

# **Childhood Housing Environment and Young Adulthood Health Status**

**Wen-Chieh Wu**

Department of Public Finance, National Chengchi University, Taipei, Taiwan. E-Mail:  
jackwu@nccu.edu.tw (corresponding author)

**Yu-Chun Ma**

International Division, ChungHua Institute for Economic Research, Taipei, Taiwan.

**Jiann-Chyuan Wang**

International Division, ChungHua Institute for Economic Research, Taipei, Taiwan.

Preliminary Draft

This paper will be presented at NBER East Asian Seminar on Economics 2016.  
National University of Singapore, Singapore, June 23-24.

## **Childhood Housing Environment and Young Adulthood Health Status**

### Abstract

This paper empirically investigates the lasting impact of childhood housing environment on the self-rated health status in the early adulthood. Using a group of Taiwanese young adults as study samples, our Heckman two-stage estimation results find that housing crowdedness, housing type, and housing location are significant childhood housing environment variables influencing the self-rated health status in the early adulthood. Young adults who resided in a crowded house at childhood have on average a higher self-rated health status than others. Moreover, young adults residing in apartments at childhood tend to have poorer self-rated health status than those residing in other types of housing. Lastly, young adults who grew up in the urban area have a better self-rated health status than others.

**Keywords:** Childhood Housing Environment, Self-rated Health, Socioeconomic Status

## 1. Introduction

It has been long recognized in the public health field that the adequate housing can promote public health.<sup>1</sup> In addition, it has also been widely acknowledged in the built environment field that the housing environment quality affects health of resident. Health threats found in the dwellings can directly or indirectly cause health problems.<sup>2</sup> Moreover, potential safety threats (e.g. unintentional injuries) to be found in dwellings are associated with the design of the dwelling structure such as the existence of stairs. Furthermore, the accessibility to places of physical activities, which are beneficial to health, is lower for residents living in a certain type of housing such as high-rise apartment building. Lastly, psychological problem can be also related to the characteristics of housing such as the type of building (e.g. high-rise building), floor level, and crowding.

Children spend much time at their own residential housing and neighborhood, so the housing environment should play a more decisive role in the health status of children. A line of literature has documented the evidence of strong association between childhood housing environment and health status of children. For instance, some studies (e.g. Wilkinson, 1999; Somerville et al., 2000) find that chronic diseases of children such as respiratory symptoms are strongly associated with dampness and mould. Blackman et al. (1989) found that there is a greater incidence of psychological distress among children in the poorer housing area. Obasanjo (1998) found that poor housing quality was highly predictive of high rates of psychosomatic illness among inner city adolescents. Evans et al. (2001) find that children residing in poorer quality housing have more psychological symptoms than their counterparts residing in better quality housing. Furthermore, Evans (2003) suggests that high-rise, multiple dwelling units are inimical to the psychological wellbeing of mothers with young children and possibly that of young children themselves.

The childhood housing environment has been considered as the important basis of health risk factors causing children's chronic diseases and psychological illnesses, both of which will directly or indirectly influence their health development in the adulthood. Therefore, there should be a causal link between childhood housing

---

<sup>1</sup> The examples of how adequate housing can promote public health include provision of safe water and personal hygiene, proper disposal of sewage, facilities for safe food preparation, and the absence of overcrowding, and protection of occupants against temperature extremes and other natural hazards (Matte et al., 2000).

<sup>2</sup> Major health threats to be found in the dwellings include indoor air quality, home safety, noise, humidity and mould growth, indoor temperature, lead and radon, lack of hygiene and sanitation equipment, and crowding (Boffoney, 2007).

environment and health status in the adulthood. However, no literature has contributed to explore such an entire link. Alternatively, the existing literature has tried to explain certain parts of this causal link. For instance, as mentioned earlier, a line of existing literature has confirmed that childhood housing environment is important for childhood health status. Moreover, another line of existing literature has discussed the link between childhood health status, and adulthood outcomes (e.g. socioeconomic status, employment, income, and adulthood health status). According to the life course model, childhood ill health status can influence the adulthood health directly through illness itself and indirectly through the educational attainment and life chances. Several studies (e.g. Currie and Madrian, 1999; Currie and Hyson, 1999) provides the statistical evidence that poor childhood health status leads to lower socioeconomic outcomes (e.g. lower educational attainment, lower employment, and lower earning). Case et al. (2005) further provide the empirical evidence to show the lasting and positive impacts of childhood health condition on the adulthood socioeconomic outcomes and on the adulthood health status. Furthermore, a few papers have tried to link childhood housing environment and school performance or educational attainment. Newman and Harkness (2000) find that children living in public housing have inferior educational attainment. Goux and Maurin (2005) find that children living in overcrowded house tend to have a poor performance at school. Lien, Wu, and Lin (2008) find that crowdedness and building age are negatively associated with educational attainment, while floor space and ownership status are positively associated with educational attainment.

The objective of this paper is to empirically investigate the causal link from childhood housing environment and adulthood health status. We develop a testable hypothesis as follows. A poor childhood housing environment causes ill health in childhood due to health hazards to be found in dwellings. The ill health in childhood then causes the ill health in adulthood through illness itself. Moreover, the ill health in childhood would result in a lower educational attainment, which leads to a poor health status in adulthood. Therefore, a poor childhood housing environment is hypothesized to cause a poor health status in the adulthood.

In this empirical study, we only focus on the health status in the young adulthood because it is more likely to be affected by childhood circumstances. Health status in the later adulthood should be largely affected by adulthood circumstances. There are two main categories of health status indicators: objective health status and subjective health status. We do not use the objective health status because there are no significant health inequalities in such an objective indicator across young adults. Alternatively,

we adopt the subjectively self-rated health status. The self-rated health status is a general indicator for both physical health and mental health. There exist self-rated health inequalities among young adults. Cullati et al. (2014) mentions that the self-rated health inequalities have increased over past decades. They find that self-rated health trajectories of disadvantaged populations have been declining at a faster rate than those of advantaged populations.

Our independent variable of interest is the childhood housing environment. Previous literature has employed different variables to indicate the poor quality of housing environment. In public health field, researchers are more interested in negative housing conditions such as dampness, mould, and air pollution. On the other hand, in built environment field, high-rise apartment, high floor level, and crowding are considered as negative health factors related to physical housing structure. Due to the data limitation, we follow the built environment researchers to focus on these three physical housing environment variables. We hypothesize that adults residing in high-rise apartment building at childhood have a poorer health status than counterparts. Our argument is that children living in a high-rise apartment building have more limits on the accessibility to physical activity fields. Therefore, they are more likely to have poorer physical health status because the adequate childhood physical activity is found to have benefits for health (Boreham and Riddoch, 2001). In addition, they are more likely to have psychological problems because of feeling isolation in residential unit. Moreover, we hypothesize that adults who lived on the higher floor level at childhood have poorer health status because they relied more on the elevator and seldom had chances to go outdoor for exercises in childhood. Furthermore, we hypothesize that housing crowdedness in childhood may have an ambiguous effect on the adulthood health status. On one hand, crowdedness lowers the sleeping quality which is negatively related to health. Crowdedness also has a negative impact on children's schooling performance and hence a negative impact on the health status in adulthood. However, on the other hand, sharing a room with siblings or parents makes children feel safe and tied. Therefore, children may have better physical health and mental health. A better social coherence in childhood leads to a better social relation in the adulthood, which is positively associated with adulthood health status.

Childhood socioeconomic circumstance is considered as another important childhood factor influencing the young adulthood health status. The white collar occupation, education of father, education of mother, and family income are often used to be the proxy variables of socioeconomic position of the family in childhood. Lundberg

(1997) summarizes a series of sociological studies and finds that the impacts of childhood socioeconomic conditions (e.g. social class, economic hardship, and social relation) on the adulthood health status are mediated by both adulthood social class and adulthood sense of coherence. A few studies (e.g. Case et al., 2002; Currie and Stabile, 2004) provide the evidence that childhood economic conditions positively influence children's health status, which will eventually influence young adulthood health status. Moreover, Case et al. (2005) argue that the impacts of childhood economic circumstances on young adulthood health status are mediated by childhood health status. Therefore, we hypothesize that the young adulthood health status rises with childhood socioeconomic position.

In addition to childhood housing and socioeconomic circumstances, young adulthood socioeconomic status is also an important determinant of young adulthood health status. However, young adulthood socioeconomic status and health status may be mutually caused. There is a widely documented "gradient" showing the positive association between health status and socioeconomic status observed in the adulthood. For instance, when young adulthood socioeconomic status is higher, his health status is observed to be better. On the other hand, when young adulthood health status is better, his employment and earning outcomes are observed to be higher. We use the educational attainment as the young adulthood socioeconomic status variable on the list of our explanatory variables because the completed educational attainment prior to adulthood is no longer affected by the young adulthood health status. We do not use employment and income variables as our socioeconomic variables because these two variables may be affected by the young adulthood health status.

Young adulthood's current housing environment is supposed to be one of factors influencing young adulthood health status. However, we argue that health status may also affect young adult's choice decision of housing environment. Moreover, many young adults may have not lived at the current housing for a long time. The effect of current housing environment may not be significant. Therefore, we exclude it from the list of independent variables. Alternatively, we take the risky behavior for health into consideration. We include the smoking behavior dummy on our explanatory variable list and expect that it negatively influences the young adulthood health status.

When we simultaneously include childhood housing environment, childhood socioeconomic circumstances, and young adulthood socioeconomic status as our independent variables, we have to be cautious of strong relations between childhood socioeconomic factors, the quality of childhood housing conditions, and young

adulthood socioeconomic status. For instance, children from poorer families are more likely to live in a poor quality housing environment. Moreover, there is an intergenerational transmission of socioeconomic status. Furthermore, the adulthood educational attainment may be affected by childhood housing environment. If we simultaneously include them in the estimation, we have to deal with the endogenous biases. In addition, it is difficult for us to disentangle the contribution of childhood socioeconomic status, childhood housing environment quality, and young adulthood socioeconomic status on young adulthood health status.

We adopt Instrumental Variable (IV) method (Two-stage Heckman Estimation) to deal with these endogenous problems. In the first stage, we try to explore the intergenerational transmission effects of socioeconomic status. The dependent variable is the young adulthood educational attainment, one of socioeconomic variables. We employ a vector of childhood socioeconomic variables as well as children-specific characteristics to be the instrumental variables of young adulthood educational attainment. In the second stage, we explore the health effect of childhood housing environment. In addition, we control the young adult's demographic characteristics, socioeconomic factors, and risky health behavior as confounding factors. Cullati et al. (2014) classify factors influencing the self-rated health trajectories into three categories: socio-demographic factors (e.g. age, gender, ethnic group), socio-economic factors (e.g. income, education, occupation, employment status), and family and marital life factors (marital status, marital transition, parental life). We follow them to include age, gender, marital status, and parental life as demographic factors of young adult. Moreover, we use the fitted value of educational attainment obtained from the first stage as the IV of education.

The data we employ is the PSFD (Panel Study of Family Dynamic) of Taiwan. In the initial waves of the panel survey, a group of adults who were born during the period of 1935 and 1964 were investigated. At the same time, a group of dependent children of these surveyed adults who were aged between 16 years old and 24 years old were also investigated.<sup>3</sup> We choose these children as our study samples. We check their parents' housing information at the initial survey wave and make sure that the family has lived at the same house since these children's early childhood.<sup>4</sup> We then follow

---

<sup>3</sup> In the west society, people older than 16 years old are considered as adults. They are basically independent after attending the college. In Taiwan, children aged between 16 years old 24 years old are still considered as dependent children. Before 24 years old, most of them are either at schools or serving the compulsory military service. A lot of them still live with parents or are financially dependent of parent. Therefore, they are closely attached to the housing where they live in the childhood.

<sup>4</sup> The data provides the information of how long the family has lived at the house.

these children till the wave conducted in a decade later (when they become early adulthood defined as the age between 25 and 35 years old). Their self-rated health statuses reported at that wave are used as their health statuses in the early adulthood. Employing 524 young adult samples who were aged between 25 and 35 years old, our estimation results find that several childhood housing environment variables such as crowdedness, apartment building, and housing locations are important factors influencing the young adulthood self-rated health status. The rest of the paper is laid out as follows. The next section reviews related literature. Section three introduces our econometric strategies. Data and sample descriptions are made in section four. Section five discusses the estimation results. The last section concludes.

## **2. Literature Review**

The causal link from childhood circumstance (e.g. childhood housing environment and childhood socioeconomic condition) to young adulthood health status can be mediated by childhood health status. We will firstly review the literature related to the causal link from childhood circumstance to childhood health. We will then review the literature exploring the impacts of childhood circumstance (e.g. childhood socioeconomic condition and childhood health) on young adult outcomes including health status, educational attainment, employment outcome, and earning outcome. In addition, we will review the literature addressing the measure of housing environment quality and the measure of health status.

### *2.1. The Causal Link from Childhood Circumstance to Childhood Health*

#### *Childhood Housing environment*

The link between housing and health has caught the attentions from public health researchers since many decades ago. It has long recognized that adequate housing promotes public health. Wilkinson (1999) summarizes a series of researches discussing the relationship between poor housing and ill health. He finds that the highest risks to health in housing are attached to cold, damp, and moldy conditions. Overcrowding and living in high-rise flats are associated with psychological symptoms including depression. Housing form and location also have effects on health. Matte (2000) provides an overview of the ways in which housing environment can affect human health. They list specific health hazards related to housing including unintentional injuries, exposure to lead, exposure to allergens, moisture and mold, and indoor air pollution. They argue that some literature has demonstrated the relationship

between housing quality and self-reported measures of well-being. However, it is difficult to demonstrate the causal relation from housing quality to physical health because of a number of reasons. First, a strong relationship between social disadvantage and living in poor quality housing makes it difficult to disentangle the contribution of social factors and housing conditions. Second, poor health may have an impact on employment opportunities and income, thereby limiting access to decent housing.

Jackson (2003) suggests that studying the impact of the built environment on health has been an emerging field. He argues that living and housing conditions are the basis of factors affecting health of occupant. Most research on housing and health has focused on physical health, but Evans (2003) emphasizes that housing type (e.g. high-rise), floor level, and housing quality (e.g. structural problems) have all been linked to mental health. He mentions that high-rise, multiple dwelling units are inimical to the psychological wellbeing of mothers with young children and possibly that of young children themselves. He provides a number of possible reasons such as social isolation of mothers and restricted play opportunities for children. Moreover, he argues that families living on the high floor have more mental problems. Furthermore, he points out a wide consensus that housing quality is negatively associated with psychological distress. Other factors including neighborhood quality, crowding, noise, indoor air pollution, and daylight are also found to be closely associated with mental health. For instance, he demonstrates that the neighborhood quality has mental health impacts on children and their families, independent of household socioeconomic status. There is a positive relationship between crowding, number of people per room, and psychological distress. Loud exterior noise sources elevate psychological distress. Malodorous air pollutants heighten negative effect, and some toxins cause behavioral disturbances. Insufficient daylight is reliably associated with increased depressive symptoms.

Boffoney (2007) provides an overview of literature exploring the relationship between inadequate housing and health. Moreover, he finds that there has been so far no commonly agreed upon definition of healthy housing in the literature. He considers that healthy housing must be a comprehensive concept taking into consideration a variety of factors contributing to the quality of housing and housing environment. Moreover, he emphasizes that the WHO understanding of housing is based on four-layer model of housing. Therefore, he defines that housing is the conjunction of physical structure of dwelling, meaning of home, the immediate housing environment, and community with neighbors (or neighborhood). He summarizes health relevance of

these four housing dimensions. First, a home perceived as safe and intimate provides major psychological benefits. Second, inadequate dwelling conditions may trigger many of the direct health effects. For instance, the occurrence of infestations is associated with the mould growth, indoor air pollution, and emissions from building materials. Potential safety threats, the social functionality, and the degree of limitation for residents are related to the quality and the design of the dwelling. Third, the quality of neighborhood can promote or impede the social interactions through the provision of diverse public spaces and facilities for social life. Lastly, the immediate housing environment has an impact on health through the quality of urban design.

In comparison with adult population, children spend more time in the residential housing. Therefore, the quality of residential housing should be quite important for children's socio-emotional development. Evans et al. (2001) investigates whether the overall housing quality can be related to children's socio-emotional development. They find that children residing in poorer quality housing have more psychological symptoms than their counterparts residing in better quality housing. They also find that preschool children living in high-rise apartments suffer negative effect related to restricted play opportunities and resulting isolation in the residential unit. As mentioned earlier, Evans (2003) also finds such a negative health effect of living in high-rise, multiple dwelling units.

### Childhood Socioeconomic Status

Case et al. (2002) find that the American children's health is positively related to household income. Children living in poor families are in worse health than children living in rich families. They find that the gaps in health status grow as children age. Currie and Stabile (2004) try to provide explanations for the gap in health status between poor and rich. They suggest that variations in the incidence of health insults are important in explaining such a gap. Based on the Canadian data, they find that poor children receive many more health insults (e.g. chronic conditions such as asthma and mental health problems) than rich children. Currie (2008) uses both Canadian and British data to show that the reported health status increases with income, even in early childhood. She finds that the children of poor or less educated parents are in worse health on average than other children. She argues that low socioeconomic status may not necessarily be the main cause of poor child health. It is possible that the third factor causes both poverty and poor child health. She suggests that perhaps parent's poor health, rather than parent's low socioeconomic status, is causally related to poor child health.

## *2.2. The Causal Link from Childhood Circumstances to Adulthood Outcomes*

Previous literature has tried to link childhood circumstances such as childhood socioeconomic condition and childhood health with the young adulthood outcomes. These young adulthood outcomes include educational attainment, health status, employment, and earning outcomes. Currie and Mandrian (1999) show that poor childhood health has negative impacts on educational attainment, employment, and earnings. Currie and Hyson (1999) find that low birth weight, a specific negative health shock, has long term effects on the education, employment, earnings, and self-reported adult health status.

Case et al. (2002) presents the evidence that the income gradients observed in adult health have antecedents in childhood, and suggests that part of intergenerational transmission of socioeconomic status may work through the impact of parents' long run average income on children's health. They find that children's health is positively related to household income, and that the positive relationship becomes pronounced as children grow older. Children from lower income households with chronic health conditions have worse health than do children from higher income households. Moreover, they find that children's health is closely associated with the long run average household income, and that the adverse health effect of lower permanent income accumulates over children's lives. These children arrive at the doorstep of adulthood with lower health status and lower educational attainment – the latter, in part, as the consequence of poor health.

Case et al. (2005) quote the emphasis from some life course models mentioned in Kuh and Wadsworth (1993). These models emphasize the extent to which illness and deprivation in childhood have lasting effects on adult health- directly, through the illness itself, and indirectly, by restricting educational attainment and life chance. They argue that these life course models can be used to explain the contemporaneous correlation between social status and health: those who have suffered from chronic conditions in childhood may reach adulthood in poorer health, and with less education and poorer labor market skills. They follow previous theory and hypothesis to develop their hypothesis that childhood circumstances including both childhood economic condition and childhood health status should have lasting effects on the educational attainment and health status in adulthood, all of which are strongly associated with employment and earning outcomes in the adulthood. First, they follow the fetal-origin hypothesis to argue that children born to poor parents may be more likely to have a

poor fetal environment, leading to poor health in the middle age. Second, they follow a line of economic literature (e.g. Currie and Mandrian, 1999; Currie and Hyson, 1999; Case et al., 2002; Currie and Stabile, 2004) to hypothesize that children with poor childhood health status arrive at the doorstep of adulthood not only in poorer health but also with lower socioeconomic status (e.g. educational attainment, employment, and earning), in part to be attributable to poorer health in the adulthood. Third, they follow pathway models proposed in Marmot et al. (2001) to conclude that early life circumstances are important because they initially influence the socioeconomic status in the early adulthood, which will in turn influence the health status in the later adulthood.

Currie (2008) argues that poor health in childhood is an important mechanism for intergenerational transmission of education and economic status. She checks whether low parental socioeconomic status has an effect on future educational and labor market outcomes through its effect on child health. She shows that there is strong evidence of links between parental socioeconomic status and child health and between child health and future outcomes.

### *2.3. Measure of Housing Environment Quality and Measure of Health Outcome*

#### *Housing quality*

Previous studies used different measures of housing quality. In public health field, epidemiologists developed individual indicators of housing quality to study housing conditions which are likely to promote physical disease. These indicators reflect individual attributes such as crowding, noise, air pollution, dampness, and mould. Most of earlier studies related to the relationship between housing quality and mental health also followed the indicators developed by epidemiologists. However, in order to reflect the multidimensional physical qualities of housing, Evans et al. (2000) develop an instrument to measure housing quality particularly for the purpose of studying the relationship between housing quality and mental health. Their housing quality index incorporates observations of structural quality, privacy, indoor climate, hazards, cleanliness, and children's resources.

Bonnefoy (2007) classifies building-related health outcomes into two categories: building related illness and sick building syndrome. He defines the building-related illness as the health effects that have a clear etiology and can be traced back to the building. One example of building-related illness is the house dust mite allergy.

Moreover, he defines the sick building syndrome as a complex of several unspecific syndromes, such as irritation of eyes, skin, nose and throat, or fatigue, headache, and decreased concentration capacity.

### Health outcome

General health can be measured by subjective and objective indicators. Self-rated health is the example of subjective indicator, while DAL and IDAL are often used as the objective indicators. Cullati et al. (2014) have a systematic review on factors of change and cumulative factors in self-rated health. They suggest that the self-rated health levels have improved, but self-rated health inequalities have increased. In particular, self-rated health inequalities across socioeconomic positions have widened. They include three types of self-rated health: general self-rated health, age comparative self-rated health, and self-assessment of change in health. They argue that general self-rated health and age comparative self-rated health are considered comparable because they are highly correlated. Moreover, they argue that both self-assessment of change in health and general self-rated health are also considered comparable. They also mention other measures of self-rated health such as satisfaction with self-rated health, scales of self-rated health, index of self-rated health with other health status measures, and retrospective self-rated health.

## **3. Econometric Specification**

### 3.1. Parameter of Interest

Let

$$Health_i = \alpha X_i + \beta h_i + \delta S_i + \theta B_i + \nu_i + \varepsilon_i, \quad (1)$$

where  $Health_i$  is a measure of individual  $i$ 's self-rated health status in the early adulthood;  $X_i$  is the vector of individual  $i$ 's observed personal characteristics in the early adulthood (e.g. gender, age, marital status, parental experience);  $h_i$  stands for individual  $i$ 's childhood housing environment;  $S_i$  is the individual  $i$ 's socioeconomic status variable (e.g. educational attainment) in the early adulthood;  $B_i$  represents the individual  $i$ 's health behaviors (e.g. smoking);  $\nu_i$  includes the personal-specific unobserved determinant of health (e.g. gene, fetal environment);  $\varepsilon_i$  stands for idiosyncratic shock that is assumed to be independent from other independent variables.

$\beta$  is our central parameter of interest. It measures the contribution of childhood housing environment on the self-rated health status in the early adulthood. The housing environment variables of interest includes: housing crowdedness, housing type (high-rise apartment), homeownership status, and floor level.

In equation (1), there are endogenous problems. For instance, the early adulthood socioeconomic status (e.g. educational attainment) and unobserved personal-specific determinants of health (e.g. gene, fetal environment, and childhood health status) are related. These unobserved factors such as gene, fetal environment, and childhood health status are closely associated with childhood socioeconomic status such as parent's educational background or social class. In order to avoid the endogenous bias, we use the instrumental variable (IV) method or two-stage Heckman estimation technique.

### 3.2. Our identification strategy

In our first stage, we employ a vector of childhood socioeconomic variables as well as children-specific characteristics as the instrumental variables of young adulthood educational attainment (the proxy of young adulthood socioeconomic status).

$$S_i = aC_i + cf_i + \xi_i, \quad (2)$$

where  $C$  stands for a vector of children-specific characteristics, and  $f$  is childhood socioeconomic status variable.  $\xi$  is assumed to be normally, independently and identically distributed.

In the second stage, we estimate the equation (1) by using the fitted value of educational attainment obtained from the first stage as the IV of young adulthood educational attainment.

$$Health_i = \alpha X_i + \beta h_i + \delta \hat{S}_i + \theta B_i + \mu_i, \quad (3)$$

where  $\hat{S}$  is the IV of young adulthood educational attainment.  $\mu$  is assumed to be normally, independently and identically distributed.

### 3.3. Robustness Estimation Strategies

In order to check if the health effect of childhood housing environment is consistent, we conduct two robustness checks. In the first robustness check, we try to respond the existing literature (e.g. Lien et al., 2008) arguing that childhood housing environment has impacts on children's educational attainment. Therefore, we add the childhood housing environment as another instrumental variable of young adulthood educational attainment in the first stage estimation. However, we still exclude the childhood socioeconomic status variables from the list of explanatory variables of health status of young adult.

In the second robustness check, we further correspond to the existing literature (e.g. Case et al., 2005) exploring the link between childhood socioeconomic status and adulthood health status. We add the childhood socioeconomic status variables in our second-stage health outcome estimation.

### 3.4. Variable Selection

In the first stage of the two-stage Heckman estimation, the dependent variable is the young adult's completed education level (the proxy of young adulthood socioeconomic status) measured in years. The explanatory variables (instrumental variables, IVs) of young adult's education attainment include basic demographic variables (e.g. gender), parents' socioeconomic variables, and childhood learning experience variables. In the past, male was traditionally expected to have a higher education level than female. However, the gender-based difference in education is getting less significant. In the modern Taiwan, female seems perform better than male at school. Therefore, we expect that the education effect of gender maybe ambiguous. Moreover, we use father's education, mother's education, and father's white collar status as the proxy variables of parents' socioeconomic status. Because of intergenerational transmission of socioeconomic status found in previous literature, parents' education and white collar status are expected to have positive impacts on the young adult's educational attainment levels. Furthermore, we use the attendance of cram school at childhood, learning difficulty at school, and reviewing school material time as the proxy variables of childhood learning experience. We expect that attending cram schools during childhood period (elementary, junior, and high schools) has a positive influence on the education level. A young adult experiencing the learning difficulty at childhood is expected to have a lower education attainment than others. We also expect that a young adult who had scarce time for reviewing school material at home during childhood is more likely to have a lower education level.

In the second stage, the dependent variable is the young adult self-rated health status. The self-rated health status of young adult is a subjective indicator of general health including physical health, and mental health. The self-rated health status is originally classified into five categories: very poor, poor, fair, good, and very good. However, we reclassify it into two categories: Good health (e.g. very good and good) and bad health (e.g. very poor, poor, and fair). Young adults evaluate their own self-rated health statuses mainly based on physical and mental conditions. Because of being still young, most of young adults are less likely to have serious physical diseases. However, some of them may have weaker physical bodies, or chronic diseases, or mental illness. As a matter of fact, many chronic diseases can be traced back to childhood. Moreover, some mental illness at young adulthood is closely related to psychological stress at childhood. Furthermore, weak physical bodies at young adulthood may be because of being lack of physical activity opportunities at childhood. By following the previous literature, we expect that these disadvantaged physical and mental conditions at childhood are associated with childhood housing environment. We use housing crowdedness, housing type (e.g. apartment building), homeownership, and floor level as childhood housing environment variables. Housing crowdedness is traditionally considered as a negative factor for both physical health and mental health in the west world. A person is more likely to have respiratory diseases if he/she lives in a crowded house. Moreover, a person is more likely to have a poor quality of sleep if he/she has to share a room with others. However, we argue that the housing crowdedness (e.g. sharing a room with other family members) variable may not only have negative impacts, but also positive impacts on health. For instance, unlike children in the western societies requiring a high degree of privacy at home, a Taiwanese or Chinese child traditionally shares a room with siblings or parents. This is a common phenomenon. In fact, sharing a room with other family members is more likely to make a child feel secure and connected. In other words, he/she does not feel lonely or insecure at nights. Therefore, he/she can have good quality of sleep, better social interaction with others, and healthier mental development. We set the dummy variable of crowdedness to be equal one if room number per children is lower than 0.5, and otherwise.<sup>5</sup> We expect that the health effect of crowdedness may be positive because closer ties with other family members at childhood house can be beneficial to future health. In comparison with ones living in single residence houses, children living in high-rise multi-residence apartment buildings are more likely to have a poorer health. In terms of physical health, children residing in apartment buildings are more difficult to access physical activity fields.

---

<sup>5</sup> We calculate the room number per children as the total room numbers in the house divided by the number of children in a nuclear family.

Moreover, in terms of mental health, children growing up in the apartment buildings are more likely to have psychological problems. We classify the housing type into four categories: apartment building, townhouse, traditional Taiwanese house (three-section-compound), and mansion. The mansion type is used as the base type. We expect that all coefficients of apartment building, townhouse, and traditional Taiwanese house are negative. In particular, we expect that the negative health effect of apartment building is the highest. Homeownership status at childhood is expected to have a positive impact on the health due to two possible reasons. First, children residing in an owner-occupied house do not have to move frequently, so they do not have to often exposure to different kinds of health risks in housing environment. Second, an owner-occupied house may have a better quality than a rental house, so children residing in owner-occupied houses are expected to be healthier than ones residing in rental houses. A high floor level is expected to have a negative impact on health. Children residing on the high floor level are less likely to access the physical activity fields. Moreover, they are less likely to walk upstairs because of taking the elevator. Furthermore, they are more likely to feel depressed on the high floor level.

In addition to childhood housing environment, we also control several confounding factors. These confounding factors of young adult self-rated health status include young adult's demographic characteristics (e.g. age, gender), young adult health behavior, and IV of education level (proxy of young adult socioeconomic status). We expect that the self-rated health status of young adult falls as he/she ages. Female young adults are traditionally considered as being healthier than male young adults because they are less likely to conduct dangerous behaviors. However, females are relatively more conservative or risk averse regarding the self-rated health status. Therefore, we expect that the gender-based difference in self-rated health status may be insignificant. According to the traditional belief, marital status is beneficial to health. However, parental experience at young adulthood is expected to have a negative impact on young adult's health because he/she has to spend much time to take care of kids. We use the smoking behavior to be the proxy of health risk behavior. Smoking is expected to have a negative effect on health.

The young adult's health is traditionally considered to be positively associated with young adult's educational attainment (the proxy of socioeconomic status). However, we argue that the educational attainment of young adult may not be a significant and positive factor for health status because of the following reasons. First, in the early adulthood, a young adult with a higher education level may not have a significantly higher income than those with lower education levels. The health effect of education

will become more significant for the later adulthood. Second, a young adult with a higher education level may have spent much time on studying and less time on physical activities at childhood. Therefore, he/she may be more likely to have weaker physical bodies and psychological problems.

The health status of young adult should be also affected by some other factors such as childhood neighborhood quality. The neighborhood quality can be measured by public health quality and available medical resource. In order to resolve the omitted variable bias problem, we control the urban area dummy variable. Young adults residing in the urban area with better public health quality and more medical resources at childhood are healthier than counterparts.

#### **4. Data Source and Sample Selection**

Our data source is the panel study of family dynamics (PSFD) of Taiwan. The panel survey was initiated in 1999. In 1999, a group of adult samples belonging to the birth cohort of year 1953 ~year 1964 were surveyed. Moreover, in 2000, new adult samples belonging to the birth cohort of year 1935~ year 1954 were added. Furthermore, more new adult samples born between 1964 and 1975 were added in 2003. Lastly, a number of adult samples born between 1976 and 1983 were added in 2009. The PSFD data has been surveyed from 1999 to 2016, but the released survey data only covers from 1999 to 2011. In other words, the survey data of 2011 is the most recent one we can use in this study.

PSFD includes basic demographic information (e.g. gender, and age), education experience (e.g. highest degree, schools at all levels, and family's educational environment), working experience (e.g. occupation, industry, employment status, working hours, employment income, and first formal job), marital status and spouse information (e.g. marital status, spouse's occupation, industry, and employment status at early marriage, current spouse's occupation, industry, and employment status), family value and attitude (e.g. filial concept, family concept), relative's information (e.g. their age, education, occupation, living arrangement, living location, interaction with respondents), living arrangement (migration, housing status, members living with respondents), family decision and expenditure, kinship relationship, and children's educational investment.

In addition to main adult samples born between 1935 and 1964, a group of children of these main adult samples were also surveyed in 2000. The survey questions for these

children samples were different from those for main adult samples. In particular, they were asked about their learning and education experiences, living arrangement, and part time employment. These children born between 1976 and 1985 were aged between 16 and 24 years old in 2000.<sup>6</sup> The number of these children samples is 1379. In 2002, 126 children born in 1986 were added. In the following years, these children samples would be gradually included into the main adult samples as they turned 25 years old. We would like to use these 1505 children born between 1976 and 1986 as our main children samples. They became young adults aged between 25 years old and 35 years old in 2011. We have their young adulthood health status information from the survey outcome of 2011.

We find out these children's childhood housing information based on their parents' housing information. The survey data from 2000 provided the housing information of the main adult samples including the detailed address, the length of stay in the house, housing size, housing ownership, room number, toilet and shower numbers, living room and kitchen numbers, housing type, floor level, and yard. We match our children samples with their parents and find children's housing information at childhood. In order to make sure that our children samples have lived in this house since early childhood, we require that parents have lived in this house since their children were younger than 12 years old. We exclude those children samples moved into the house after 12 years old. We also exclude children samples without the full information regarding childhood learning experiences, and other important explanatory variables. After the whole process of selecting samples, our final sample size is 524.

As shown in Table 1, we find that 55% of young adults consider themselves healthy. In our sample, male young adults are slightly more than female young adults. Their average education level is 15 years, and their mean age is 29 years old. They are still young, so only 28% of them are married. Moreover, their average kid number is only 0.3. Regarding the health risk behavior, 29% of them have the smoking habit.

When they were children, 6% of them felt difficult in learning and 4% of them did not allocate time well to fit into school learning schedule at high school. Moreover, the percentages of them ever attending cram schools at elementary schools, junior high schools, and senior high schools are 65%, 77%, and 44% respectively. The average education level of these young adults' fathers is 10 years, whereas one of their mothers is about 9 years. 13.7% of them are from the families with white collar

---

<sup>6</sup> In Taiwan, most people aged below 24 years old are still considered as dependent children. For young males, they complete the college degree at 22 years old and then serve in the military for another 2 years. Most of them become independent after 25 years old.

fathers.

Regarding the childhood housing environment, only 5% of them resided in a crowded house. 93% of them resided in owner-occupied houses. Majority of them resided in either townhouses or apartment buildings. For instance, half of them resided in townhouses, while 28% of them resided in apartment buildings. The average floor level is 1.73. About 33% of them are from urban areas.

## **5. Estimation Results**

### **5.1. Main Model Estimation**

Table 2 shows the results of first-stage Heckman estimation on educational attainment of young adult. As shown on the first column, our main model estimation results suggest that the gender-based difference in education level is not significant. Our estimation results support the traditional argument that there is an intergenerational transmission of socioeconomic status. For instance, we find that the young adult's education attainment is significantly and positively affected by parents' education levels. Although it is not statistically significant, but we find that the social class of father has a positive impact on the educational attainment of young adult. Moreover, our estimation results show that childhood learning experiences play important roles in educational attainment of young adult. For example, young adults who attended cram schools at both junior high school and senior high school have higher educational attainment than those who did not. Moreover, young adults who had scarce learning time tend to have lower educational attainment than others.

The results of second-stage Heckman estimation on self-rated health status are summarized in Table 3. The main model estimation results shown on the first column find that self-rated health status falls with age. In a similarity with the educational attainment of young adult, the gender-based difference in self-rated health status is not significant either. However, according to the estimated coefficients, we find that young male adults have on average a higher self-rated health status than young female adults. Both IV of education and marital status are found to have positive, but statistically insignificant effects on self-rated health status of young adult. Our results do not find a negative health effect of parental status. Contrarily, having kids at young adulthood has a positive, but insignificant effect on the self-rated health status. As expected, we find that smoking behavior has a significantly negative impact on self-rated health status.

A few childhood housing environment variables are found to be important for the self-rated health status of young adult. They are housing crowdedness, housing types, and urban area. Unlike that the literature employing western data finds the negative health effect of crowding, our results find that young adults who resided in a crowded house at childhood have on average a higher self-rated health status than others. Such a positive health effect of crowdedness is statistically significant. This finding actually matches our expectation. Our findings suggest that crowdedness at childhood may not be a big issue for both sleep quality and respiratory disease. Alternatively, children residing in a crowded house can have more social interactions with family members. When they have a better social coherence at childhood, they tend to have less psychological problems at young adulthood. In a similarity with the existing literature employing western data, our results also find that young adults who resided in apartments at childhood significantly have a lower self-rated health status than those who resided in other housing types. As expected, our results find that young adults who resided in the urban area at childhood have on average a higher self-rated health status than those who resided in the rural area.

Homeownership status and floor level are not significant housing environment variables influencing self-rated health status of young adult. The results show that the positive health effect of homeownership status at childhood is not statistically significant. One possible reason is that our samples all live in their houses for a long period time, so the rental status does not significantly imply the frequent mobility and instability. Moreover, our results show that the health effect of floor level is insignificant.

## 6.2. Robustness Estimation Results

As shown on the second column and the third column of Table 2, the results of our robustness estimations find that childhood housing environment does not play a significant role in the educational attainment of young adult. Moreover, based on the results shown on the third column of Table 3, we find that childhood socioeconomic status does not play a significant role in the self-rated health status of young adult. These robustness estimation results, therefore, support our main model specification which excludes childhood housing environment from the first-stage estimation and childhood socioeconomic status from the second-stage estimation.

By comparing two robustness estimation results with the main model estimation

results, we find that the health effects of childhood housing environment variables are quite consistent across different specifications. Crowdedness, housing types, and urban area are consistently found to be significant factors influencing self-rated health status of young adult, while homeownership status and floor level are not.

## **6. Conclusion**

In both public health and built environment fields, housing environment has been long recognized as an important factor for health. They all agree with that childhood housing environment can influence the health status of children. In both sociology and economic fields, health status has been found to be closely associated with socioeconomic status. They have confirmed that childhood socioeconomic status has impacts on the health status of children. Moreover, they have proved that childhood economic circumstances have lasting impacts on educational attainment, employment outcomes, and health status in the young adulthood. These impacts are mediated by childhood health status. To our limited knowledge, however, no existing literature has empirically explored the causal link from childhood housing environment to young adulthood health status. The main contribution of this paper is to find out childhood housing environment variables which are important for the young adulthood health status.

In order to deal with endogenous problems, this paper adopts the Heckman two-stage estimation approach. In the first stage, we employ a vector of childhood socioeconomic variables as the instrumental variables of young adulthood educational attainment. The regression results show the intergenerational transmission of socioeconomic status. In the second stage, we estimate the health effects of childhood housing environment. Our results show that housing crowdedness, housing types, and urban area are significant childhood housing environment variables for young adulthood health status.

This paper finds an interesting phenomenon. Unlike that the previous literature suggesting a negative health effect of crowding, this paper finds that young adults residing in a crowded house at childhood tends to have a higher self-rated health than others. Our main explanation for this is that sharing a room with other family members at childhood makes children have better social coherence and mental development, which will benefit to health in the young adulthood. This paper also corresponds to the existing literature showing the negative health effect of high-rise apartment building. We find that young adults who resided in apartments at childhood

on average have a poorer health status than those who resided in other types of housing.

This paper faces some restrictions. One of these restrictions is the data of objective health status indicator. Unlike previous literature using specific types of disease, we do not have related information. However, unlike children or older adults, young adults may not have serious diseases. Therefore, the objective health status indicator may not be appropriate for this study. Alternatively, young adults are more likely to have mental problems and chronic diseases originated from childhood. Therefore, the self-rated health status, which is evaluated basing on the combination of mental and physical conditions, may significantly vary across young adults. Therefore, we think that it is more appropriate for our study.

## Reference

Blackman, T., Evanson, E., Melaugh, M., Woods, R. (1989), Housing and Health: A Case Study of Two Areas in West Belfast, *Journal of Social Policy*, 18, 1-27.

Bonnefoy, X. (2007), Inadequate Housing and Health: an Overview, *International Journal of Environment and Pollution*, 30 (3/4), 411-429.

Boreham, C. and C. Riddoch (2001), The Physical Activity, Fitness, and Health of Children, *Journal of Sport Sciences*, 19, 915-929.

Case, A., Fertig, A., and C. Paxson (2005), The Lasting Impact of Childhood Health and Circumstance, *Journal of Health Economics*, 24(2), 365-389.

Case, A., Lubotsky, D., and C. Paxson (2002), Socioeconomic Status and Health in Childhood: The Origins of the Gradient, *American Economic Review*, 92(5), 1308-34.

Cullati, S. and Rousseaux, E. and Gabadinho, A. and Courvoisier, D. and Burton-Jeangros, C. (2014), Factors of Change and Cumulative Factors in Self-rated Health Trajectories: A Systematic Review, *Advances in Life Course Research*, 19, 14-27.

Currie, J. and Hyson, R. (1999), Is the Impact of Health Shocks Cushioned by Socioeconomic Status? The Case of Low Birth Weight, *American Economic Review Papers and Proceedings*, 89(2), 245-250.

Currie, J. and Madrian, B. (1999), Health, Health Insurance, and the Labor Market, Chapter 50 in *Handbook of Labor Economics*, Amsterdam: North Holland, 3309-3407.

Currie, J. and M. Stabile (2004), Socioeconomic Status and Health: Why is the Relationship stronger for Older Children? *American Economic Review*, 93(5), 1813-23.

Currie, J. (2008), Healthy, Wealthy and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development, *NBER working papers* #13987.

Evans, G., N. Wells, E. Chan, H. Saltzman(2000), Housing Quality and Mental Health, *Journal of Consulting and Clinical Psychology*, 68, 526-530.

Evans, G., H. Saltzman, and J. Cooperman(2001), Housing Quality and Children's Socioemotional Health, *Environment and Behavior*, 33, 389-399.

Evans, G. (2003), The Built Environment and Mental Health, *Journal of Urban Health*, 80(4), 536-555.

Goux, D., and E. Maurin (2005), The Effect of Overcrowded Housing on Children's Performance at School, *Journal of Public Economics*, 89 (5-6), 797-819.

Jackson, R.J. (2003), The Impact of the Built Environment on Health: an Emerging Field, *American Journal of Public Health*, 93(9), 1382-1384.

Kuh, D., and Wadsworth, M. (1993), Physical Health Status at 36 years in a British National Birth Cohort, *Social Science and Medicine*, 37(7), 905-916.

Lien, H.M., Wu, W.C., and Lin, C.C. (2008), New Evidence on the Link between Housing Environment and Children's Educational Attainment, *Journal of Urban Economics*, 64(2), 408-421.

Lundberg, O. (1997), Childhood Conditions, Sense of Coherence, Social Class and Adult Ill Health: Exploring Their Theoretical and Empirical Relations, *Social Science and Medicine*, 44(6), 821-831

Mantte, T.D. (2000), Housing and Health: Current Issues and Implications for Research and Programs, *Journal of Urban Health*, 77, 7-25.

Marmot, M, Shipley, Brunner, and Hemingway (2001), Relative Contribution of Early Life and Adult Socioeconomic Factors to Adult Morbidity in the Whitehall II Study, *Journal of Epidemiology and Community Health*, 55, 301-307.

Newman, S., and J. Harkness (2000), Assisted Housing and the Educational Attainment of Children, *Journal of Housing Economics*, 9, 40-63.

Obasanjo, O. (1998), The Impacts of the Physical Environment on adolescents in the Inner City, doctoral dissertation, University of Michigan.

Somerville, M., I. Mackenzie, P. Owen, and D. Miles (2000), Housing and Health: does installing heating in their homes improve the health of children with asthma, *Public Health*, 114, 434-439.

Wilkinson, D. (1999), Poor Housing and Ill Health: A Summary of Research Evidence, central research unit, the Scottish Office.

**Table 1. Descriptive Statistics**

	<b>Mean</b>	<b>Std Dev</b>	<b>Minimum</b>	<b>Maximum</b>
<b>Young Adult Characteristics</b>				
Self-rated Health Status	0.555344	0.497403	0	1
Male	0.545802	0.498374	0	1
Education (Years)	15.00191	2.323296	6	23
Age	29.12977	2.422479	25	34
Marital Status	0.288168	0.453343	0	1
Parental Status(# of kids)	0.326336	0.698532	0	3
Smoking	0.299618	0.458529	0	1
<b>Childhood Learning Experience</b>				
Learning Difficulty	0.064886	0.246559	0	1
Scarce Learning Time	0.040076	0.196326	0	1
Primary Cram School	0.658397	0.4747	0	1
Junior Cram School	0.770992	0.420596	0	1
Senior Cram School	0.446565	0.497612	0	1
<b>Childhood Socioeconomic Variables</b>				
Father's Education (years)	10.01718	4.031152	0	18
Mother's Education (years)	8.937023	3.919584	0	18
Father as White Collar	0.137405	0.344603	0	1
<b>Childhood Housing Environment</b>				
Very Crowded	0.053435	0.225114	0	1
Homeownership	0.931298	0.253189	0	1
Apartment	0.28626	0.452444	0	1
Townhouse	0.507634	0.50042	0	1
Traditional Taiwanese House	0.093512	0.291426	0	1
Floor level	1.729008	1.47089	1	15
Urban area	0.328244	0.470023	0	1
Sample Size	524			

**Table 2. First Stage Estimation Results**

	Main		Robustness I		Robustness II	
	First Stage: Education					
	Coefficient	t	Coefficient	t	Coefficient	t
Constant	12.10366	39.68	12.00866	22.97	12.00866	22.97
Male	0.020121	0.12	0.016549	0.09	0.016549	0.09
Father's Education	0.090538	3.07	0.086208	2.86	0.086208	2.86
Mother's Education	0.090198	2.97	0.086459	2.72	0.086459	2.72
Father as White Collar	0.130929	0.49	0.165201	0.61	0.165201	0.61
Primary Cram School	0.078542	0.43	0.078708	0.42	0.078708	0.42
Junior Cram School	0.628584	2.85	0.598869	2.65	0.598869	2.65
Senior Cram School	1.492262	7.96	1.486076	7.86	1.486076	7.86
Learning Difficulty	0.050521	0.14	0.048668	0.13	0.048668	0.13
Scarce Learning Time	-1.24216	-2.73	-1.23987	-2.71	-1.23987	-2.71
Very Crowded	-	-	-0.63884	-1.59	-0.63884	-1.59
Homeownership	-	-	0.176319	0.51	0.176319	0.51
Apartment	-	-	0.007503	0.02	0.007503	0.02
Townhouse	-	-	0.0106	0.04	0.0106	0.04
Traditional Taiwan House	-	-	0.123608	0.32	0.123608	0.32
Floor Level	-	-	0.020759	0.25	0.020759	0.25
Urban Area	-	-	0.029181	0.15	0.029181	0.15
Adjusted R-squared	0.30075		0.29561		0.29561	

**Table 3. Second-Stage Estimation Results**

	Main		Robustness I		Robustness II	
	Second-Stage: Self-rated Health					
	Coefficient	t	Coefficient	t	Coefficient	t
Constant	0.840812	2.03	0.835856	2.01	0.719235	1.6
Father's Education	-	-	-	-	0.001335	0.16
Mother's Education	-	-	-	-	-0.00868	-1.04
Father as White Collar	-	-	-	-	-0.00375	-0.06
Age	-0.0202	-2.05	-0.0202	-2.05	-0.02105	-2.11
Male	0.061981	1.33	0.061988	1.33	0.062811	1.34
IV of Education	0.020118	1.09	0.020708	1.1	0.034886	1.3
Marital Status	0.026999	0.42	0.026926	0.42	0.020448	0.32
Parental Status	0.0749	1.8	0.074956	1.8	0.078112	1.85
Smoking	-0.1066	-2.09	-0.10645	-2.08	-0.10323	-2
Very Crowded	0.304007	3.03	0.317166	3.09	0.316087	3.06
Homeownership	0.024925	0.29	0.021468	0.25	0.018352	0.21
Apartment	-0.21984	-2.48	-0.22003	-2.49	-0.21721	-2.42
Townhouse	-0.09706	-1.36	-0.09734	-1.36	-0.10294	-1.42
Traditional Taiwan House	-0.19786	-2.07	-0.20051	-2.1	-0.21935	-2.25
Floor level	0.010459	0.51	0.010016	0.48	0.010003	0.48
Urban Area	0.122249	2.53	0.121687	2.52	0.120973	2.48
Adjusted R-squared	0.04709		0.04712		0.04317	