Living Arrangements and Disability Among Older Adults in China

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WEN Ming and GU Danan

Using data from a large representative longitudinal sample of older adults in China, the current study examines the associations between living arrangements and disability measured by activities of daily living (ADL) and instrumental activities of daily living (IADL). The cross-sectional models showed that living alone was associated with the lowest odds of disability among all the seven types of living arrangements. Living with others who are not spouses or offspring and living in an institution were linked to the highest odds of disability, particularly in more recent waves. Other forms of living arrangements such as living with spouse only, living with adult children and living in skipped-generation households lay somewhere in the middle in the correlation to disability. Findings from the transitional models revealed that moving from independent living towards co-residence with family corresponded to higher risks of disability. Overall, the associations were stronger for ADL disability than for IADL disability. The authors observed temporal fluctuations rather than linear trends in these patterns across the 16 years of the study from 2002 to 2018. Study implications are discussed.

Due to largely reduced fertility and dramatic improvement in life expectancy, China is ageing at a rate that few countries have matched historically, exacerbated by the 36 years of the one-child birth-planning policy.[1] With the ageing of a population comes an increase in prevalence of chronic diseases and geriatric syndromes (e.g. falls and frailty), and potential challenges affecting many aspects of the society including health and long-term care systems, social security, education, housing, sociocultural activities, family life and the economic sector.[2] Healthy ageing, defined as "the process of developing and maintaining the functional ability that enables wellbeing in older age",[3]

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[1] Theresa Hesketh, Lu Li and Xing Zhuwei, "The Effect of China's One-Child Family Policy after 25 Years", *New England Journal of Medicine* 353, no. 11 (2005): 1171–6.

[2] Feng Zhanlian, Liu Chang, Guan Xinping and Vincent Mor, "China's Rapidly Aging Population Creates Policy Challenges in Shaping a Viable Long-Term Care System", *Health Affairs* 31, no. 12 (2012): 2764–73; Meltem Ince Yenilmez, "Economic and Social Consequences of Population Aging: the Dilemmas and Opportunities in the Twenty-First Century", *Applied Research in Quality of Life* 10, no. 4 (2015): 735–52.

[3] World Health Organization, "Decade of Healthy Ageing: Baseline Report", 2020, at <https://www.who.int/publications/m/item/decade-of-healthy-ageing-baseline-report> [18 February 2021].

is thus a major public health goal for ageing societies.[4] A basic prerequisite of enjoying a happy and healthy life in later years is the avoidance of disability. Identifying associated factors of disability would inform the development of effective programmes or interventions to prevent it. Social and environmental factors are significant social determinants of the causes and experiences of disability.[5]

To most people, the household is a critical socio-ecological context where daily activities happen and the primary social support networks are formed and maintained. According to life span and life course theories and the socio-emotional selectivity theory, the family becomes more important for older adults as the need for support increases and as they tend to constrict the focus of their socio-emotional contacts to include predominantly close family.[6] Living arrangements, defined by whom one lives with, represent the family's structural aspect that plays a salient role in affecting health and well-being in later life. The changing family dynamics observed in many developed and developing countries, concomitant with global socio-economic and cultural shifts, have major implications for intergenerational relationships and caregiving in ageing families.[7]

Numerous studies in the United States and other developed countries have documented that living arrangements matter for health and mortality.[8] Consistent with these findings, cumulative evidence has shown that older Chinese people's living arrangements are an important predictor of their physical and cognitive health, emotional well-being and survival.[9] However, perhaps due partly to the heterogeneity in health implications of living arrangements and partly to the observed discrepancies in methodology, the specific patterns of the living arrangement and well-being relationship diverge in different settings and for different outcomes even for the same

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[4] Agnieszka Sowa, Beata Tobiasz-Adamczyk, Roman Topór-Mądry, Andrea Poscia and Daniele Ignazio la Milia, "Predictors of Healthy Ageing: Public Health Policy Targets", *BMC Health Service Research,* 16 (2016): 289, at <https://doi.org/10.1186/s12913-016-1520-5>.

[5] Robert J. Gatchel, "The Continuing and Growing Epidemic of Chronic Low Back Pain", *Healthcare* 3, no. 3 (2015): 838–45.

[6] Heather R. Fuller, "The Convoy Model and Later-Life Family Relationships", *Journal of Family Theory & Review* 12, no. 2 (2020): 126–46.

[7] Deborah Carr and Rebecca L. Utz, "Families in Later Life: A Decade in Review", *Journal of Marriage & Families* 82, no. 1 (2020): 346–63.

[8] Judith C. Hays, "Living Arrangements and Health Status in Later Life: A Review of Recent Literature", *Public Health Nursing* 19, no. 2 (2002): 136–51.

[9] Feng Zhixin, Jane Falkingham, Liu Xiaoting and Athina Vlachantoni, "Changes in Living Arrangements and Mortality among Older People in China", *SSM Population Health* 3, no. C (2017): 9–19; Ren Qiang and Donald J. Treiman, "Living Arrangements of the Elderly in China and Consequences for Their Emotional Wellbeing", *Chinese Sociological Review* 47, no. 3 (2015): 255–86; Wen Ming, Ren Qiang, Kim Korinek and Ha N. Trinh, "Living in Skipped Generation Households and Happiness among Middle-aged and Older Grandparents in China", *Social Science Research,* 80 (2019): 145–55; Zhou Zi, Mao Fanzhen, Ma Jiaping, Hao Shichao, Zhengmin (Min) Qian, Keith Elder, Jason S. Turner and Fang Ya, "A Longitudinal Analysis of the Association between Living Arrangements and Health among Older Adults in China", *Research on Aging* 40, no. 1 (2018): 72–97.

living arrangement. For example, although co-residential arrangements are presumably better than living alone in promoting healthy lifestyles, emotional well-being and, in turn, physical health and longevity, empirical results are mixed, with research finding that living alone is detrimental to self-rated health and emotional well-being beneficial to cognitive and functional health.[10] Theoretical paradoxes exist regarding the health implications of living alone. While it can be linked to adverse effects due to loneliness and lack of support and economic resources, solo living can also be beneficial in terms of the absence of home-based conflicts and increased social engagement out of home, autonomy and independence.[11] It is also conceptually unclear whether living in skipped-generation households is salubrious or injurious to older grandparents. On the one hand, raising grandchildren in the absence of the parents can be physically and emotionally exhausting. On the other hand, providing care for grandchildren is culturally normative and often emotionally satisfying in Chinese families, where the filial obligation is extended downstream from the older generation to the younger generation and altruistic family ideals permeate, aiming towards the comfortable survival of all members.[12] Living alone and living in skipped-generation households have gained considerable attention in the past decades, representing new family trends in China.[13]

There seems to be a health benefit of living with a spouse regardless of whether other family members are present.[14] Co-residence with adult children and grandchildren, the most prevalent and traditional multigenerational living arrangement, seems in

[10] Wen Ming and Ren Qiang, "Cognitive and Psychological Health Implications of Living Alone among Middle-aged and Older Adults in China", *Asian Population Studies* 17, no. 2 (2021): 181–200; Zhou et al., "A Longitudinal Analysis of the Association Between Living Arrangements and Health Among Older Adults in China".

[11] Wen and Ren, "Cognitive and Psychological Health Implications of Living Alone among Middle-aged and Older Adults in China"; Gu Danan, Feng Qiushi and Wei-Jun Jean Yeung, "Reciprocal Dynamics of Solo-Living and Health Among Older Adults in Contemporary China", *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 74, no. 8 (2019): 1441–52.

[12] Zachary Zimmer, "Health and Living Arrangement Transitions among China's Oldest-Old", *Research on Aging* 27, no. 5 (2005): 526–55.

[13] Wen and Ren, "Cognitive and Psychological Health Implications of Living Alone among Middle-Aged and Older Adults in China"; Wen, Ren, Korinek and Trinh, "Living in Skipped Generation Households and Happiness among Middle-Aged and Older Grandparents in China".

[14] Chiu Chi-Tsun, "Living Arrangements and Disability-Free Life Expectancy in the United States", *PLoS One* 14, no. 2 (2019): e0211894; Lydia W. Li, Zhang Jiaan and Jersey Liang, "Health among the Oldest-Old in China: Which Living Arrangements Make a Difference?", *Social Science & Medicine* 68 (2009): 220–7; Ren and Treiman, "Living Arrangements of the Elderly in China and Consequences for Their Emotional Wellbeing"; Wang Jinfeng, Chen Tianyong and Han Buxin, "Does Co-residence with Adult Children Associate with Better Psychological Well-being among the Oldest Old in China?", *Aging & Mental Health* 18, no. 2 (2014): 232–9; Wen, Ren, Korinek and Trinh, "Living in Skipped Generation Households and Happiness Among Middle-Aged and Older Grandparents in China"; Zhang Yong, Liu Zifeng, Zhang Lingling, Zhu Paiyi, Wang Xin and Huang Yixiang, "Association of Living Arrangements with Depressive Symptoms among Older Adults in China: A Cross-Sectional Study", *BMC Public Health* 19 (2019): 1017.

general health-beneficial.[15] Evidence about the importance of co-residence with adult children without a grandchild's presence for older grandparents' subjective well-being is mixed.[16] Living with others or in an institution appears to be associated with the worst health outcomes among elderly Chinese, with few exceptions.[17]

Several studies have examined living arrangements and disability in China. In a cross-sectional study of older adults in China, researchers found that living with family was associated with higher odds of disability than living alone.[18] A study used the first two waves of data from the Chinese Longitudinal Healthy Longevity Surveys (CLHLS) in 1998 and 2000, and examined the risk associated with activities of daily living (ADL) disability at the second wave among oldest-old respondents.[19] The findings show that those living alone were less likely to have ADL disability at the second wave, compared with those living with children, with others and in institutions, after controlling for baseline health and other covariates. Analysing the 2002–05 CLHLS data, Wang and colleagues confirmed that living alone lowered the prevalence of disability among study participants aged 65 to 99 years who were free of ADL disability at baseline; they also reported the benefit of living with a spouse.[20] A more recent study used the third to sixth waves of the CLHLS, which were conducted in 2002, 2005, 2008/2009 and 2011/2012, and examined the effects of living arrangements on health outcomes, including ADL disability. The results showed that those living alone had the lowest risk of ADL disability, while those living with others and living in institutions were in the highest rate category.[21] Therefore, it seems that the functional benefits of living alone have been consistently reported, whereas comparative functional implications of other living arrangements are less clear.

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[15] Ren and Treiman, "Living Arrangements of the Elderly in China and Consequences for Their Emotional Wellbeing"; Wen, Ren, Korinek and Trinh, "Living in Skipped Generation Households and Happiness among Middle-Aged and Older Grandparents in China".

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[17] Feng, Falkingham, Liu and Vlachantoni, "Changes in Living Arrangements and Mortality among Older People in China"; Gu Danan, Matthew E. Dupre and Liu Guangya, "Characteristics of the Institutionalized and Community-Residing Oldest-Old in China", *Social Science & Medicine* 64, no. 4 (2007): 871–83; Li, Zhang and Liang, "Health among the Oldest-Old in China"; Ren and Treiman, "Living Arrangements of the Elderly in China and Consequences for Their Emotional Wellbeing".

[18] Chen Wei, Fang Ya, Mao Fanzhen, Hao Shichao, Chen Junze, Yuan Maoqiong, Han Yaofeng, Alicia Y. Hong and Stefano Federici, "Assessment of Disability among the Elderly in Xiamen of China: A Representative Sample Survey of 14,292 Older Adults", *PLoS One* 10, no. 6 (2015): e0131014.

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[20] Wang Hui, Chen Kun, Pan Yifeng, Jing Fangyuan and Liu He, "Associations and Impact Factors between Living Arrangements and Functional Disability among Older Chinese Adults", *PLoS One* 8, no. 1 (2013): e53879.

[21] Zhou, Mao, Ma, Hao, Qian, Elder, Turner and Fang, "A Longitudinal Analysis of the Association Between Living Arrangements and Health Among Older Adults in China".

Most published studies focusing on living arrangements and functional health operationalise living arrangements in static form even though changes in elderly living arrangements frequently occur in China.[22] Multigenerational arrangements are usually lumped together without differentiating two-generation and three-generation households. The functional health of Chinese elderly living in skipped-generation households has not been examined. Moreover, no research has examined instrumental activities of daily living (IADL) as a less severe disability outcome in relation to living arrangements in China. Socio-environmental influences could vary for different levels of functional limitation.

Using the six most recent waves of the CLHLS data, this study examines the cross-sectional associations between living arrangements and prevalence of disability in each wave, and investigates the longitudinal links between the living arrangement transitions across two adjacent waves and the disability risks. The authors included both ADL and IADL to measure disability and explore the temporal trends in the associations between living arrangements and disability. Based on theory and evidence previously developed, the authors hypothesise that study participants who live alone or live with a spouse only are less likely to have a disability or become disabled, and that those living in institutions or living with others are the most likely. Hypotheses on how other living arrangements are linked to disability are difficult to formulate *a priori* due to conceptual and empirical discrepancies. The authors presume the benefits of living alone would become stronger over time given the trends towards lifestyle westernisation in China and increased appreciation of independence among Chinese older adults.[23] The authors also expect generally stable trends in the relationship of other living arrangements with disability.

METHODS

Data and Sample

This study uses six waves of the Chinese Longitudinal Healthy Longevity Survey (CLHLS) from 2002, 2005, 2008/2009 (2008 briefly considered), 2011/2012 (2011 briefly considered), 2014 and 2018/2019 (2018 briefly considered). Initiated in 1998, the CLHLS randomly selected half of the cities/counties in 22 of 31 provinces through in-home interviews. From 2002 onwards, the CLHLS included participants aged 65 to 79 and those aged above 80 were recruited in 1998 and 2000. In 2008, the CLHLS further expanded its geographic coverage to include one county in Hainan province, making 23 sampled provinces in total. The CLHLS aimed to interview all centenarians

[22] Zimmer, "Health and Living Arrangement Transitions among China's Oldest-Old"; Kim Korinek, Zachary Zimmer and Gu Danan, "Transitions in Marital Status and Functional Health and Patterns of Intergenerational Coresidence among China's Elderly Population", *Journals of Gerontology Series B: Psychological Sciences and Social Sciences* 66, no. 2 (2011): 260–70.

[23] Wang, Chen and Han, "Does Co-residence with Adult Children Associate with Better Psychological Well-Being among the Oldest Old in China?".

in the sampled counties/cities. It oversampled older participants and male participants to maintain a comparable sample size by age and sex. With exceptions for the 2011 and 2014 waves, each wave recruited a new sample to replace the deceased participants and those that were missing in the follow-ups to ensure a sufficient sample size in subsequent waves. More information about the CLHLS study design is available and accessible elsewhere.[24] The analytical sample of this study included 47,090 participants with 79,963 observations for the 2002–18 period.

Variables and Measures

The outcome of interest was disability, measured by ADL and IADL. The authors define a participant as not ADL disabled if he or she could perform all six items (i.e. bathing/showering, dressing, indoor ambulating, toileting, eating and exercising continence) without assistance and as ADL disabled, if otherwise. IADL functioning includes eight tasks (i.e. visiting neighbours, cooking meals, going shopping, doing laundry, continuously walking for one kilometre, lifting weights of five kilogrammes, continuously crouching and standing up three times, and taking public transportation). A participant was considered not IADL disabled if he or she could perform all eight tasks without any help and IADL disabled, if otherwise.

Living arrangements and transitions

The CLHLS collects detailed information on the living arrangements of the participants. Living arrangements were classified into seven categories: (i) living alone; (ii) living with spouse only; (iii) living with an adult child regardless of whether the spouse was present (two generations); (iv) living in a skipped-generation household regardless of whether the spouse was present (no children); (v) living with children and grandchildren (three-plus generations regardless of whether great-grandchildren were present); (vi) living with others who are not spouses or offspring; and (vii) living in an institution. Categories (iii) to (v) represent co-residence with family, with at least the following offspring (i.e. children, children-in-law, grandchildren, grandchildren-in-law, great-grandchildren) around.

In analysing the associations between living arrangement transitions and ADL/IADL disability incidences, the authors focused on the following transitions: from living alone to co-residence with family, from living with spouse only to co-residence with offspring, from co-residence with offspring to living alone, and from co-residence with offspring to living with spouse only.

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[24] Gu Danan, "General Data Quality Assessment of the CLHLS", in *Healthy Longevity in China: Demographic, Socioeconomic and Psychological Dimensions*, ed. Zeng Yi, Dudley L. Poston, Denese Ashbaugh Vlosky and Gu Danan (Dordrecht: Springer Netherlands, 2008), pp. 39–60; Gu Danan, Feng Qiushi, Chen Huashuai and Zeng Yi, "Chinese Longitudinal Healthy Longevity Survey", in *Encyclopedia of Gerontology and Population Aging*, ed. Gu Danan and Mathew E. Dupre (Cham, Switzerland: Springer, 2021).

Covariates

Based on previous research, the covariates included demographics (age, sex, urban–rural residence), socio-economic characteristics (education, economic independence, primary lifetime occupation, having adequate access to health care, marital status), health behaviour (smoking, exercise) and other health conditions (cognitive impairment and chronic disease conditions).[25] Cognitive function was measured based on participants' responses to the Chinese version of the Mini-Mental State Examination (MMSE), with scores of 24 and above out of 30, denoting cognitively unimpaired.[26] Table 1 presents information on the detailed categorisation of study variables and sample statistics.

Data Analysis

The authors ran logistic regression models to compare odds ratios of the prevalence of ADL/IADL disabilities for living arrangements in each of the six waves (termed as disability prevalence models). People living with children and grandchildren with or without great-grandchildren present (born three or four generations later) composed the reference group. The authors also executed logistic regression models to examine the associations between living arrangements at time 1 (T1), and the incidence of ADL/IADL disabilities at time 2 (T2), as well as the associations between living arrangements from T1 to T2 and the incidence of ADL/IADL disabilities at T2 across the waves. Those who did not experience a change in living arrangements from T1 to T2 were labelled the reference group.

The authors did not apply the sampling weight in the regression analysis. The published sample weights in the CLHLS waves considered only national age-sex-urban–rural distribution without taking into consideration other major sociodemographic characteristics of the population or the geographic distribution on which the CLHLS waves of 2008, 2011 and 2014 relied heavily. Furthermore, the variables age, sex and urban–rural residence were included in the model. Previous studies have shown that weighted regression modelling would introduce bias in the coefficient estimates if the model included the variables that were used to construct weight.[27] Besides, competing risk (for example, losses to follow-up and deaths) was also considered in alternative modelling of living arrangement transitions. The results are very similar to those without consideration of these competing risks. All analyses were performed using Stata 16.

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[25] Wen Ming and Gu Danan, "The Effects of Childhood, Adult, and Community Socioeconomic Conditions on Health and Mortality among Older Adults in China", *Demography* 48, no. 1 (2011): 153–81.

[26] Zeng Yi, Dudley L. Poston, Denese Ashbaugh Vlosky and Gu Danan, eds., *Healthy Longevity in China: Demographic, Socioeconomic, and Psychological Dimensions* (Dordrecht: Springer Netherlands, 2008).

[27] Christopher Winship and Larry Radbill, "Sampling Weights and Regression Analysis", *Sociological Methods & Research* 23, no. 2 (1994): 230–57.

RESULTS

Table 1 presents the weighted sample statistics for each of the six waves of the CLHLS across the 16 years of the study period from 2002 to 2018. The Chinese older adults' mean age stabilised around 73 years in this period, whereas their educational attainment exhibited a remarkable upward trend. For instance, the percentage having no formal schooling dropped from 52 per cent in 2002 to 15 per cent in 2018, reflecting the achievement of the national movement to eradicate illiteracy in the early 1950s shortly after the foundation of the People's Republic of China.[28] The majority of the sample were married women with one or more chronic diseases. About 48 to 55 per cent of the older Chinese adults in the 2002–18 period reported that they were economically independent. From 2002 to 2018, the percentages of current smokers and the cognitively impaired decreased, while the percentage of respondents who regularly exercised and those with at least one chronic disease increased.

The prevalence of ADL disability ranged from six per cent in 2008 to nearly 13 per cent in 2014, and the prevalence of IADL disability ranged from 34 per cent in 2008 to 40 per cent in 2005. The incidence of ADL disability ranged from five per cent in 2008 to nearly 15 per cent in 2011, and the incidence of IADL disability ranged from 30 per cent in 2008 to about 36 per cent in either 2005 or 2014. There is no monotonic trend observed for ADL or IADL disability burden or risk across the 16 years of the study.

Among the seven living arrangements, living in three-plus-generation households was the most prevalent, ranging from about 35 per cent in the most recent two waves to more than 40 per cent in 2002, the first wave included in this study. In other words, this traditional living arrangement experienced a downward trend but remained the most common for elderly Chinese. Living with spouse only without offspring was the second-most prevalent living arrangement, followed by living with adult children only without the third generation. The solo-living share increased monotonically, from about 10 per cent in 2002 to more than 13 per cent in 2018, and was ranked the fourth-most prevalent living arrangement. About five per cent of the study participants lived in skipped-generation households, and there was a minimal temporal change in this living arrangement. In all of the waves, living with other non-family members was the most uncommon arrangement. The percentage of older Chinese living in institutions was around one to two per cent throughout the study period. The distribution of living arrangements is consistent with the censuses (100 per cent tabulations)[29] and intercensal interpolations.

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[28] Glen Peterson, "State Literacy Ideologies and the Transformation of Rural China", *Australian Journal of Chinese Affairs* 32 (1994): 95–120.

[29] National Bureau of Statistics of China, *Tabulations of the 2000 Population Census of China* (Beijing: China Statistics Press, 2002); National Bureau of Statistics of China, *Tabulations of the 2010 Population Census of China* (Beijing: China Statistics Press, 2012).

TABLE 1
SAMPLE STATISTICS, CHINESE LONGITUDINAL HEALTHY LONGEVITY SURVEYS (CLHLS), 2002–2018

	2002	2005	2008	2011	2014	2018
Sample size	15,914	15,326	16,339	9,643	7,053	15,708
Disability						
% ADL disabled	9.8	8.2	6.0	13.0	14.9	11.3
% IADL disabled	39.0	40.5	34.7	37.2	37.9	35.5
% Incidence of ADL disability	–	7.9	5.3	14.6	13.4	7.8
% Incidence of IADL disability	–	35.5	29.7	33.0	35.0	29.3
Living arrangements						
% Living alone (one generation)	9.6	10.6	11.6	12.4	12.2	13.4
% Living with spouse only (one generation)	18.6	20.1	21.4	22.6	26.1	25.1
% Living with children only (without grandchildren) (two generations)	19.4	23.3	22.1	21.8	19.8	20.3
% Living with grandchildren (without children) (skipped generations)	5.4	5.4	5.3	5.0	4.9	4.8
% Living with children, grandchildren and/or great grandchildren (three-plus generations)	45.0	38.4	36.8	34.9	34.1	33.4
% Living with others	0.9	0.9	1.3	2.0	1.1	1.1
% Institutionalised	1.0	1.2	1.4	1.4	1.8	1.9
Living arrangement transitions						
% From living alone to with family	–	33.6	28.3	33.0	26.4	42.44
% From living with spouse only to with family	–	22.7	22.6	23.1	21.2	32.7
% From living with family to living alone	–	9.0	12.0	9.9	12.3	7.9
% From living with family to living with spouse only	–	19.9	23.9	19.3	20.1	29.8
Covariates						
Mean age	72.8	73.0	73.3	73.5	73.2	72.5
%Male	47.3	47.6	48.2	48.1	48.9	47.4
%Urban	37.6	40.2	43.0	45.7	47.8	52.9
% Years of no schooling	52.1	47.9	38.3	27.1	22.0	15.3
% Years of schooling, 1 to 6	33.8	35.0	41.3	47.9	48.1	47.1
% Years of schooling, 7 and more	14.1	17.1	20.1	25.0	30.0	37.6
% Economically independent	47.9	47.9	52.2	49.4	42.3	55.0
% Professional job category	12.4	13.4	13.2	12.7	11.1	14.0
% Adequate access to medical care	92.0	89.8	93.4	93.6	96.7	96.5
% Married	60.5	61.5	62.9	64.0	67.7	71.7
% Currently smoking	25.5	27.1	23.7	23.8	22.0	20.1
% Regular exercise	37.5	41.3	41.0	43.6	40.2	45.8
% Cognitively impaired	14.5	15.1	14.4	11.7	11.9	8.5
% Having one or more chronic disease	61.7	63.8	62.8	63.0	65.5	73.0

Notes: Percentages were weighted; "–" denotes not applicable; ADL denotes activities of daily living; IADL denotes instrumental activities of daily living.

The data on the living arrangement transitions show that the most common transition was from living alone to living with family, followed by the transition from living with spouse only to living with family and vice versa. The transition from living with family to living alone was the least common but still non-trivial.

Table 2 shows the cross-sectional associations between living arrangements and prevalence of disability in each wave. Relative to living in three-generation households, living alone was consistently associated with lower odds of ADL and IADL disability. The associations exhibited slight temporal variation for ADL disability and appeared weaker for IADL in more recent waves. Living with spouse only was negatively linked to ADL disability in earlier waves but became non-significant in recent waves and mattered considerably less for IADL. Living in skipped-generation households was either a negative covariate or a non-significant covariate across the waves for both disability outcomes. Meanwhile, living with children only, living with others and living in an institution were positively associated with disability in most cases.

TABLE 2
ODDS RATIOS OF PREVALENCE OF ADL/IADL DISABILITY FOR LIVING ARRANGEMENTS BY WAVE, CHINESE LONGITUDINAL HEALTHY LONGEVITY SURVEYS (CLHLS)

	Waves					
	2002	**2005**	**2008**	**2011**	**2014**	**2018**
Prevalence of ADL disabled						
Living alone (one generation)	0.50***	0.45***	0.33***	0.54***	0.67***	0.56***
Living with spouse only (one generation)	0.95	0.83^{+}	0.64***	0.99	0.97	1.08
Living with children only (without grandchildren) (two generations)	1.13*	1.35***	1.28***	1.45***	1.40***	1.51***
Living with grandchildren (without children) (skipped generations)	0.93	0.66***	0.96	0.77^{+}	0.88	1.06
Living with children, grandchildren, great-grandchildren (three-plus generations)	1.00	1.00	1.00	1.00	1.00	1.00
Living with others	1.24	1.27	1.33^{+}	1.74***	1.72^{+}	2.72***
Institutionalised	0.83	0.95	0.90	1.43*	2.42***	2.75***
Prevalence of IADL disabled						
Living alone (one generation)	0.64***	0.65***	0.63***	0.73***	0.81*	0.79**
Living with spouse only (one generation)	0.86*	0.98	1.02	1.14	1.09	1.06
Living with children only (without grandchildren) (two generations)	1.10	1.15*	1.24**	1.31**	1.36**	1.09
Living with grandchildren (without children) (skipped generations)	0.89	1.00	1.03	0.81	0.54***	0.77*
Living with children, grandchildren, great-grandchildren (three-plus generations)	1.00	1.00	1.00	1.00	1.00	1.00
Living with others	0.69*	1.12	0.92	0.72*	1.13	2.60***
Institutionalised	1.32*	1.10	2.03**	1.90*	4.27***	3.39***

Notes: Odds ratios were unweighted. They were adjusted for all covariates listed in Table 1. The reference of living arrangements is living with children, grandchildren and great-grandchildren. ADL denotes activities of daily living; IADL denotes instrumental activities of daily living.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.1$

TABLE 3
ODDS RATIOS OF INCIDENCE OF ADL/IADL DISABILITY FOR LIVING ARRANGEMENTS AND LIVING ARRANGEMENT TRANSITIONS, CHINESE LONGITUDINAL HEALTHY LONGEVITY SURVEYS (CLHLS)

	2002–05	2005–08	2008–11	2011–14	2014–18
	Incidence of ADL disability from T1 to T2				
Living arrangements at T1					
Living with spouse only (living alone)	1.30	1.30	1.39*	0.99	1.93**
Living with family (living alone)	1.31*	1.40**	1.39***	1.19*	1.33*
Living arrangement transitions from T1 to T2					
Living alone TO with family (still living alone)	2.50***	2.02**	2.51***	1.99***	1.97**
Living with spouse TO with family (still with spouse)	1.85***	1.25	1.67***	1.29	1.82*
Living with family TO alone (still with family)	0.69^{+}	0.44***	0.74*	0.81	0.44*
Living with family TO with spouse only (still with family)	1.22	0.63	1.02	0.89	0.45*
	Incidence of IADL disability from T1 to T2				
Living arrangements at T1					
Living with spouse only (living alone)	1.17	1.08	1.24	1.20	1.21
Living with family (living alone)	1.09	1.10	1.19	1.10	0.95
Living arrangement transitions from T1 to T2					
Living alone TO with family (still living alone)	1.24	1.68*	1.84**	1.31	1.43
Living with spouse TO with family (still with spouse)	1.65**	1.57*	0.99	1.63*	1.21
Living with family TO alone (still with family)	0.70^{+}	0.77	1.01	0.64^{+}	1.23
Living with family TO with spouse only (still with family)	1.02	0.86	0.80	0.95	0.82

Notes: Odds ratios were unweighted. They were adjusted for all covariates listed in Table 1. The category in the parentheses is the reference category. ADL denotes activities of daily living; IADL denotes instrumental activities of daily living; T1 denotes time 1; T2 denotes time 2.
*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $^{+}$ $p < 0.1$

Table 3 presents results from analyses on disability incidence. Among the participants free of disability in the previous wave (T1), living alone corresponded to lower risks of ADL disability in the current wave (T2) than living with spouse only or living with family. However, the differences were not significant for IADL. As for the relation to living arrangement transitions, for ADL disability, moving towards dependence was associated with significantly higher risks compared to continuously living independently either alone or with spouse only, and vice versa. For example, from 2014 to 2018, those who moved from solo living to living with family were nearly twice as likely as those who continued to live alone to develop ADL disability (OR [odds ratio] = 1.97; $p < 0.01$); by contrast, among those who moved from living with family in 2014 to living alone (OR = 0.44; $p < 0.05$) or with spouse only (OR = 0.45; $p < 0.05$) in 2018, the risk of developing ADL disability was half that for those who continued to live with family in both waves. The patterns for IADL were generally similar, but the associations were much weaker.

DISCUSSION

Using the six most recent waves of data from the CLHLS, derived from a large representative sample of older adults in China, this study produces evidence to confirm that living arrangements and changes in living arrangements are associated with subsequent risk of disability for ADL and to a lesser extent for IADL as well. Temporal fluctuations rather than linear trends are detected in these relationships across the 16 years of the study from 2002 to 2018. The authors' cross-sectional models showed that living alone was associated with the lowest odds of disability among the seven types of living arrangements. Living with others and living in an institution were linked to the highest odds of disability, particularly in more recent waves. Other living arrangements such as living with spouse only, living with adult children and living in skipped-generation households lay somewhere in the middle in relation to disability. Findings from the transitional models revealed that moving from independent living to co-residence with family corresponded to higher risks of disability. Overall, the associations were stronger for ADL disability than for IADL disability. The authors observed temporal fluctuations rather than linear trends in these patterns. Due to the nature of the observational study design, no causal inference can be derived from these study findings. It is reasonable to assume that these associations result from bidirectional influences between living arrangements and functional health conditions.[30]

The perspective that altruistic behaviour is common in Chinese families would predict that intergenerational co-residence is often triggered by the needs of the older family members for physical, emotional and social support.[31] Empirical work has corroborated that co-residence shifts in later life are primarily shaped by the needs of older adults.[32] Among a variety of health outcomes, functional deterioration is the strongest predictor of subsequent co-residential living arrangements, particularly for unmarried Chinese aged 80 or older.[33] Net of the reverse causation of older people's health conditions on living arrangements, however, the household structure may also influence subsequent health. This is because, in some household structures, individuals are more likely to experience a resource surplus and enjoy better health than those who perceive that demands exceed resources in their lives and suffer from deficiencies such as a lack of social support and chronic strains.[34] The results from the authors' transitional models corroborate this causal interpretation of the observed link between living arrangements and health in later life.

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[30] Gu, Feng and Yeung, "Reciprocal Dynamics of Solo-Living and Health among Older Adults in Contemporary China".

[31] Zimmer, "Health and Living Arrangement Transitions among China's Oldest-Old".

[32] Korinek, Zimmer and Gu, "Transitions in Marital Status and Functional Health and Patterns of Intergenerational Coresidence among China's Elderly Population".

[33] Zimmer, "Health and Living Arrangement Transitions among China's Oldest-Old".

[34] Mary Elizabeth Hughes and Linda J. Waite, "Health in Household Context: Living Arrangements and Health in Late Middle Age", *Journal of Health and Social Behavior* 43, no. 1 (2002): 1–21.

The findings from both cross-sectional and transitional models regarding the negative link between living alone and disability are consistent with the hypothesis that the authors formulated and the results from several previous China-based studies on functional health[35] and studies conducted in non-Chinese settings.[36] Meanwhile, research also shows that living alone is linked to poorer mental and cognitive health, lower life satisfaction, lower medical quality of life, a worse emotional state and weaker social support for the older person.[37] Perhaps the physical and social environment and psychological processes associated with solitary life have pros and cons with differential implications for different health outcomes. Arguably, household composition impacts can be highly variable across population subgroups, i.e. by cohort, gender, rural–urban residence and socio-economic status. Another plausible moderator is whether solo living results from a voluntary choice. Living alone in later life does not necessarily mean living in social isolation. Some older persons live alone and thrive because they enjoy the personal space and independence, cherish the high degree of autonomy and appreciate the freedom from the caregiving burden. At the same time, for others, living alone means ageing alone and being socially isolated and invisible, which can foster negative emotions such as loneliness and a sense of helplessness, and in turn, lead to increased risks of morbidity and mortality. Nearly 14 per cent of older Chinese lived alone in 2018, a 3.3 percentage point increase from 2002. To date, empirical investigations lag behind theorising of the mechanisms linking solo living to health for older Chinese. More research needs to be done to better understand the antecedents and sequelae of older people's solitary life, given the rising trends in this living arrangement worldwide.[38]

[35] Chen, Fang, Mao, Hao, Chen, Yuan, Han, Hong and Federici, "Assessment of Disability among the Elderly in Xiamen of China"; Gu, Feng and Yeung, "Reciprocal Dynamics of Solo-Living and Health among Older Adults in Contemporary China"; Wang, Chen, Pan, Jing and Liu, "Associations and Impact Factors between Living Arrangements and Functional Disability among Older Chinese Adults"; Li, Zhang and Liang, "Health among the Oldest-Old in China"; Zhou, Mao, Ma, Hao, Qian, Elder, Turner and Fang, "A Longitudinal Analysis of the Association between Living Arrangements and Health among Older Adults in China".

[36] Roger T. Anderson, Margaret K. James, Michael E. Miller, Angela S. Worley and Charles F. Longino, "The Timing of Change: Patterns in Transitions in Functional Status among Elderly Persons", *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences* 53 (1998): S17–S27; A.R. Sarwari, Lisa Fredman, Patricia Langenberg and J. Magaziner, "Prospective Study on the Relation between Living Arrangement and Change in Functional Health Status of Elderly Women", *American Journal of Epidemiology* 147 (1998): 370–8.

[37] Hays, "Living Arrangements and Health Status in Later Life"; Nina Tamminen, Tarja Kettunen, Tuija Martelin, Jaakko Reinikainen and Pia Solin, "Living Alone and Positive Mental Health: A Systematic Review", *BMC Systematic Reviews* 8 (2019): 134; Wen and Ren, "Cognitive and Psychological Health Implications of Living Alone among Middle-Aged and Older Adults in China"; Gu, Feng and Yeung, "Reciprocal Dynamics of Solo-Living and Health among Older Adults in Contemporary China".

[38] Eric Klinenberg, *Going Solo: The Extraordinary Rise and Surprising Appeal of Living Alone* (New York: Penguin, 2012).

The authors' inferences on the positive associations between disability and living with adult children but not with grandchildren are unresolved. On the one hand, this pattern may be an unintended consequence of loss of elder independence due to strong home-based daily support provided for the older person by their adult children who are free of child-care duties. On the other hand, if family conflicts are frequent and peaceful resolutions are rare, living with adult children can be stressful, and the stress from the relationship strain can expedite the ageing process for the older person. The reverse causation is also possible, namely older parents move in with their adult children due to their deteriorating functional health. Evidence on how this household composition is linked to health is not readily available. It is often lumped into a broad category of intergenerational households, including the traditional three-generation households.

Another under-researched intergenerational household composition is the skipped-generation household where grandparents raise their grandchildren as surrogate/substitute parents. Skipped-generation households form when the parental generation is absent for various reasons. Labour migration is a primary one due to the geographically rooted wealth and opportunity divide in China. A key demographic consequence of internal mass migration is the nearly 70 million left-behind children in rural areas, about half of whom stay with neither of their parents.[39] Media coverage and research literature on left-behind children are abundant; however, much less attention has been paid to China's left-behind grandparents, who constitute most older persons living in skipped-generation households.[40] From a household demands-resources model[41] and the person–environment fit framework[42] in ageing and household composition research, the relationship between skipped-generation living and well-being can be complex for older grandparents depending on the health outcomes being studied as well as a range of personal and contextual factors. Previous research has documented the beneficial effects of skipped-generation living on functional, physical and mental health[43] but also revealed detrimental effects on emotional health[44] in the cultural context of Chinese experiences. Perhaps these empirical discrepancies reflect the real complexity of demands, resources and intergenerational ties in skipped-generation families.

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[39] United Nations Children's Fund, *Country Office Annual Report: China* (2018).

[40] Wen, Ren, Korinek and Trinh, "Living in Skipped Generation Households and Happiness among Middle-Aged and Older Grandparents in China".

[41] Hughes and Waite, "Health in Household Context".

[42] Frank Oswald, Annette Hieber, Hans-Werner Wahl and Heidrun Mollenkopf, "Ageing and Person–Environment Fit in Different Urban Neighbourhoods", *European Journal of Ageing* 2, no. 2 (2005): 88–97.

[43] Korinek, Zimmer and Gu, "Transitions in Marital Status and Functional Health and Patterns of Intergenerational Coresidence among China's Elderly Population"; Xu Hongwei, "Physical and Mental Health of Chinese Grandparents Caring for Grandchildren and Great-Grandparents", *Social Science & Medicine* 229 (2019): 106–16.

[44] Wen and Ren, "Cognitive and Psychological Health Implications of Living Alone among Middle-Aged and Older Adults in China"; Zhang, Liu, Zhang, Zhu, Wang and Huang, "Association of Living Arrangements with Depressive Symptoms among Older Adults in China".

Similar to prior work, this study also reveals positive associations between the odds of disability and living with others or in an institution. Jointly these two living arrangements account for less than three per cent of the Chinese older adult population. Nonetheless, there is a monotonically upward linear trend in the proportion of older persons institutionalised (see Table 1), presaging the increasing significance of institutions as the source of old-age support and care. The authors' analyses show that the positive associations between institutional living and disability have become stronger in more recent waves. This trend may be a consequence of functionally impaired older Chinese being more likely to move into institutions today than before. Alternatively, it may also imply that institutional living is becoming increasingly detrimental to older persons' health and functional ability over time. The authors' study was not able to disentangle these different explanations due to the issue's cross-sectional nature. The line of research specifically focusing on older Chinese living in institutions needs to be further developed to deepen our understanding of old-age care institutions' material and spatial arrangements and the everyday practices and social interactions that are important for the residents' self-perceptions, service needs and well-being in China.

Perhaps the best living arrangement is one perceived as the best by the individual. Agency factors play a critical role in the meanings ascribed by the older person to various living arrangements. Among both institutionalised and community-residing older adults, living arrangement concordance has been linked to increased likelihood of self-rating health as good, with concordance having a greater impact on health for institutionalised elders than for community-residing elders.[45] Due to space limitations, this study does not examine subgroup variations in the living arrangement and disability associations. Research is warranted to explore the specificity of various living arrangements' developmental impacts by testing the moderating effects of a range of sociodemographic and environmental factors.

The authors recognise that their measurement of the living arrangement transitions is crude. They managed to capture only a one-time living arrangement transition between living alone and living with spouse or family between two adjacent survey years. Presumably, evaluating household compositional suitability is continuous, and multiple changes in living arrangements in later life are possible.[46] Similarly, due to unavailability of data in the CLHLS, the authors were not able to better measure the incidence of disability by using multiple episodes of transition between a survey interval. They were also unable to account for the distance between older persons' households and those of adult offspring. While physical proximity can facilitate contact frequency and strengthen kinship exchange and bonds, the dependence of support on geographic proximity may have been substantially weakened in the digital age.[47] How proximity

[45] Melanie D. Sereny and Gu Danan, "Living Arrangement Concordance and its Association with Self-Rated Health Among Institutionalized and Community-Residing Older Adults in China", *Journal of Cross-Cultural Gerontology* 26 (2011): 239–59.

[46] Hays, "Living Arrangements and Health Status in Later Life".

[47] Eugene Litwak and Stephen Kulis, "Technology, Proximity, and Measures of Kin Support", *Journal of Marriage and the Family* 49 (1997): 649–61.

to extended families affects support provided for older adults is largely unknown. Another limitation of this study is the small sample size of the young–old in some waves. Although the overall CLHLS samples were large, only 30 to 50 participants aged from 65 to 70 who were from eight provinces were included in the 2011 and 2014 waves, as these two waves were mostly follow-up waves. Furthermore, the 2008, 2011 and 2014 waves oversampled some cities where the oldest-old were a relatively high percentage of the total local population in eight provinces. Due to a lack of detailed survey information and census data, the authors could not make additional adjustments for the sample distribution to account for such non-randomness. Consequently, the authors' findings may have some biases, especially for the prevalence of disability in these three waves.

Despite these limitations, the study contributes to the literature by performing repeated cross-sectional analyses of the latest six waves of the CLHLS and providing additional evidence of the importance of living arrangements for functional health among community-dwelling and institution-dwelling older Chinese. A key finding from this research is that living alone, rather than multigenerational co-residence, corresponds to the best functional health status despite the social, emotional and material benefits theoretically associated with co-residence.[48] As a result of these expected benefits, multigenerational co-residence used to be considered an indicator of well-being for older Chinese.[49] However, its meaning has changed over time, along with its health implications. More research on ageing and ageing families is needed as China becomes a more aged society and as parents of the first generation of China's only children enter old age.[50] While the older person living with offspring is likely to continue to be the primary family support system in China,[51] the number of non-co-residential ageing families has progressively increased[52] with a growing need for instrumental services and social support outside the family.[53] More emphasis should be placed on encouraging mixed-methods research to identify vulnerable seniors, provide valuable insights for understanding household-based protective and risk factors, and inform new policy and intervention design to promote healthy ageing in China.

[48] Chen Feinian, Bao Luoman, Rachel M. Shattuck, Judith B. Borja and Socorro Gultiano, "Implications of Changes in Family Structure and Composition for the Psychological Well-Being of Filipina Women in Middle and Later Years", *Research on Aging* 39, no. 2 (2017): 275–99.

[49] Zachary Zimmer, "Health and Living Arrangement Transitions among China's Oldest-Old".

[50] Wang Ning and Gu Danan, "Only-Child Older Parents in China", *in Encyclopedia of Gerontology and Population Aging*, ed. Gu Danan and Matthew E. Dupre (Cham, Switzerland: Springer, 2020).

[51] John Giles, Wang Dewen and Zhao Changbao, "Can China's Rural Elderly Count on Support from Adult Children? Implications of Rural-to-Urban Migration", *Journal of Population Ageing* 3 (2010): 183.

[52] Zeng Yi and Wang Zhenglian, "Dynamics of Family Households and Elderly Living Arrangements in China, 1990–2010", *China Population and Development Studies* 2 (2018): 129–57.

[53] Xu, "Physical and Mental Health of Chinese Grandparents Caring for Grandchildren and Great-Grandparents".