Geography and Spatial Planning at Utrecht University. Her works are published in a variety of peer-reviewed journals, including International Journal of Environmental Research and Public Health, Population, Space & Place and Environmental Research.

