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## Nowcasting and forecasting the care needs of the older population in China: analysis of data from the China Health and Retirement Longitudinal Study (CHARLS)

Jinquan Gong<sup>\*</sup>,  
Gewei Wang<sup>\*</sup>,  
Yafeng Wang<sup>\*</sup>,  
Xinxin Chen,  
Yanfeng Chen,  
Qinqin Meng,  
Peng Yang,  
Yao Yao<sup>†</sup>,  
Yaohui Zhao<sup>†</sup>

(J Gong PhD, G Wang PhD, Y Wang PhD, Prof X Chen PhD, Q Meng PhD), **China Center for Health Development Studies** (Y Yao MD), and **China Center for Economic Research, National School of Development** (Prof Y Zhao PhD), **Peking University, Beijing, China**; **North China Electric Power University, Beijing, China** (Y Chen PhD); **Hubei University of Technology, Wuhan, China** (P Yang PhD)

### Summary

**Background**—An ageing population coupled with an increase in morbidity places a considerable burden on health and social care systems. The aim of our study was to estimate the trends in functional dependency and project future care needs for older people in China.

**Methods**—We analysed data from the China Health and Retirement Longitudinal Study, a nationally representative survey of a cohort of Chinese people (aged ≥45 years) from 150 counties or districts and 450 villages or urban communities across 28 provinces, who were selected by use of multistage stratified probability-proportionate-to-size sampling. The baseline survey was

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Correspondence to: Prof Yaohui Zhao, China Center for Economic Research, National School of Development, Peking University, Beijing 100871, China, yzhao@nsd.pku.edu.cn.

<sup>\*</sup>Contributed equally

<sup>†</sup>Joint senior authors

Contributors

XC, YW, and YZ designed the study. Data collection was led by XC and QM, analysed by JG, GW, YC, and PY. The manuscript was written by all authors and reviewed by YY and YZ. JG, GW, YW, and YC accessed and verified the data. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

For the Chinese translation of the abstract see Online for appendix 1

See Online for appendix 2

For more on the **Institute of Social Science Survey** see <http://charls.pku.edu.cn>

Declaration of interests

We declare no competing interests.

conducted in 2011 and follow-up surveys were conducted in 2013, 2015, 2018, and 2020. We excluded people younger than 60 years or people who had missing variables on dependency in the five follow-up interviews. Three dependency levels were determined on the basis of activities of daily living (ADLs) and instrumental activities of daily living (IADLs): any ADL items (level 1 dependency); any ADL items or difficulty cooking, shopping, or taking medications (level 2 dependency); and difficulty in any ADL or IADL items (level 3 dependency). The dependency rates were extrapolated to derive the number of people older than 60 years with dependency in China from 2011 to 2020. We used a regression model to project future changes and forecast the size of the older population with dependency between 2021 and 2030.

**Findings**—A total of 89 031 individuals across five waves completed the surveys, of whom 46 619 were eligible for inclusion. The prevalence of level 1 dependency among older Chinese adults declined from 11.7% (95% CI 10.6–12.8) in 2011 to 8.1% (7.5–8.7) in 2020. Level 2 and level 3 dependency also declined. The total number of older people requiring care in 2020 was 20.61 million (95% CI 19.01–22.20) with level 1 dependency, 36.33 million (34.27–38.40) with level 2 dependency, and 45.30 million (43.02–47.59) with level 3 dependency. Improved education, housing, and access to health care was associated with 41.84% of the decline in level 3 dependency prevalence between 2011 and 2020. By 2030, the projected dependency rates could decline to 8.04% for level 1 dependency, 13.28% for level 2 dependency, and 16.05% for level 3 dependency. Nonetheless, the cohort size will grow, resulting in more older Chinese people who need care (29.71 million [27.07–32.36] in level 1, 49.07 million [45.98–52.16] in level 2, and 59.32 million [55.94–62.70] in level 3) in 2030. By 2030, we estimate that 14.02 million more older Chinese people will need care than in 2020.

**Interpretation**—Rapid ageing of the population could offset the decline in dependency and result in a substantial increase in the population with complex care needs. Promoting healthy ageing and investing in an age-friendly environment are important in reducing care burdens in China.

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## Introduction

The care needs of an ageing population are of particular concern for policy makers. The growing number of older people (ie, aged ≥ 60 years), combined with an increase in morbidity, represents a major burden for health systems and social services.<sup>1</sup> Although morbidity compression (ie, reduction in total lifetime days of functional disability before death) has been observed in some high-income countries since 1980,<sup>2</sup> relevant data concerning patterns and trends of functional dependency in low-income and middle-income countries are scarce and urgently needed for health-care and social policy.<sup>3</sup>

China has the largest older population globally,<sup>4</sup> making the country particularly susceptible to the burdens associated with caring for older people. Traditionally, in China, care for older people is provided by families. However, the mean family size in China has steadily declined in the past three decades, and adult children have been migrating from rural to urban areas on a substantial scale, thus the availability of traditional family care in rural

areas has declined substantially. Moreover, people born between 1962 and 1975 have begun to reach retirement age (60 years old).<sup>5</sup> Therefore, reducing the dependency of older adults to address the care burden is regarded as a prime strategy by the Chinese Government.

Although compression of morbidity has been observed in many countries, how would this affect China is not known.<sup>6</sup> According to a UK study, functional disability rates increased between 2002 and 2012.<sup>7</sup> Another UK study projected that functional dependency would increase by a third between 2015 and 2035, despite a decline in the prevalence of dependency.<sup>8</sup> In the USA, the prevalence of disability in older people increased steadily from 1990 to 2002.<sup>9</sup> Another analysis of longitudinal data in the USA showed increased limitations in activities of daily living (ADLs) across all ages in the study population (ie, age 50–80 years) from 1995 to 2008.<sup>3</sup> Studies in China have reported contrasting results regarding the trends of functional dependency in older adults, hindering the planning and allocation of health and social care. For example, China Sampling Surveys on Disability conducted national surveys between 1987 and 2006 and reported a slight increase in disability prevalence in people aged 60–74 years and a decrease in disability rates in the people aged 75 years or older.<sup>10</sup> By contrast, the China Health and Nutrition Survey reported that the rate of disability in ADLs decreased from 13.2% in 1997 to 9.9% in 2006.<sup>11</sup> A Chinese Longitudinal Healthy Longevity Survey study also reported declines in functional disability among the oldest-old group (ie, aged ≥ 80 years), and further analysis showed that the declines were partly due to mortality and loss to follow-up.<sup>12</sup> Another study, based on the Sample Survey of the Aged Population in Urban/Rural China, showed a complex trend of disability between 2000 and 2010. The study showed that the prevalence of moderate morbidity related to ADLs had decreased, whereas the prevalence of minor morbidity related to instrumental activities of daily living (IADLs) had increased, especially in the oldest-old group (ie, aged ≥ 80 years).<sup>13</sup> To the best of our knowledge, no studies have been conducted to inform the contemporary trend of functioning dependency among older Chinese adults and project the need for care needs in the future. By use of a nationally representative sample of older Chinese adults, this study provides the first estimates of trends in functional dependency and care needs among older Chinese adults between 2011 and 2020. Furthermore, we aimed to identify the factors responsible for the changes in dependency and project changes in these factors between 2021 and 2030 to estimate the extent of care needs for older Chinese people.

## Methods

### Study design and participants

We used data from baseline and follow-up surveys in the China Health and Retirement Longitudinal Study (CHARLS) done in 2011, 2013, 2015, 2018, and 2020. CHARLS is a national survey of a representative sample of Chinese residents aged 45 years and older. To ensure a representative sample, the CHARLS baseline survey covered 150 counties or districts and 450 villages or urban communities across 28 provinces by use of multistage stratified probability-proportionate-to-size sampling (the detailed sampling strategy can be found in appendix 2 p 3). The CHARLS team obtained full lists of all dwellings (ie, a mapping frame) in each area and randomly selected households to complete the survey.

Within each selected household, one resident aged 45 years or older was randomly selected for the sample and their spouse was automatically included. If nobody aged 45 years or older lived in the selected household, then the household was not interviewed. A total of 17 708 individuals from 10 257 households were successfully interviewed for the 2011 baseline CHARLS survey, of which 17 214 were within the representative sample age of 45 years or older. We excluded participants younger than 60 years or people who had missing variables on dependency in the five waves. Full details of the study design, methods, and response rates have been published previously.<sup>14,15</sup>

All participants or their legal representatives signed written informed consent forms to participate in the baseline and follow-up surveys. Informed consent was obtained from study participants before completing the study questionnaire. The study was approved by the Biomedical Ethics Committee of Peking University (IRB00001052-11015).

## Procedures

Participants were interviewed in their normal place of residence by interviewers trained at Peking University, Beijing, China, by CHARLS staff members. The five waves of CHARLS from 2011 to 2020 used the same ascertainment and assessment protocols. Information collected for this study included basic sociodemographic status (ie, age, sex, marital status, education, and rural or urban household), living environments (ie, availability of tap water, availability of an indoor sit or squat toilet), access to health-care services (ie, distance to most-visited health centres), and self-reported ability to do basic ADLs and IADLs. Health-care centres included general hospitals, specialised hospitals, Chinese medicine hospitals, community health service centres, community health service stations, and township health centres, but not village clinics or infirmaries.

Dependency was defined as a participant's inability to perform the basic ADLs and IADLs on their own.<sup>8</sup> Basic or physical ADLs are the skills required to perform daily physical tasks, including dressing, bathing, feeding, moving from bed to chair, using the toilet, and maintaining continence. IADLs include more complex activities than basic ADLs, related to the ability to live independently, which constitute doing housework, cooking, shopping, managing money, and taking medication. Dependency in any items of ADLs and IADLs was recorded as "having any difficulty and needing help" versus "no difficulty" or "with difficulty but still can do it".

On the basis of a previous publication,<sup>8</sup> we developed three dependency levels that incorporated items of ADLs and IADLs, to comprehensively reflect dependency levels and estimate the level of care needed. The three levels categorised participants according to the severity of dependency and their requirements for care: level 1 dependency (having any difficulty with six ADL items), level 2 dependency (having any difficulty with ADL items and essential daily IADLs, including cooking, shopping, and taking medicine), and level 3 dependency (having any difficulty with six ADLs or five IADLs).

## Statistical analysis

We calculated the prevalence of the three levels of functional dependency in older Chinese adults in each wave (ie, 2011, 2013, 2015, 2018, and 2020) to identify the trends in

dependency and estimate the care needs. We examined the trends in dependency between 2011 and 2020 in subgroups by sex, hukou (ie, rural and urban registry), and geographical location (ie, east China, middle China, and west China; appendix 2 p 4). Secondary outcomes were the factors responsible for changes in dependency and projected changes over the next decade.

All statistics were weighted to reflect the dependency of older Chinese people at the national level, whereby the weighting was the inverse of sampling probabilities. The sampling probability was calculated sequentially from stages of selecting county or district, community, household, and individual. Non-response in each wave was estimated at the household and individual levels by logit regressions and incorporated into the weights. We then applied post-stratification weights by use of the National Population Census Data to adjust for age–sex compositions.<sup>16</sup> Detailed procedures for calculating the weights have been published elsewhere.<sup>14</sup>

In estimating the older population with dependency, notably, about 1% (619 of 47 238) of the CHARLS sample did not report their dependency status (appendix 2 pp 10–11), and our measure of dependency prevalence was obtained from the response sample. Therefore, we inferred the total population with dependency between 2011 and 2020 by multiplying the dependency prevalence ( $P$ ) by the entire older population ( $N$ ):

$$N_{20} * P_{20} - N_{11} * P_{11} = (N_{20} - N_{11}),$$

in which the population change  $N_{20} * P_{20} - N_{11} * P_{11}$  is decomposed into two terms. The first term can be attributed to the change in the population base  $N_{20} - N_{11}$ , a contribution from ageing, and the second term is attributable to the change in the dependency prevalence  $P_{20} - P_{11}$ , for which we explored the infrastructural factors (appendix 2 pp 4–5).

We fitted a linear probability model to establish the major factors associated with the change in functioning dependency between 2011 and 2020:

$$Y_{it} = \beta_0 + \sum_{j=1}^k \beta_j x_{ijt} + u_{it}, \quad (1)$$

in which  $y_{it}$  is the dependency dummy variable for individual  $i$  at time  $t$ .  $x_{ijt}$  are the  $k$  (where  $k$  is the number of explanatory variables in the regression) explanatory variables related to dependency, including age (groups), education (groups), sex, hukou, availability of an indoor toilet, type of toilet (ie, sitting toilet or squatting toilet), availability of indoor tap water, and the distance to the health centre most visited.  $u_{it}$  is the error term. The regression sample omitted the 2020 wave, during which the variable of distance to the most-visited health centre was not available, and therefore  $t$  denotes the four waves from 2011 to 2018. We estimated SEs by clustering the sample at the individual level to address the issue of within-person correlations.<sup>17</sup> With the exception of distance as a continuous variable, each  $x_{ijt}$  is denoted by a full set of dummy variables, omitting one category as the reference group. The proportion of each  $x_j$ 's contribution in explaining the decline in the prevalence is thus denoted by:

$$\hat{\beta}_j(\bar{x}_{j,2020} - \bar{x}_{j,2011})/(\bar{y}_{2020} - \bar{y}_{2011}),$$

where  $\hat{\beta}_j$  is the estimated coefficient of factor  $j$  from the regression, and  $\bar{x}_{(j,t)}$ ,  $\bar{y}_t$ , denote the wave- $t$  averages across  $i$  (appendix 2 pp 5–6).<sup>18</sup>

Based on the estimated coefficients and the same model as equation (1), we projected future changes in dependency among older people from 2021 to 2030, on the basis of demographic and infrastructural trends in  $x_j$ . We project changes in dependency between 2021 and 2030 using regression coefficients from equation (1) and projected future values of independent variables in that model. We used the age and sex structure of older people predicted by the UN World Population Prospects (median variant projection for the years 2021–30)<sup>19</sup> and estimated future educational levels on the basis of the assumption that school attainment for people aged 60 years and older in 2021–30 is the same as the school attainment for the same group of people in 2015.<sup>20</sup> The ratio of rural residents with agricultural hukou was assumed to decrease by 1 percentage point annually. The distance to health-care services was assumed to be constant between 2021 and 2030. We assumed that the improvements in the age-friendly home environments would continue and by 2030 all older people would have access to tap water and sitting toilets. To derive values for the home environment between 2021 and 2030, we considered linear trends in the improvement in the availability of tap water and indoor sitting toilets (also replacing squat toilets) from 2021 to 2030 (appendix 2 pp 6–7).

In our study, the CHARLS sampling weights were constructed by taking into account non-response and attrition. We performed a robustness check on attrition by investigating the relationship between non-response and existing dependencies. We also conducted a validation analysis on the forecasting of dependency in older Chinese people. Details of the robustness analysis are in the appendix 2 (pp 7–9). Statistical analyses were performed with STATA version 16.

### Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

### Results

A total of 89 031 participants were interviewed between June 22, 2011, and Sept 12, 2020, of whom 46 619 participants across the five waves were included in our analyses (figure 1). The sample inclusion, exclusion, and attrition can be found in the appendix 2 (pp 10–11). 50% (3601 of 7260) of participants in the baseline 2011 survey were women and 50% (3659 of 7260) of participants were men, with a total mean age of 68.33 years (SD 6.97). 37% (2709 of 7260) of participants were illiterate and 76% (5507 of 7260) lived in rural areas. The distributions of sex, age stratum, and rural–urban households were generally similar across the five waves, and there was an increase in middle-school (ie, 9 years of formal

education) and high-school (ie, 12 years of formal education) educational attainment, the use of sitting toilets, and the availability of household tap water (appendix 2 pp 12–15).

Over the 10-year duration of the study, the dependency profile of older people has changed. The prevalence of level 1 functional dependency in older Chinese adults decreased from 11·7% (95% CI 10·6–12·8) in 2011 to 8·1% (7·5–8·7) in 2020 (figure 2). Similar trends were observed for level 2 (decreased from 20·3% [95% CI 19·1–21·6] in 2011 to 14·3% [13·5–15·1] in 2020) and for level 3 dependency (from 24·5% [23·1–25·8] in 2011 to 17·8% [16·9–18·7] in 2020).

The dependency rate decreased across subgroups (ie, aged 60–69 years and aged ≥70 years, men and women, and urban and rural residents) and across the three geographical areas in China (east, middle, and west China). The older age group (≥70 years) had a higher prevalence of dependence at all three levels than the younger-old group (aged 60–69 years). We also observed some differences in dependency by sex and residence local (ie, urban or rural). Compared with men, women had higher dependency, and compared with people who lived in urban areas, people who lived in rural areas had higher dependency (appendix 2 pp 28–29). The dependency rate was lower in east China than in middle or west China, reflecting less dependency in wealthier regions than in less wealthy regions (appendix 2 pp 30–31). Additionally, we examined trends in dependency for each of six ADL items and five IADL items. Between 2011 and 2020, the dependency for bathing, transferring, eating, toileting, and continence declined. Dressing dependency, however, increased between 2021 and 2030. IADL items showed similar trends, with dependency rates declining substantially for cooking, taking medication, managing money, and shopping. Dependency for housework slightly decreased (appendix 2 p 32).

At all three dependency levels, being older, less educated, a women, living in a rural area, having no toilet in the house, having no tap water available, and residing a large distance from the health-care centre were associated with higher dependency between 2011 and 2020 (appendix 2 pp 16–17).

There have been improvements in factors that contribute to reducing care needs. Educational levels increased substantially in China between 2011 and 2020. The proportion of people with middle-school education increased from 11·8% (95% CI 10·9–12·7) to 19·6% (18·3–20·9) and the proportion of people with high-school education or above increased from 9·4% (8·2–10·6) to 16·6% (15·4–17·9). Residential age-friendly environments improved substantially: use of tap water increased by 24·0 percentage points (from 67·9% to 91·9%), the proportion of people with indoor toilets increased by 14·6 percentage points (from 74·7% to 89·3%), and the number of people with sitting toilets increased by 20·9 percentage points (from 23·3% to 44·2%). The distance to the most-visited health centres also decreased from 3·8 km (95% CI 3·6–4·0) in 2011 to 1·1 km (1·0–1·1) in 2018, indicating improved access to health-care services in China (appendix 2 pp 34–35).

Changes in age structure of the population explained only a small proportion of changes in level 1 dependency among older adults between 2011 and 2020 compared with education improvement and residential age-friendly environments (such as having a sitting toilet and

tap water). Overall, improvements in education attainment and age-friendly environments explained up to 23.29% of the decline in dependency rates between 2011 and 2020. Improvements in educational attainment, age-friendly environments, and health-care access explained up to 41.84% of the declines in level 3 dependency among older Chinese adults between 2011 and 2020 (table).

Based on the estimated dependency rates and extrapolating to the older Chinese population on a national scale, we estimated the number of people with dependency among older Chinese adults between 2011 and 2020 (figure 3). The proportion of older Chinese adults with level 1 dependency increased steadily from 21.56 million (19.54–23.58) people in 2011 to 24.93 million (23.16–26.70) people in 2018, then decreased by 4.32 million to 20.61 million (19.01–22.20) people in 2020. The trends for level 2 and level 3 dependency for the same time period were similar. We estimated that in 2020, 36.33 million (34.27–38.40) people had level 2 dependency and 45.30 million (43.02–47.59) people had level 3 dependency.

Using the definition for level 1 dependency, changes in the number of older Chinese people with care needs between 2011 and 2020 can be attributed to changes in dependency prevalence (ie, disability effect) and changes in cohort size (ie, population effect). The decline in dependency for ADLs partly offset the growth in the size of the older population, which subsequently resulted in lower total care needs in 2020 (20.61 million people, [95% CI 19.01–22.20]) than in 2018 (24.93 million people [23.16–26.70]). Analyses using level 2 and level 3 dependency definitions yielded similar conclusions: a steady increase in the size of older populations and a decline in prevalence existed simultaneously, resulting in a competing effects on care needs for older Chinese people (figure 4, appendix 2 p 36).

We projected the dependency rates of older people in China between 2021 and 2030 (appendix 2 pp 37–39). For level 1 dependency, our model predicts that a small decrease in dependency rate for ADLs would be expected between 2021 and 2030 (from 8.15% [95% CI 8.07–8.22] in 2021 to 8.04% [7.33–8.76] in 2030). Our projections for level 3 dependency showed that dependency would decrease from 17.71% (95% CI 17.62–17.80) in 2021 to 16.05% (15.14–16.97) in 2030. A similar trend was observed for level 2 dependency: dependency prevalence would decrease from 14.25% (95% CI 14.17–14.34) in 2021 to 13.28% (12.45–14.12) in 2030. The national number of people aged 60 years or older with care needs trends upwards (appendix 2 p 37). We estimated that 29.71 million (95% CI 27.07–32.36) older Chinese people will have level 1 dependency in 2030. Nationally, 49.07 million (95% CI 45.98–52.16) people are projected to have level 2 dependency and 59.32 million (55.94–62.70) people are projected to have level 3 dependency by 2030. According to our projections, by 2030, the older Chinese population will require a greater amount of care than in 2021, with an increase of 38.90% (from 21.39 million in 2021) for people with level 1 dependency, 31.13% (from 37.42 million in 2021) for people with level 2 dependency, and 27.57% (from 46.50 million in 2021) for people with level 3 dependency (appendix 2 p 37). By 2030, we estimate that an additional 14.02 million older Chinese people will require care in terms of level 3 dependency than in 2020. The decomposition analyses indicated that the growth in the number of older people is the main reason for these increases in total care needs between 2021 and 2030 (appendix 2 pp 38–39).



## Discussion

This study provides compelling evidence of a steady reduction in the proportion of older Chinese people with dependency between 2011 and 2020. We found that the proportion of dependent older adults for both ADLs and IADLs decreased between 2011 and 2020, and the improvements in educational attainment, advancement in age-friendly residential environments, and accessibility of health-care services were among the major factors contributing to this decline. The rapid increase in the number of older people has, however, offset the decline in dependency rates and is likely to result in an increase in complex care needs for older populations between 2021 and 2030. By 2030, we estimate that 14.02 million more older Chinese people will need care than in 2020. As the Chinese population ages, family sizes reduce in most areas, and adult children out-migrate, these findings have substantial implications for older people and their families in China and, potentially, for other countries that are also planning appropriate responses for an ageing population.

According to our study, the prevalence of dependency in terms of ADLs and IADLs decreased substantially among older Chinese populations between 2011 and 2020. The decline occurred for all groups—ie, men and women, rural and urban residents, and participants from east, middle, and west China—however, dependency was notably high among rural residents and women. Therefore, interventions should be targeted at these populations in particular. Our findings showed that the proportion of people with ADL dependency decreased from 11.7% (95% CI 10.6–12.8) in 2011 to 8.1% (7.5–8.7) in 2020. By using a nationally representative sample, weighting the demographic data, and excluding the potential bias from sample attrition, our study was able to provide a more accurate estimate of the dependency rates than previous estimates. The previous two national surveys (ie, the China Health and Nutrition Survey and the Chinese Longitudinal Healthy Longevity Survey) have reported similar trends.<sup>6,11</sup> However, some studies reported inconsistent trends. For example, Peng and colleagues reported a slight increase in disability in people aged 60–74 years and a decrease in disability in people aged ≥75 years) between 1987 and 2006 using China Sampling Surveys on Disability.<sup>10</sup> Lu and colleagues reported that ADL dependency has followed a declining trend for younger age groups (ie, aged 60–74 years) but an expansion trend for the oldest age groups (ie, aged ≥75 years).<sup>13</sup> Inconsistencies are mainly attributed to differences in study duration, sample selection, and dependence measurements.

Distinguishing the modifiable factors driving the decline in dependency, especially those affecting the whole population, could provide a useful and pragmatic framework to be replicated in other countries.<sup>21</sup> In our study, three categories of drivers were identified: improving educational attainment, creating age-friendly living environments, and expanding health-care access. A study that harmonised data from eight ageing cohorts showed the substantial benefits of early education for health and functioning in older age (ie, aged ≥65 years).<sup>22</sup> Education has been considered one of the most important influences on improving health, especially for Chinese women.<sup>23</sup> Additionally, improved education attainment could help to reduce gender disparities in healthy ageing.<sup>24</sup> In our study, dependency among women declined at a faster rate than dependency among male due partly to higher educational attainment for men than for women. Another key component of dependency

decline in older Chinese people was the creation of age-friendly residential environments, such as retrofitting toilets and providing sanitary tap water. According to the China Health and Family Planning Statistical Yearbook, the proportion of sanitary toilets in rural areas increased from 7.5% to 78.5% from 1993 to 2015.<sup>25</sup> From 2011 to 2020, we observed a steady increase in use of household flush toilets and consumption of tap water. Retrofitting toilets provides older adults with accessible and sanitary toilets, such as toilets with seats and flushing water (instead of conventional squatting toilets).<sup>26</sup> Access to health-care services was also crucial to reducing the prevalence of functional dependency. Among a nationwide sample of older adults in China, inadequate access to health care was associated with higher rates of functional disability, cognitive impairment, and all-cause mortality.<sup>27</sup>

Our study has some limitations. First, although the definition of dependency was observed and recorded by the interviewers, it was limited to data that were collected and primarily assessed via self-report or proxy report. Despite this limitation, the standardised protocol of the CHARLS survey allowed us to obtain reliable and comparable measurements across waves. Second, the longitudinal design of CHARLS might raise concerns about sample attrition. According to a comprehensive examination of the attrition patterns, the sample attrition and selection was not likely to bias our estimates because the CHARLS sampling weights are constructed by taking into account non-response and attrition, we provided details of how the participants are followed up over time (eg, sample attrition, replacement, and refreshment), the non-response rates for ADLs and IADLs dependency are low (<1.31%), and the CHARLS sample in subsequent waves indicate that the dependency status was statistically irrelevant to individual non-responses. Additionally, we did not perform subanalyses by ethnicity due to the scarcity of relevant data in the 2011 wave. Third, some other potential drivers of declines in dependency rates, such as renovation of old houses, expanding pilot projects of long-term care, and improvement of health literacy, were not analysed in our study due to the absence of data.

Finally, we estimated that the number of older adults with level 3 dependency requiring complex care could increase by 39.0%, from 45.30 million in 2020 to 59.32 million in 2030. The projected large increases in care needs emphasise the importance of promoting healthy ageing and building an age-friendly environment as a national strategy for reducing the burden of population ageing.<sup>28</sup> China also needs to strengthen its aged-care sector to prepare for increases in the number of older people needing care. Future research should closely monitor the trends in older people's functional dependency, the improvement in age-friendly facilities, and whether care needs are met.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

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## Data sharing

The data that support the findings of this study are available from the Institute of Social Science Survey, Peking University, Beijing, China (<http://charls.pku.edu.cn>). Data for 2020 will be available upon request to the corresponding author.

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## Research in context

### Evidence before this study

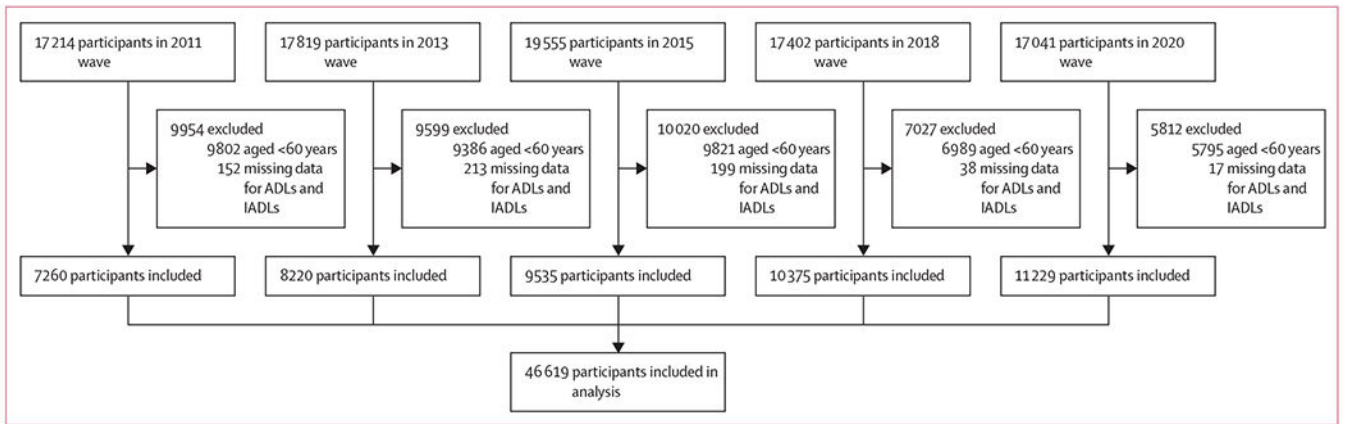
We searched PubMed, Embase, MEDLINE, and Web of Science for studies published on dependency and care needs in China from the inception of each database to Nov 15, 2021. We used the following search terms with no language restrictions ((“Dependency” [MeSH Terms] OR “Disability” [MeSH Terms] OR “ADL” [MeSH Terms] OR “Care needs” [MeSH Terms]) AND “China” [All Fields])) for PubMed, and the terms were subsequently adapted for other databases. We excluded studies with one set of cross-sectional data. Some studies focused on visual, hearing, and speech disability, physical or intellectual disability, and mental disability, on the basis of administrative data. Only two studies reported the trends in dependency in activities of daily living among older Chinese people. One study showed a decrease in dependency rate from 1997 to 2006 and another showed a complex trend of dependency in activities of daily living and instrumental activities in daily living from 2000 to 2010. No previous studies examined the contemporary trends (ie, between 2011 and 2020) in the prevalence of dependency and estimated the size of care needs for older people (age ≥ 60 years) in China.

### Added value of this study

In this study, we present the largest and most comprehensive assessment of the scale and trends of dependency and care needs among the older Chinese population at the national level between 2011 and 2020. Our research suggests that morbidity rate relevant to functional dependency decreased in China between 2011 and 2020, as shown by declines in the number of people with functional dependency. We provide a framework to account for net changes in the total scale of dependency from diverging trends in dependency rates and cohort size, which allowed us to understand past trends and make projections for the future.

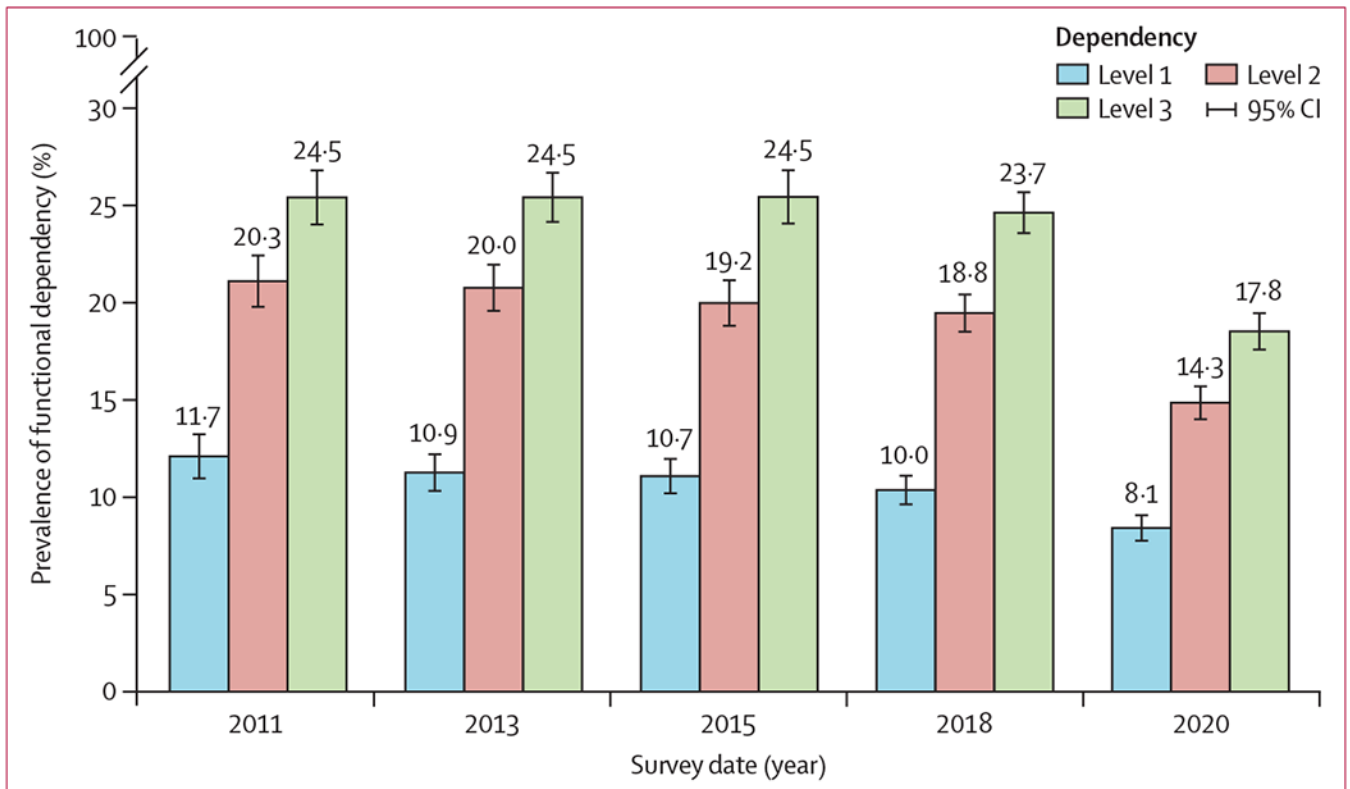
### Implications of all the available evidence

According to our study, the decline in dependency prevalence in China was partly driven by efforts to improve educational attainment, create age-friendly residential environments, and increase access to health-care services. Should such improvements continue in China, they will provide the potential impetus for the further compression of morbidity in terms of decline in functional dependency. The second generation of baby boomers (born between 1962 and 1975) in China have begun to reach retirement age (60 years). This rapid ageing of the population will partly offset the efforts to reduce dependency rates and, as a consequence, result in a substantial increase in care needs for the older population in China. Timely interagency collaborations among institutions of medical services, public health, and social care are needed to reduce the burden of dependency and care needs for older people in China.



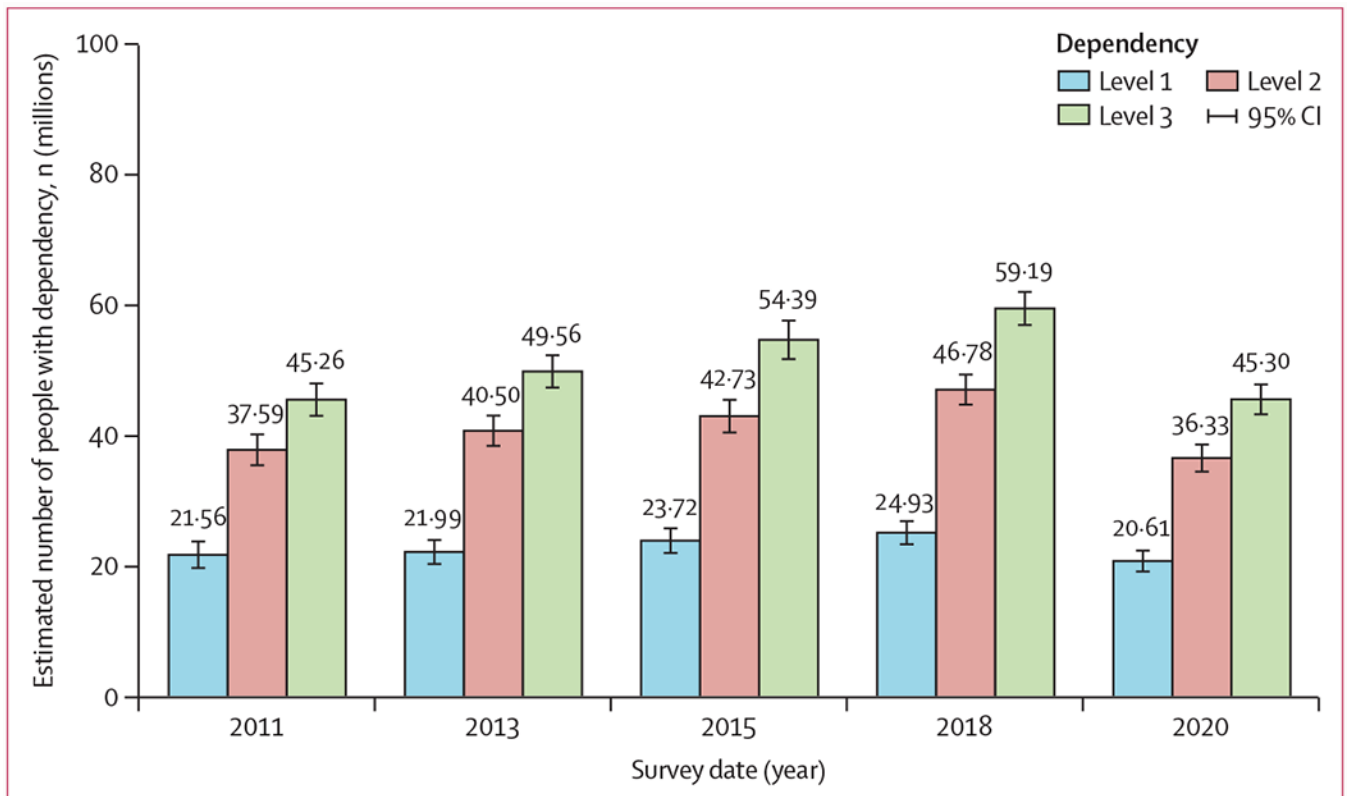
**Figure 1: Study diagram**

ADLs=activities of daily living. IADLs=instrumental activities of daily living.



**Figure 2: Trends in functional dependency of older adults between 2011 and 2020**

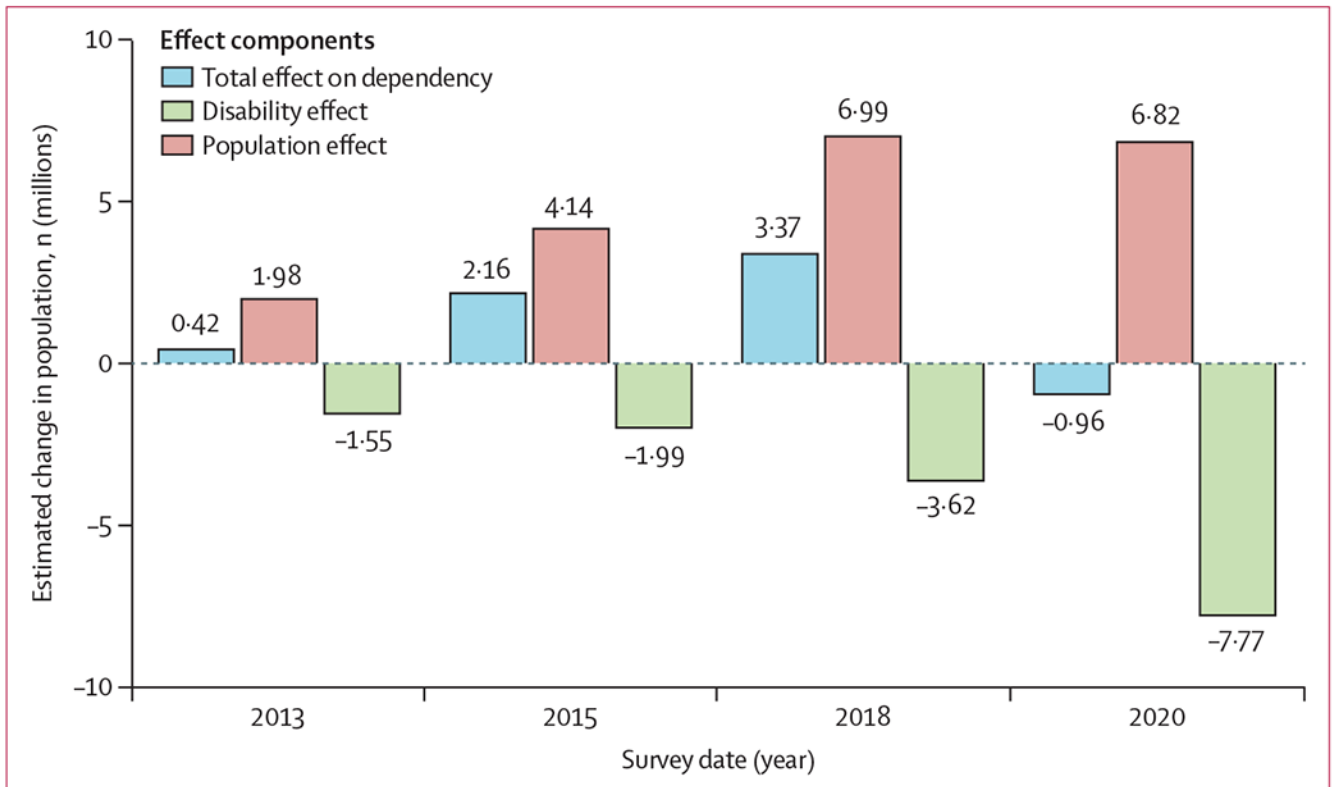
Level 1 dependency was defined as dependency in any item of ADLs. Level 2 dependency was defined as dependency in any item of ADLs and cooking, shopping, or taking medicine. Level 3 dependency was defined as dependency in any item of ADLs or IADLs. ADLs=activities of daily living. IADLs=instrumental activities in daily living.



**Figure 3: Trends in the total number of older Chinese adults with care needs between 2011 and 2020**

Level 1 dependency was defined as dependency in any item of ADLs. Level 2 dependency was defined as dependency in any item of ADLs and cooking, shopping, or taking medicine. Level 3 dependency was defined as dependency in any item of ADLs or IADLs. ADLs=activities of daily living. IADLs=instrumental activities in daily living.





**Figure 4: Decomposition of the trends in the number of people with level 1 dependency among older adults in China between 2011 and 2020**

Level 1 dependency was defined as dependency in any item of activities of daily living.

**Table:** Contribution of different factors to decline in dependency rates among Chinese older adults between 2011 and 2020

	Weighted mean difference between 2011 and 2020	Level 1 dependency		Level 2 dependency		Level 3 dependency	
		Explained change	Proportion of total change, %	Explained change	Proportion of total change, %	Explained change	Proportion of total change, %
Change in dependency	..	-0.0354	100%	-0.0602	100%	-0.0663	100%
<b>Age, years</b>							
Total (reference group 60-64)	..	-0.0002	0.64%	-0.0008	1.27%	-0.0007	1.07%
65-69	0.049	0.0010	-2.87%	0.0017	-2.87%	0.0022	-3.34%
70-74	-0.0031	-0.0002	0.53%	-0.0003	0.49%	-0.0003	0.48%
75-79	-0.0204	-0.0018	5.12%	-0.0034	5.65%	-0.0038	5.72%
80	0.0033	0.0008	-2.15%	0.0012	-1.99%	0.0012	-1.78%
<b>Educational attainment</b>							
Total (reference group illiterate)	..	-0.0043	12.21%	-0.0100	16.61%	-0.0123	18.61%
Literate	-0.0281	0.0004	-1.08%	0.0016	-2.69%	0.0018	-2.76%
Primary school	-0.041	0.0009	-2.66%	0.0031	-5.13%	0.0040	-6.00%
Middle school	0.0779	-0.0023	6.45%	-0.0067	11.18%	-0.0090	13.54%
High school and above	0.0719	-0.0034	9.50%	-0.0080	13.25%	-0.0092	13.83%
<b>Demographics</b>							
Female (reference group male)	0.0072	0.0001	-0.18%	0.0002	-0.29%	0.0003	-0.41%
Rural hukou (reference group urban)	0.0073	0.0000	0.04%	0.0001	-0.18%	0.0003	-0.38%
<b>Age-friendly residential environments</b>							
Total (reference group outdoor toilet and no indoor tap water)	..	-0.0039	11.08%	-0.0096	15.91%	-0.0116	17.53%
Indoor sitting toilet (reference group outdoor toilet)	0.2089	-0.0012	3.43%	-0.0040	6.62%	-0.0060	9.00%
Indoor squat toilet (reference group outdoor toilet)	-0.0635	0.0005	-1.48%	0.0010	-1.67%	0.0013	-1.98%

	Weighted mean difference between 2011 and 2020	Level 1 dependency		Level 2 dependency		Level 3 dependency	
		Explained change	Proportion of total change, %	Explained change	Proportion of total change, %	Explained change	Proportion of total change, %
Indoor tap water (reference group not indoor tap water)	0.2397	-0.0032	9.13%	-0.0066	10.95%	-0.0070	10.51%
Access to health-care services*	-2.703	-0.0013	3.71%	-0.0044	7.28%	-0.0038	5.70%
Total explained change <sup>‡</sup>	..	-0.0097	27.50%	-0.0244	40.60%	-0.0279	42.12%
Total unexplained change	..	-0.0257	72.50%	-0.0358	59.40%	-0.0384	57.88%

\* Measured by distance (in km) to the most-visited health-care centre between 2011 and 2018.

<sup>‡</sup> Sum of all contributing factors.