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On the relationship between economic conditions around the time of birth and late life cognitive abilities: Evidence from Taiwan

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ABSTRACT

This study investigates the casual linkage between economic conditions around the time of birth and late life cognitive abilities. The zero-inflated negative binomial and multivariate logistic regression models were used to evaluate the direct and indirect effect of economic conditions around the time of birth on late life cognitive abilities, respectively. Both direct and indirect effects of economic conditions around the time of birth on late life cognitive abilities were identified. The relative risk ratio in adjusted mean scores of the Short Portable Mental Status Questionnaire (a means to measure cognitive impairment) indicates that being born in an economic recession year (experiencing economic recession during the year prior to birth) increases the risk of difficulties with cognition by 17.40% (11.70%). Being born in an economic recession year decreases the likelihood of high educational attainment in later life by an odds ratio of 0.962.

1. Introduction

Given the rapid rate of population aging around the world, the preservation of cognitive abilities plays an important role in maintaining a good quality of late life. Cognitive impairment has been proved to be a crucial predictor for dementia, one of the major causes of disability and dependency among older people worldwide (World Health Organization, 2012; Mitchell and Shiri-Feshki, 2009). Since there is no effective cure for dementia, it has physical, psychological, social and economic impacts on caregivers, families and society (World Health Organization, 2012). According to estimates from the World Health Organization, the total number of people with dementia worldwide was 35.6 million in 2010, and there are 7.7 million new cases every year, implying an additional new case every four seconds (World Health Organization, 2012). In addition, the total societal costs of dementia were approximately US$ 604 billion in 2010, corresponding to 1% of the aggregated worldwide GDP, and annual cost of care for dementia per capita varied from US$ 868 in low-income countries to US$ 32,865 in high-income countries (World Health Organization, 2012). Owing to the prevalence and economic burden of dementia resulting from a dramatic increase in the ageing population, the World Health Organization has made dementia a public health priority since 2008 (World Health Organization, 2012).

From the perspective of dementia prevention, understanding the factors influencing cognitive abilities among the elderly allows us to identify those who are particularly at risk of dementia. In this study, we investigate the relationship between economic conditions around the time of birth and cognitive abilities late in life by using data from a survey of the Taiwan Longitudinal Study of Aging (TLSA, hereafter). The significance of this study is threefold: First, Taiwan has one of the highest rates of population aging in the world. In 1993, the elderly population (aged 65 and higher) accounted for approximately 7% of total population (complying with the United Nation definition of the aging society), and this population in 2013 comprised approximately 12% of the total population (Ministry of Interior, 2014). If this trend in population aging remains unchanged, the elderly population is expected to occupy more than 14% of total population (complying with the

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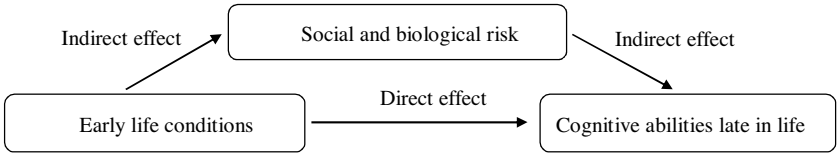

Fig. 1. The conceptual frameworks of the DOHaD vs. cumulative risk hypothesis.

United Nation definition of the aged society) in 2018, and approximately 21% of total population (complying with the United Nation definition of the hyper-aged society) in 2025 (National Development Council, 2014). Second, approximately a quarter of the Taiwanese elderly population is identified as having mild or worse impairment in their intellectual function (Chiu et al., 2013). The dementia prevalence rate among the elderly was approximately 4.97% in 2012 (or 130,000 people), going up from 3.38% in the early 1990s (or 50,000 people) (Chiu et al., 2013). This 2.6 times rise in the total number of elderly people with dementia within a 20-year span is much higher than the rise in the world average level (about 2.0) reported by the World Health Organization (Chiu et al., 2013). Third, establishing a relationship between economic conditions around the time of birth and cognitive abilities late in life relates to the justification for two hypotheses, the Developmental Origins of Health and Disease (DOHaD, hereafter) and the cumulative risk hypotheses. The conceptual framework of these two hypotheses is outlined in Fig. 1. The DOHaD hypothesis asserts that nutritional status during early life has significant consequences on later health through irreversibly altering development of vital organs and the immune system in utero (Barker and Osmond 1986; Barker 2007), and this hypothesis brings attention to the direct effect of early life conditions[1] on cognitive abilities late in life. However, the cumulative risk hypothesis states that health in late life is a result of exposure to social and biological risk factors throughout the life cycle (Hertzman, 1994; Kuh and Ben-Shlomo, 2004), and this hypothesis illustrates the indirect effect of early life conditions on cognitive abilities late in life.

In fact, there is a substantial amount of research identifying the effects of social and biological risk factors on cognitive abilities late in life. For examples, Lipnicki et al. (2013),World Health Organization (2012), and Singh-Manoux et al. (2012) documented age and gender as important risk factors for late life cognitive decline, and Yen et al. (2010) identified ethnicity as one of the risk factors influencing cognitive abilities late in life. Mousavi-Nasab et al. (2012) stressed the effect of marital status on cognitive abilities in middle aged and old individuals. Some studies have suggested educational attainment as a crucial factor that affects the individual's cognitive abilities (Meng and D'Arcy, 2012; Maurer, 2011). Other studies indicated that social network condition (Yen et al., 2010) and health habits (such as smoking (Chen et al., 2013), drinking alcohol (Roizen et al., 2013), chewing betel nuts (Hsu, 2010), and taking vitamins (Grima et al., 2012)) are also possible factors affecting the individual's cognitive abilities. In addition, many studies have found that parental educational attainment (serving as an indicator of an individual's early life socioeconomic status) is positively correlated with children's educational attainment (Dubow et al., 2009). The aforementioned literature has suggested that there are many pathways linking early life conditions and cognitive abilities later in life; therefore, there may exist a possible indirect effect of early life conditions on cognitive abilities late in life.

There is another strand of literature investigating the direct effect of early life conditions on cognitive abilities late in life. Some studies have tried to find an association between early life socioeconomic status (as indicated by birth place and parental education or occupation) and cognitive abilities late in life (Glymour et al., 2012; Al Hazzouri et al., 2011; Packard et al., 2011; Zhang et al., 2008). Other studies have evaluated the effect of nutritional status (indicated by height, weight and the experience of famine) during the period from gestation to early childhood on cognitive abilities at later ages (Guven and Lee, 2015, 2013; de Rooij and Roseboom, 2013; Raikkonen et al., 2013; Factor-Litvak et al., 2011; de Rooij et al., 2010; Zhang et al., 2010; Maurer, 2010; Case and Paxon, 2008).[2] Much research has focused on the casual linkage between disease exposure during the period from gestation to early childhood and cognitive abilities in later life (Venkataramani, 2012; Case and Paxon, 2009).

It is important to acknowledge that there are two major challenges to establishing a causal relationship between early life conditions and late life cognitive abilities. First, the individual data that contain micro-information from the early stage of life to the stage of late life are scarce and usually do not cover a sufficiently long time span to investigate the full life course of individuals (van den Berg et al., 2009a, 2006). Second, early life conditions and health outcomes later in life may be jointly affected by some unobserved factors (Doblhammer et al., 2013; van den Berg et al., 2011, 2010, 2009a,b, 2006; Maurer, 2010; Bengtsson and Broström, 2009). For example, the association between early life conditions (as measured by anthropometric measures such as height and weight at birth) and health outcomes in later life is likely to be influenced by some unobserved factors such as genetic determinants and hazard exposure predisposing individuals to diseases (Cook and Fletcher, 2014). Failure to control the potential endogeneity of early life conditions will bias inferences regarding the effect of early life conditions on later health outcomes (Doblhammer et al., 2013; van den Berg et al., 2011, 2010, 2009a,b, 2006; Maurer, 2010; Bengtsson and Broström, 2009).

In response to the challenge of limited individual life course data, recent studies have incorporated historical macroeconomic data with individual data to verify the relationship between early life conditions and late life cognitive abilities (Doblhammer et al., 2013; van den Berg et al., 2010). In addition, we deal with the possible endogeneity of early life conditions by using economic conditions (as measured by different states of the business cycle) around the time of birth as an indicator of early life conditions (Doblhammer et al., 2013; van den Berg et al., 2011, 2010, 2009a,b, 2006; Bengtsson and Broström, 2009). The rationale for using the business cycle around the time of birth as an indicator of early life conditions stems from the fact that an economic shock during pregnancy and early childhood could be treated as a natural experiment, with the economic shock being considered an

[1] Early life conditions (including nutrition, health, socioeconomic status, economic condition, and disease exposure in early life) have been studied in the field of the developmental origins of health and disease (see McEniry, 2013 for an excellent review of the relationship between early life conditions and health outcomes in later life).

[2] Nutritional status in early life has been measured by various indicators such as birth weight (Raikkonen et al., 2013; Factor-Litvak et al., 2011), height at birth (Raikkonen et al., 2013), knee height (Maurer, 2010; Zhang et al., 2010), and adult height (Guven and Lee, 2015, 2013; Case and Paxon, 2008).