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ORIGINAL ARTICLE

Familial factors, depression and cognitive decline: A longitudinal mediation analysis based on latent growth modeling (LGM)

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Abstract

Background: Cognitive decline of ageing population has become one of the major public health challenges worldwide, and familial factors (such as household income, marital status, etc.) have been identified as risk factors. Currently, we mainly focused on two familial factors: living with spouse/child and intergenerational rearing (taking care of grandchildren), exploring their relations with cognitive ageing. We also tested the possible mediating role of depression between the two family factors and cognitive decline.

Methods: Data was derived from China Health and Retirement Longitudinal Study (CHARLS) database, and a total of 8474 participants (3602 females, mean age = 69.64) were included in the current research. Latent growth model (LGM) has been constructed for cognitive functions, with initial level and declining rate being estimated respectively. We further examined: (1) whether living with spouse/child and intergenerational rearing could influence the declining trajectory (initial level and declining rate) of elders' cognitive functioning; (2) and if so, whether depression could mediate the effects of living with spouse/child and intergenerational rearing on cognitive functioning.

Results: First, while living with spouse/child was related to higher initial level of cognitive functions and slower declining rate, intergenerational rearing was associated with neither of them. Second, growth trajectory of depression partly mediated the effects of living with spouse/child on cognitive functioning (Indirect effect = 0.14; $p < 0.01$).

Conclusions: Familial factors (living with spouse/child and intergenerational rearing) may be influential on declining trajectories of elders' cognitive functions, and depression may mediate such effects. More research efforts are needed to investigate the mechanisms underlying the relations between familial factors and cognitive ageing.

KEYWORDS
cognitive ageing, cognitive decline, family status, intergenerational rearing

1 | INTRODUCTION

As the ageing population increased rapidly in recent decades, cognitive impairments of elders have been identified as one of the major public health challenges worldwide. Investigations showed that 46.8 million elderly people (aged over 60) are suffering from any kinds of cognitive impairments, such as Alzheimer's Disease, Mild Cognitive Impairments, etc. (Prince, 2015). However, cognitive decline is a social-psycho-biological problem, with socio-demographic factors being one of the sources of influence. In recent decades, the effects of familial factors (e.g. family status, Mousavi-Nasab et al., 2012) on elders' cognitive health have received much research attention, yet the findings are inconsistent to a large extent (Mazzuco et al., 2016). Therefore, the current study aims to deal with this issue and add to the literature in this line. Besides, we also aim to investigate the effect of a very prevalent rearing pattern, intergenerational rearing on elders' cognitive functions.

1.1 | Familial factors (family status, intergenerational rearing) and cognitive functioning

According to previous studies, living with spouse/child is one of the influential factors to cognitive decline in ageing population. For example, Mazzuco (2017) found that elders who live with spouse or adult children performed better than those who live alone on various cognitive tasks (i.e. orientation, simultaneous recall, delayed recall etc.). Using person-orientating methods (i.e. latent mixed model), Elovainio (Elovainio et al., 2018) has found that elders who cohabite with spouse or children have lower declining rate for their cognitive functions. Actually, for elderly people, living with other family members is considered to be beneficial for cognitive functioning in three ways. First, cohabitation may provide more opportunity for elderly people to engage in cognitive-facilitating activities, such as in-depth communication with other household members (Kuiper et al., 2015). Second, elders who cohabitate with others are usually in better conditions of mental health, having higher life satisfaction, lower levels of depression and loneliness (Giannelis et al., 2020). Some evidence also showed that elders who cohabitate with adult children are more likely to keep a healthy life style (Kelly et al., 2017; Small et al., 2012). Thus, the positive effects of cohabitation on cognitive functioning may derive from keeping elders mentally healthy (being less depressed (Shankar et al., 2013)). Third, cohabitation may have indirect effects on elderly people's cognitive health, considering that cohabitation is related with higher economic status, better living conditions etc. (Burholt et al., 2019).

However, the findings that cohabitation is beneficial for maintaining cognitive functions may not be conclusive. For example, some evidence suggested none or negative effects of cohabitating with a partner on cognitive functions. Based on previous literature, we consider that such inconsistency may possibly derive from three confounding factors: (1) Covariates. Although most previous studies in this line have incorporated basic demographic factors (i.e. gender, age, socioeconomic status etc.) as covariates, they still have different covariate list. For example, Elovainio et al. (2018) controlled for health behaviors and cardio-metabolic factors when examining the effects of cohabitation on elders' cognitive trajectories. As the possible confounders are endless when examining the relation between cohabitation and cognitive health, controlling for different lists of covariates may have different effects on the results. (2) Geographical factors. Mazzuco's findings showed that the protective role of cohabitation on cognitive health is less significant in Southern Europe countries such as Italy and Spain than in other Europe countries. This result may indicate that the relation between cohabitation and cognitive functions of elderly people varies with geographic areas. (3) Methodological issues. It's possible that the inconsistency of previous findings may derive from methodological shortcomings. Although longitudinal design has been widely recommended in examining the causal relationship between variables, some studies in this filed still utilize cross-sectional data (Bordone & Weber, 2012). And thus, the results of these studies may be affected by selection bias. It's necessary to take the aforementioned factors into consideration when we explore the relation between cohabitation and cognitive health of elders.

Besides, the effects of family role-taking on elders' cognitive health remain unexplored. Family role-taking has been defined as participating in various household activities (such as housework, caregiving etc.), which has been proven to be related to subjective health of elderly people. Research evidence showed that elders who participated in housework activities were higher on general health status than those who did not (Adjei & Brand, 2018). Currently, we focused on a special type of family role-taking, intergenerational rearing (i.e. taking care of grand children) which is common in China (Sun, 2012). Intergenerational rearing is a comprehensive concept which includes a bunch of cognitive, behavioral and emotional activities. According to the "cognitive-stimulation" hypothesis, sophisticated activities such as intergenerational rearing may activate "… alternate brain networks and cognitive strategies to compensate for cognitive difficulties… (Stern et al., 2003)". Still, previous research showed that intergenerational rearing is related to lower levels of loneliness and depression (Tsai et al., 2013). Taking the evidence together, intergenerational rearing may be beneficial to elders' cognitive functioning.

1.2 | The mediation role of depression

Moreover, little studies so far have explored explicitly how familial factors may influence cognitive decline. One of the most recognized hypotheses is that cohabitation may alleviate negative emotions (such as depression and loneliness) which are related closely to living alone. Considering that depression has been identified as a risk factor to cognitive decline, cohabitation with spouse or adult children may influence cognitive functioning via alleviating depression. And we will examine this hypothesis explicitly in the current research.

1.3 | Methodology

It has long been recommended that longitudinal data should be adopted when testing causal relationships. In the current research, familial factors such as intergenerational rearing could be bi-directionally associated with elderlies' cognitive functions. For example, elderly parents living with their kids are not given childcare responsibilities if they are failing cognitively, while childcare may also facilitate their cognitive functions. Thus, longitudinal data is necessary to determine the causal direction. Traditionally, the methods commonly used to deal with longitudinal data are Analysis of Covariance (ANCOVA) and Repeated-Measure Analysis of Variance. These methods can only be used to examine whether the latter measurement is significantly higher (or lower) than the former one, with important information being omitted. For example, with traditional methods, one cannot tell whether baseline level of cognitive functions is related to the rate of change, or whether the individual difference in the rate of change is larger for one variable than another. And thus, the current research adopted Latent Growth Modeling (LGM), a method based on structure equation modeling to explore the pattern of cognitive decline and its relation with familial factors. In all, the current research utilized longitudinal data and LGM methods to investigate: (1) whether family status and intergenerational rearing is related to cognitive health of Chinese elders; (2) whether depression may mediate the effects of family status and intergenerational rearing on cognitive functions.

2 | METHODS

2.1 | Participants

Data of the research was derived from CHARLS (China Health and Retirement Longitudinal Study) 2011-2018 which is a program initiated by Peking University lasting for 7 years (from 2011 to 2018), with every two years holding a large scale household survey aiming at collecting a comprehensive set of data about family and health conditions of elderly populations. Data from the program can be openly accessed. A total 15803 individuals from 9727 households participated in the first wave of investigation and 8474 of them completed the full four waves (attrition rate = 46.3%). Demographic information of participants was listed in the Table 1. Four waves of data were obtained and only three waves (2011, 2013 and 2015) were adopted by the current research. The fourth wave of the data was omitted because its measurements for cognitive functions were changed substantially which rendered it not comparable to the first three waves.

2.2 | Exclusion criteria

Following participants were excluded from the research: (1) individuals who have met clinical diagnostic criteria for Alzheimer's disease (AD). As we mainly focused on cognitive decline in normal ageing populations, elders who are affected by AD or other types of neurodegenerative diseases may constitute as confounders; (2) individuals who had missing data on all aforementioned measurements; (3) individuals who aged lower than 55 (N = 6715).

TABLE 1 Demographic information of the participants

Demographic information	The initial wave
Sample (N)	6715
Gender	
Female	3602 (53.6%)
Marriage	
Married	5714 (85.1%)
Divorced	107 (1.6%)
Widowed	894 (13.3%)
Age	
M	69.64
S.D.	6.65
Education level	
Middle school or lower	6440 (95.4%)
Bachelor (vocational school)	303 (4.5%)
Graduate school or higher	8 (0.1%)

3 | MEASUREMENTS

3.1 | Depression

Depression was measured by Center for Epidemiological Studies Depression Scale (CES-D). CES-D consists of 10 items and has been proven to be a measurement for depression with well-established validity and reliability. In the current research, the reliability of the scale was acceptable (α = 0.81;0.79;0.85 respectively).

3.2 | Cognitive functioning

Cognitive functioning was evaluated by a comprehensive measurement adapted from Mini Mental State Examination (MMSE). MMSE was a widely used screening tool for cognitive impairments, including an evaluation of orientation, attention, short-term recall etc. The current measurement expanded the short-term memory test and also included a delay recall test. The full measurement can be found in Supplementary Materials.

3.3 | Demographic interview

A comprehensive demographic interview was conducted and variables adopted by the current research were: (1) gender and age; (2)

education level; (3) marital status; (4) family status; (5) taking care of grandchild. Family status was coded into a two-category variables (1 = live with partner/child; 0 = live alone).

4 | STATISTICAL ANALYSIS

The mean scores and standard deviations of depression and cognitive ability were computed respectively for males and females. Then a series of growth models were built in sequence with LGM methods. LGM is a commonly used method for longitudinal data analyzing, which is able to estimate simultaneously the initial level (intercept) and development (slope) of constructs. Currently, unconditional LGM (latent growth model) was first estimated for cognitive functions to evaluate its growth pattern during the five years.

Then, a set of conditional LGMs were estimated: (1) LGM for cognitive functions without any covariates (unconditional model); (2) LGM including family status and intergenerational rearing as time-invariant covariates controlling for demographic variables (gender, baseline age, and education). Finally, longitudinal mediation analysis (from family status to cognitive ability via depression) based on LGM was conducted. All statistical analysis procedures were completed using SPSS 21.0 and Mplus 7.0.

5 | RESULTS

5.1 | Preliminary results

Means and standard deviations of depression and cognitive abilities were listed in Table 2.

5.2 | Unconditional LGM

Intercepts and slopes of unconditional growth models were shown in Table 3. As recommended by Bentler, CFI (Comparative Fix Index), TLI (Tucker-Lewis index) and RMSEA (root-mean-square error of approximation) were used as model fit indices. Results showed that both depression and cognitive abilities changed significantly between the three waves of assessments. All the models fitted well (CFI, TLI > 0.9; RMSEA < 0.05). Results showed that elders' cognitive functions and depression level declined with time. As the residual covariance between the two latent variables (intercept and slope) was significant, a series of models with covariates should be tested.

5.3 | Conditional LGM with time-invariant covariates for cognitive functions

A conditional LGM was estimated with *living with spouse or child* and *intergenerational rearing* as covariates, controlling for three demographic variables (gender, baseline age and education). Results showed that elders who cohabitate with spouse or children were higher on initial cognitive level ($\beta_1 = 0.16$, $p < 0.001$) and showed slower declining rate ($\beta_2 = 0.13$, $p < 0.001$) comparing to those who live alone. The effects of intergenerational rearing on neither initial level nor declining rate of cognitive functions were significant. Model fit indices were acceptable (RMSEA = 0.08, CFI = 0.92; TLI = 0.85, SRMR = 0.07). As intergenerational rearing was not significantly associated with cognitive functions, it was omitted from the further mediation analysis (Figure 1).

5.4 | A longitudinal mediation test using latent growth model

In order to evaluate whether the effect of living status on cognitive decline was due to the increase in depression, a longitudinal mediation model was estimated. Currently, we examined the mediation hypothesis based on LGM. Results showed that the cognitive functions of those who live with spouse or child declined slower than those who live alone ($\beta = 0.25$, $p < 0.01$), and such effects were partially due to their steeper rate of decline in depression (indirect effect = 0.14; $p < 0.01$), but not baseline depression level (indirect effect = −0.01, $p > 0.05$). In general, although depression level of elders decline with time, those who live with spouse or child have faster declining rate of depression ($\beta_1 = -0.29$, $p < 0.001$), which in turn facilitate slower decline of cognitive functioning ($\beta_2 = -0.49$, $p < 0.001$). The model fit indices were acceptable (CFI = 0.95; TLI = 0.91; RMSEA = 0.05; SRMR = 0.02). Alternative mediation models were also constructed to rule out possible mediating chains (e.g. from *living with spouse/child* to *depression* via *cognitive decline*). However, model fit indices showed that these alternative models were not acceptable (RMSEA = 1.01; CFI = 0.82; TLI = 0.70; SRMR = 0.09). The final mediation model was shown in Figure 2.

6 | DISCUSSION

In the current research, we examined the effects of living with spouse/child and intergenerational rearing on cognitive decline of elders, and also identified the mediating role of depression. This is the first research to our knowledge exploring the relations between living with spouse/child and intergenerational rearing and trajectories of cognitive decline in an ageing population. Considering the rapid increase in the rate of elders who live alone, it's quite necessary to clarify how familial factors may affect their cognitive functioning.

First, our results showed that elders' cognitive functions declined linearly over the 4 years, which is inconsistent with several previous findings (Han & Shibusawa, 2015). There are two possible explanations for such inconsistency. First, considering the relatively short time range of this research (4 years), it probably depicted only a part of cognitive decline process rather than the whole. One study using 20-years longitudinal data showed that there is a significant "turning point" at approximate 75 years old when most individuals may

TABLE 2 Means and standard deviations of depression and cognitive abilities

	Cognitive abilities			Depression		
	Male	Female	*t*-test	Male	Female	*t*-test
Wave 1	11.73 (3.73)	9.59 (4.27)	21.64***	13.31 (4.74)	15.29 (5.52)	−15.04***
Wave 2	11.69 (3.72)	9.56 (4.36)	21.21***	12.03 (4.34)	13.91 (5.28)	−15.15***
Wave 3	11.19 (3.79)	9.21 (4.42)	19.50***	12.61 (4.59)	14.84 (5.80)	−16.10***

*$p < 0,05$, **$p < 0,01$, ***$p < 0.001$.

TABLE 3 Model fit of growth models

	Model fit indices			
	CFI	TLI	RMSEA	Slopes
Cognitive abilities	0.99	0.99	0.07	−0.28***
Depression	0.99	0.98	0.04	−0.09**

Note: The coefficients were not standardized.

*$p < 0,05$, **$p < 0,01$, ***$p < 0.001$.

experience acceleration in cognitive decline (Bur Acc Hio et al., 2010). Second, cognitive decline may derive from normal ageing or from dementia-related diseases, such as Alzheimer's Disease (AD) or Mild Cognitive Impairment (MCI). It's quite difficult to differentiate the two kinds of decline from each other, especially for individuals who are at the initial stage of AD (Ferreira et al., 2017). As the current focus is on normal ageing, we excluded all participants who have had a dementia diagnosis, and this may explain the linear pattern of cognitive decline observed in this research.

Second, we found that individuals who live alone had lower baseline level of cognitive abilities and their cognitive functions declined faster. This may provide initial evidence that living with spouse/child is related with cognitive decline trajectories of elders. We consider that living with spouse/child has distinctive effect on elders' cognitive functioning for it provides intimacy and coping resources which other types of social relationships cannot (Kelly et al., 2017). As a significant portion of ageing population cannot enjoy a full set of social network, it's necessary to examine which kind of social relation plays a predominant role in protecting cognitive functioning. Further research efforts are needed to compare the relative strength of effects of various sources of social relations on elders' cognitive functioning.

Further, intergenerational rearing is related to neither initial cognitive functions nor the declining rate. According to previous research, participating in intergenerational rearing is a "two-edged sword". On the one hand, taking care of grandchildren makes elders keep their family role as a "provider", which is beneficial to their mental health. Evidence showed that individuals who take care of a grandchild had higher levels of self-rated health and engaging in more instrumental activities (Fujiwara et al., 2020), which is a positive factor to maintenance of cognitive functions. On the other hand, intergenerational rearing is also related to higher levels of stress, which has been identified as a risk factor to cognitive impairments. For example, Yang (Yang et al., 2021) showed that elders who participated in intergenerational rearing had higher anxiety level than those who did not. These findings indicate that the effects of intergenerational rearing may be contradictory, as it has been shown in the current research. In the future, more research efforts are needed to clarify the effects of this rearing pattern on elders' cognitive health.

Finally, a longitudinal mediation model was estimated, with depression trajectory being the mediator. Results showed that individuals who live with spouse or child have steeper declining rate of depression, which in turn facilitate slower declining of cognitive functioning. This result indicates that living with spouse/child may affect elders' mental health and further influence their cognitive functioning, and such serial effects are longitudinal in nature. As so many studies have focused on the direct effects of various socio-demographic factors and mental health conditions (i.e. depression) on cognitive decline, little research has integrated these risk factors into a comprehensive model. More studies in the future are needed in this line.

7 | STRENGTHS, LIMITATIONS AND FUTURE DIRECTION

One of the major strengths of this research is using LGM to examine the effects of household factors on the trajectories of cognitive decline. Although lots of studies have explored the effects of various socio-demographic factors on cognitive impairments using longitudinal data, few of them adopted LGM methods. LGM is more advantageous than other methods which are commonly used for longitudinal data process for it's able to estimate the baseline level and the developmental rate of a psychological variable (i.e. cognitive ability) respectively. In the current research, intergenerational rearing only affected the baseline level of cognitive functioning but not the declining rate. This result indicates that the effects of intergenerational rearing on cognitive functioning may derive from other possible confounding variables. With other methods (i.e. ANOVA with repeated measurements), such effects cannot be detected. And thus, further research on this line is needed using LGM methods.

There are also several methodological limitations of the current research which should be noted. First, considering that the structure of the last wave of investigation changed substantially, only the first three waves of data were adopted. Although three-times repeated measurements are acceptable for most longitudinal studies, Muthen (Jo & Muthen, 2003) still recommend that four-times or more should be adopted for the precision of model estimation. Second, the

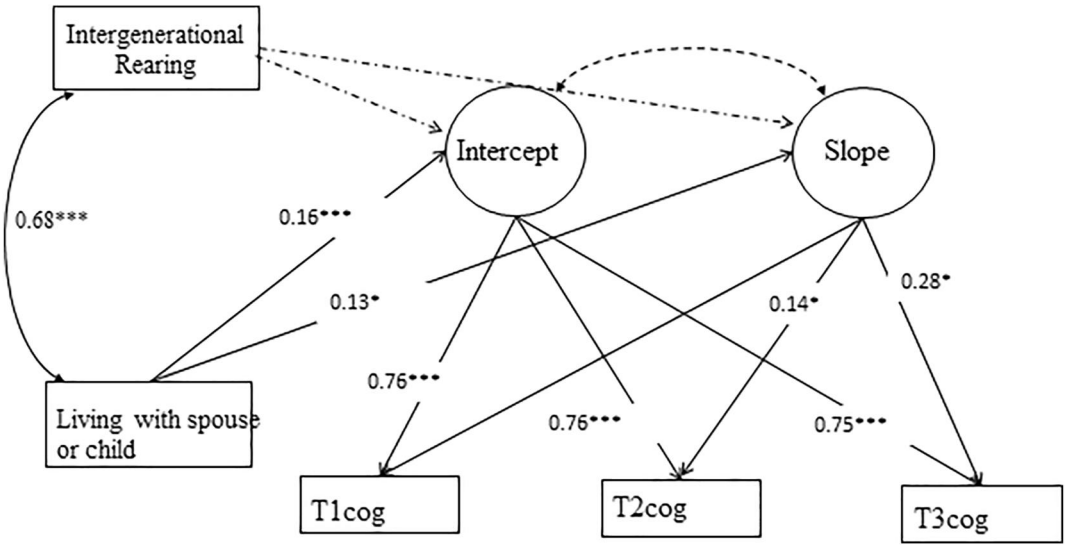

FIGURE 1 Latent growth model including covariates. 1. cog, cognitive functions; 2. Demographic covariates were not shown in the diagram for the purpose of presentation; 3. $p < 0.05$*, $p < 0.01$**, ***$p < 0.001$

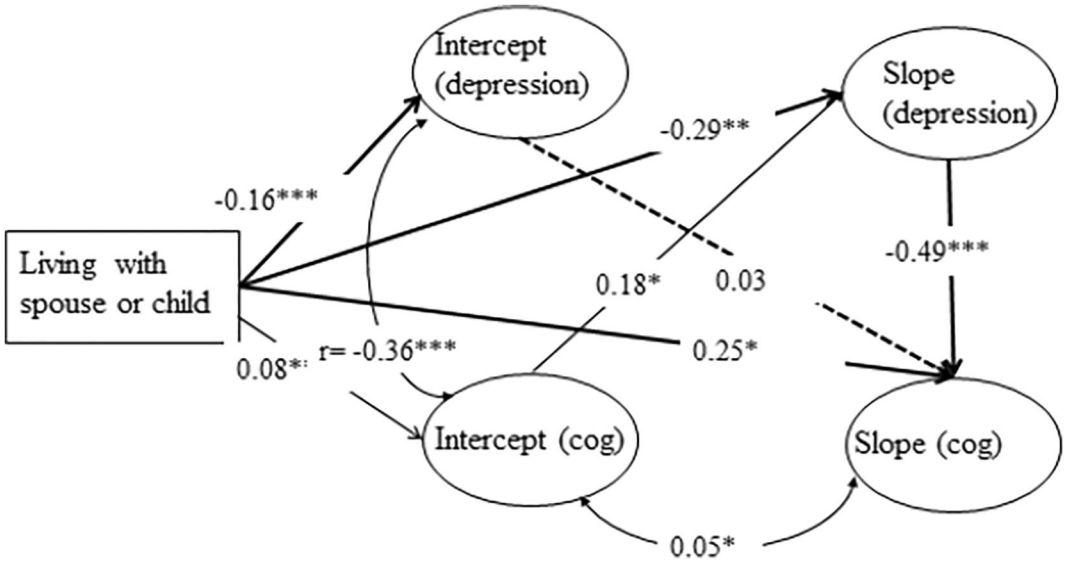

FIGURE 2 Longitudinal mediation analysis based on LGM. (1) The observed variables, demographic covariates standard errors were omitted for the presentation purpose; (2) The two mediating paths were highlighted with bold lines. *$p < 0.05$; ***$p < 0.001$

concept of family structure is much more complex than "core family (i.e. cohabitating with spouse and offspring)", and other types of family such as "intergenerational family (i.e. cohabitating with intergenerational offspring), "joint family (i.e. cohabitating with brothers and sisters and their offspring") are still very common in China, especially in rural areas. Limited by the information provided by CHARLS database, the concept of family structure have been oversimplified in the current research. These factors should be taken into consideration by future research. Third, cohabitation with spouse/child could be beneficial to elderlies in two ways (i.e. obtaining more frequent opportunities to engage in cognitive-facilitating activities and/or support and intimacy), and the two possibilities were not tested limited by the current database. In future studies, control group (e.g. elderlies who live with non-family members) should be included to elucidate on the mechanism how cohabitation with spouse/child may influence elderlies' cognitive functioning.

8 | CONCLUSIONS

In conclusion, the current research found that: (1) cohabitating with partner or children has positive effect on elders' cognitive functioning; (2) intergenerational rearing only has effects on initial level but not declining rate of cognitive functioning; (3) the effects of cohabitation on cognitive functions were partly mediated by depression.

CONFLICTS OF INTEREST

No.

AUTHOR CONTRIBUTION

Haoran Wang finished the main part of the manuscript. Chunyan Yang participated in the data analyzing process and created the tables. Ye Yao proposed the idea and controlled the quality of the whole research.

DATA AVAILABILITY STATEMENT

The data that support the findings of the current study is available from Institute of Social Science Survey, Peking University. Data are available from Institute of Social Science Survey, Peking University with permission.

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