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# Forecasting Informal care needs of the urban-rural older adults in China based on microsimulation model

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## Abstract

**Background** Forecasting the intensity, source, and cost of informal care for older adults in China is essential to establish and enhance policy support systems for informal care within the context of East Asian traditional culture that emphasizes filial piety. This study aims to analyze the current situation and influencing factors for the informal care needs and predict the trends of informal care needs for older adults in China from 2020 to 2040.

**Methods** Using the CHARLS database from 2015 to 2018, this study first combined a two-part model and a multinomial logit to analyze the influencing factors for the informal care needs of urban-rural older adults in China. Secondly, a multi-state Markov model was constructed to forecast the number of urban-rural older populations in each health state from 2020 to 2040. Finally, based on a microsimulation model, this study predicted the trends of informal care intensity, source, and cost for older adults in urban and rural areas from 2020 to 2040.

**Results** In 2040, the size of the disabled older population in China will expand further. In rural areas, the total number of disabled people in 2040 (39.77 million) is 1.50 times higher than that in 2020; In urban areas, the total number of disabled people in 2040 (56.01 million) is 2.51 times higher than that in 2020. Compared with 2020, older adults population with mild, moderate and severe disability in 2040 would increase by 87.60%, 101.70%, and 115.08%, respectively. In 2040, the number of older adults receiving low-, medium-, and high-intensity care in China will be 38.60 million, 22.89 million, and 41.69 million, respectively, and older people will still rely on informal care provided by spouses and children (from spouses only: 39.26 million, from children only: 36.74 million, from spouses and children only: 16.79 million, other: 10.39 million). The total cost of informal care in 2040 will be 1,086.65 billion yuan, 2.22 times that of 2020 (490.31 billion yuan), which grows faster than the economic growth rate.

**Conclusion** From 2020 to 2040, the informal care needs of older people in rural areas will increase first and then decrease due to the demographic structure and rapid urbanization. In contrast, the informal care needs of older people in urban areas will continuously increase from 2020 to 2040, with the growth rate gradually slowing down.

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This study provides an evidence-based rationale for scientifically measuring the economic value of informal care and reasonably allocating care resources.

**Keywords** Older adults, Informal care, Needs forecast, Markov Model

## Background

The provision of informal care depends on the family, and the number of family members who provide informal care will directly affect the quality of life of disabled older adults [1]. If the long-term heavy care burden is not alleviated and released in a timely and effective manner, it will eventually hurt both older adults and caregivers [1, 2]. Informal care refers to the provision of daily living assistance, medical care, or long-term care to individuals in need, by non-professional individuals such as family members, friends, or neighbors [3]. This type of care is typically based on close relationships, emotional bonds, and social obligations, rather than employment or professional contracts. Family caregivers spend a great deal of money and time caring for older adults while also experiencing both physical and psychological burdens [4, 5]. In addition to their role as caregivers, family caregivers face multiple conflicting social roles and responsibilities, such as employment, work, and caring for minor children [1]; On the other hand, most family caregivers lack knowledge, skills, and equipment related to caregiving, and are often overwhelmed with caregiving tasks beyond their capacity [6]. Thus, in the context of both population aging and disablement of the aging population, accurate prediction of informal care needs is not only helpful for the formulation of family caregiver subsidy system, but also conducive to the healthy development of community day care centers, such as skill support and care duration [1, 6, 7].

The development of population aging in China is more serious, showing the characteristics of large base, rapid growth rate, and urban-rural imbalance [8]. It was predicted that the number of disabled older people will grow from 24.85 million in 2020 to 54.72 million in 2050, and the demand for long-term care is growing fast [9]. However, with the miniaturization of family structure, increasing female labor force participation rate, and rising old adults dependency ratio, the availability of traditional home care model has significantly decreased to meet the informal care needs of the old adults [6]. Therefore, satisfying their informal care needs is essential to easing the current plight of older people in China, as well as in developing countries in Asia.

Unlike developed countries, China's strict household registration system (*hukou*) divides the population into urban and rural areas [10]. Compared to rural residents, urban residents enjoy more social benefits such as education, medical care, housing, and employment [11]. Despite the increasing urbanization in China, *hukou*

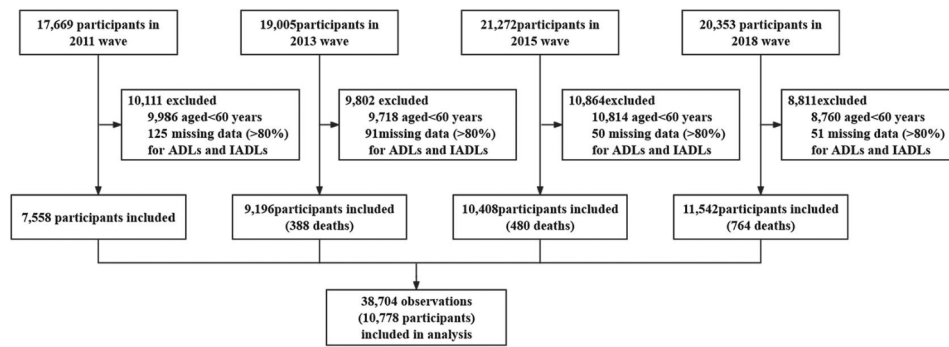
status remains an important driver of inequality between rural and urban residents, affecting care resources [12]. Rural *hukou* tends to be associated with poor health status, leaving rural residents with limited access to health care and social benefits, and therefore may increase the informal care needs of rural older adults [13]. In addition, there are significant differences between urban and rural areas in terms of the number of children available for intergenerational family support [14]. On the one hand, the stricter enforcement of family planning policies in towns compared to rural areas leads to smaller family sizes and less informal care available to older adults [15]. On the other hand, the migration of young adults from rural to urban areas is eroding the filial culture and intergenerational family support of older adults in rural China [12]. Therefore, this study contributed to analyzing the trends in informal care needs of older adults stratified by urban and rural areas.

Zhang [16] applied the Markov model to predict that there would be about 52.6 million older adults aged 80 or above in 2025, and the long-term care needs would show an increasing trend. Kingston [17] used a dynamic micro-simulation model to estimate the probability of metastasis of each feature by simulating the state changes during a two-year follow-up, and the results showed that the number of older adults aged 85 and above in the UK who needed 24-hour care would double from 2015 to 2035. However, at present, demand forecasting is still focused on long-term care, and formal and informal care have not been clearly distinguished, and few studies have comprehensively analyzed the intensity, source, and cost of informal care. Thus, this study conducted a comprehensive analysis of the three aspects of informal care, and, unlike other studies, included the prediction of informal care needs of independent older adults. Through scientific informal care needs forecasting, this study explored how to promote the flow and sharing of care resources among all social parties for China's national conditions.

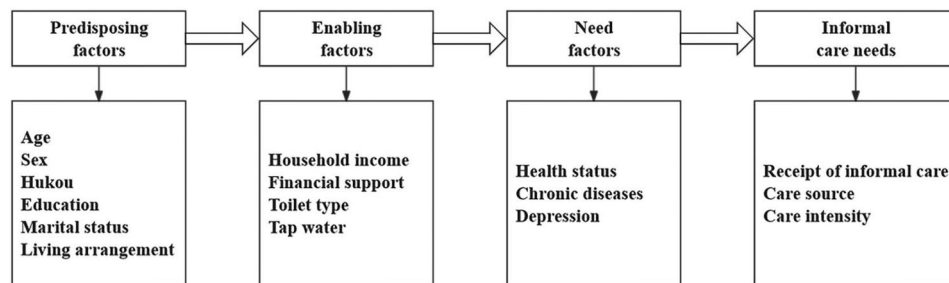
## Methods

### Data

This study utilized data from the CHARLS conducted by the National Development Research Institute of Peking University, which conducted survey interviews in 150 counties and 450 communities in 28 provinces and cities across China through a four-stage sampling, with a nationally representative response rate of 80.51% [18]. Specifically, at the county-district and village-neighborhood levels, CHARLS utilized probability proportional to



**Fig. 1** Study diagram. Note The participants in each wave included deaths



**Fig. 2** Andersen theory model

size (PPS) sampling based on population size. The sample of the survey followed the random principle, and we selected fixed participants with continuity as the sample for research. In this study, 2011, 2013, 2015, and 2018 older adults aged 60 years and above in the CHARLS database were used as the study population, and participants with missing disability variables were excluded, resulting in the inclusion of 7,558, 9,196, 10,408, 11,542 participants, respectively (Figs. 1), 2011–2013 CHARLS data were used for model validation, and 2015–2018 CHARLS data were used for informal caregiving demand prediction. After testing, the fitting degree of the data before and after censoring was  $P > 0.05$ , and there was no significant difference.

**Informal Care needs**

Andersen model, as one of the classic models for studying service utilization in the medical and health field, can well summarize the differences in service utilization behavior among individuals, which is not only suitable for studying medical service utilization, but also widely used in long-term care, quality of life of patients with chronic diseases, health expenses, and pension intention [19]. Based on Andersen’s model [19,2], this study divided the influencing factors of informal care needs into predisposing factors, enabling factors, and need factors, including a total of 12 indicators (Table S1). The informal care needs in this study included care intensity, care source and care cost. Activities of Daily Living (ADLs)

and Instrumental Activities of Daily Living (IADLs) were used to assess care acceptance. The ADLs included bathing, dressing, toileting, transferring, bowel and bladder control, and eating. Because the China Health and Retirement Longitudinal Research Study (CHARLS) waves were inconsistent, this study defined IADLs as doing housework, cooking, shopping, financial management and taking medicine according to previous studies. All items in ADLs and IADLs were defined as not receiving care if they did not receive help from others, otherwise they were receiving care. Informal sources of care were measured by the question “Do ADL and IADL have assistance?”. No assistance with ADLs or IADLs was defined as no assistance. When assistance with any of the items was provided, it was defined as four types according to the selected objects (spouse, ex-wife/ex-husband, parents, parents-in-law, children, siblings, volunteers, etc.). These included only from spouse, only from children, only from spouse and children, and other. The informal care intensity was measured by the question “how many days did the selected helper help you in the past month” and “how many hours did he/she help you in those days”, defined as 0–10 h/week, 10–30 h/week, 30+ h/week [20].

**Microsimulation model**

In this study, a two-part model was used to examine the factors influencing the receipt of informal care and the informal care intensity, and a multinomial logit model was used to analyze the factors influencing the informal

care source. After identifying the influencing factors, a Markov model with five states was constructed to represent the transfer process of each health state of older adults (Figure S1) [21]. Among them, death as an absorbing state cannot be transferred to other states, while independency and mild, moderate and severe disability are transient states and can be transferred in both directions. Meanwhile, independency and mild, moderate and severe disability can be transferred in both directions across intermediate stages.

The year 2020 was identified as the baseline, and the number of the old population by health status in 2020 was projected by hukou, sex and age stratification. The study assumes that all 60-year-olds enter the study cohort with a health status of independency. Based on the measured number of older adults by health status in 2020, the number of hukou-sex-age specific older adults by health status in 2020 was obtained based on the population proportion method.

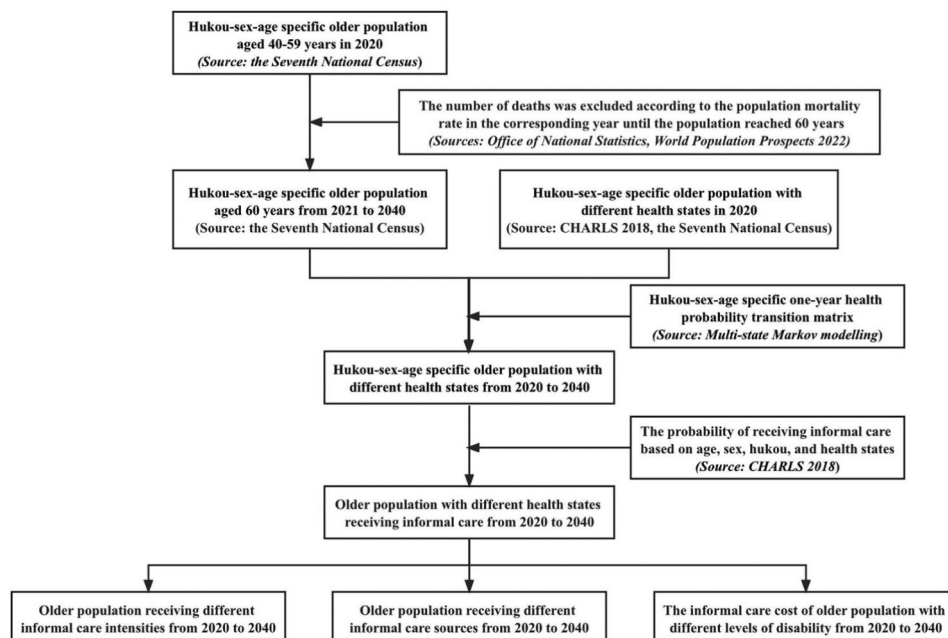
Based on the baseline data in 2020, the number of newly included older adults aged 60 years old and the number of older adults aged 61 years and above for each health states were simulated each year using the population mortality rate projected by World Population Prospects 2022. Then it was summed to obtain the number of hukou-sex-age specific older adults by health status from 2020 to 2040. Combined with the binomial logit model, we can calculate the number of older adults receiving informal care. This study assumed that the probability of receiving the intensity and source of informal care by health status under the conditions of informal care would

not change over time, and thus predicted the informal care needs for urban and rural older adults in China in the next two decades (Fig. 3).

### Results

Age, gender, hukou, education, financial support from children, age-friendly environment, and degree of disability significantly affected the informal care needs ( $P < 0.05$ ) (Table S3-4). Increasing education ( $\beta = -0.31$ ,  $P < 0.05$ ) and improving age-appropriate environment (type of toilet:  $\beta = -0.21$ ,  $P < 0.05$ ; running water:  $\beta = -0.23$ ,  $P < 0.05$ ) favor satisfaction of the informal care needs of older adults (Table S2-3). Compared with 2020, the older population with mild, moderate and severe disability in rural areas in 2040 would increase by 44%, 57% and 59%, respectively. In urban areas, the number of older adults with mild, moderate and severe disability would increase by 140%, 149% and 191%, respectively (Table S5-6). The increase of severe disability was greatest in both rural and urban areas, and the increase of each degree of disability was greater in urban areas than in rural areas (Fig. 4).

Taking 2040 as an example, the number of the older adults receiving informal care would be about 103 million, while the number of disabled older adults would be about 96 million, indicating that the older adults in independency state also have a need for informal care (Table S7-8). In 2020, the number of rural older people receiving low-intensity care (13.83 million) was 1.41 times that receiving high-intensity care (9.82 million), while it would decrease to 1.33 times in 2040 (Table S7-8). On the contrary, the high-intensity care needs of the



**Fig. 3** Structure of the microsimulation model



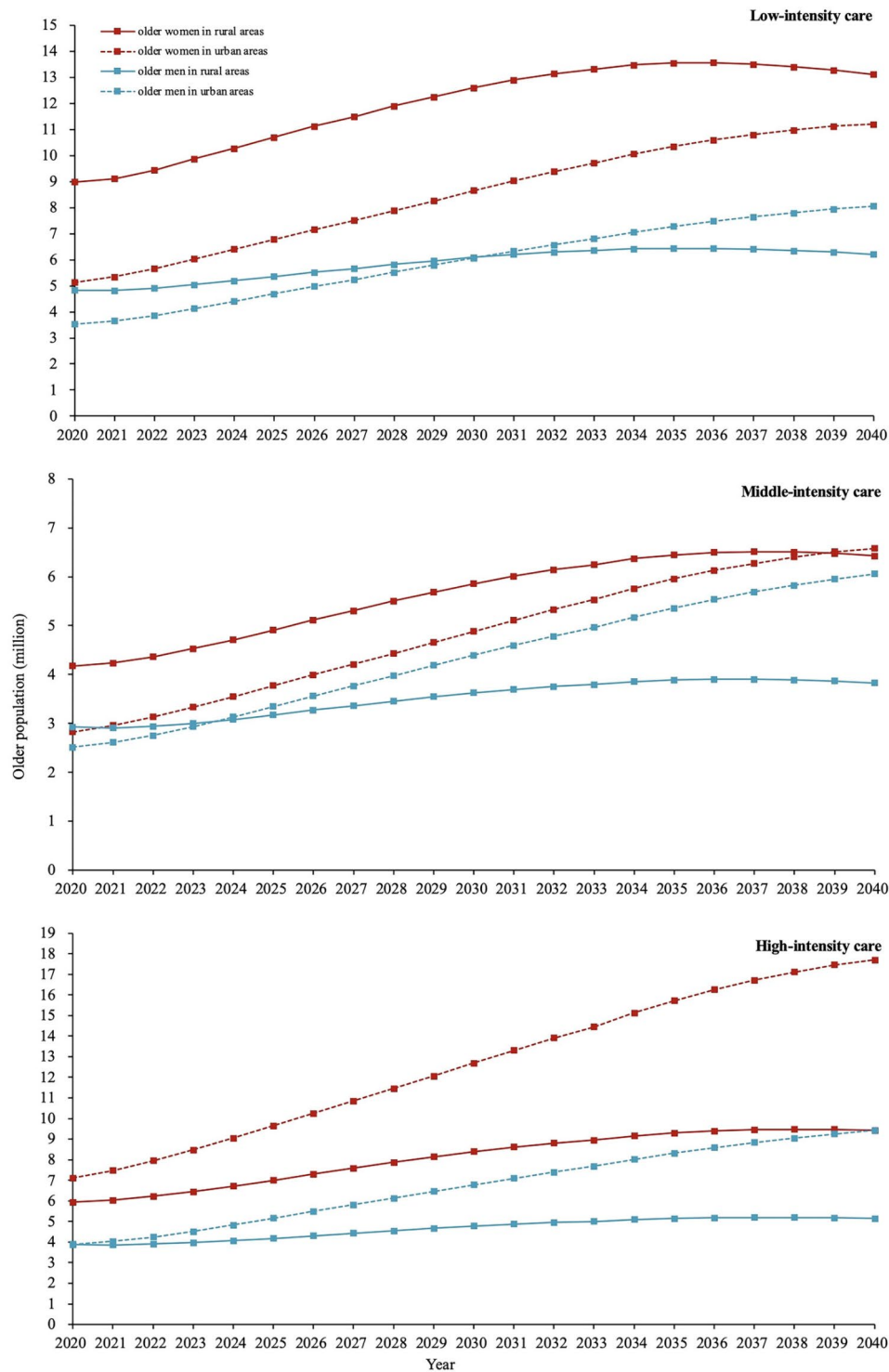
**Fig. 4** Age-hukou specific older population in different health states in 2020 and 2040

urban older adults have always been higher than the low-intensity care needs, and the gap is gradually increasing. In 2040, the number of rural older people receiving high-intensity care will be 14.57 million, which is 1.48 times that of 2020. The number of urban older adults receiving high-intensity care was 27.12 million, which was 2.47 times of that in 2020, indicating that the need for high-intensity care in urban areas was higher than that in rural areas. In general, the need for informal care intensity in old women was higher than that in old men (Fig. 5). From 2020 to 2040, the demand for different levels of informality intensity of rural old women and men showed the same trend of first increasing and then decreasing (Fig. 5). The demand of urban old women and men for different degrees of informal care intensity would increase year by year, and the growth rate slowed down. After 2028, the rural older adults will have lower need for informal care intensity than the urban older adults (Table S7-8).

In 2040, in rural areas of China, 16.95 million people received care from spouses only, 16.06 million from children only, 6.70 million from both spouses and children only, and 4.44 million from other sources of care (Table S9). The needs of urban older adults for the four types of informal care sources were higher than those of rural older adults (Table S10). As shown in Fig. 6, from 2020 to 2040, the needs of the rural older adults for the four types of care sources (only from spouse, only from children, only from spouse and children, and others) would

increase year by year to 2038, and then showed a downward trend. The urban older population also showed an upward trend, but the growth rate slowed down gradually.

From 2019 to 2022, China’s economic growth rate is impacted by various factors and fluctuated greatly. Therefore, the economic growth rate of 2018 of 6.57% was used in this study. According to the forecast of the Development Research Center of The State Council, China’s economic growth rate will be 6.20% in 2025. This study assumed a uniform decline in economic growth, and China’s economic growth rate will be 5.41% in 2040. Assuming that the wage growth of urban and rural residents keeps pace with economic growth, the results of measuring the total cost of informal care in urban and rural areas are shown in Table 1. In 2020, the cost of informal care for the mild, moderate and severe disabled older adults in rural areas was 56.39 billion yuan, 53.43 billion yuan and 45.79 billion yuan, respectively. In urban areas, 119.52 billion yuan, 128.487 billion yuan and 86.72 billion yuan; The total cost of informal care in urban area was 2.15 times of that in rural area. In 2040, the cost of informal care for the mild, moderate and severe disabled older adults in rural areas would increase to 80.309 billion yuan, 83.099 billion yuan and 72.026 billion yuan, respectively. In urban areas, 284.52 billion yuan, 316.83 billion yuan and 249.86 billion yuan; The total cost of informal care in urban and rural areas was 1,086.65 billion yuan, which was 2.22 times of that in 2020. The total cost of

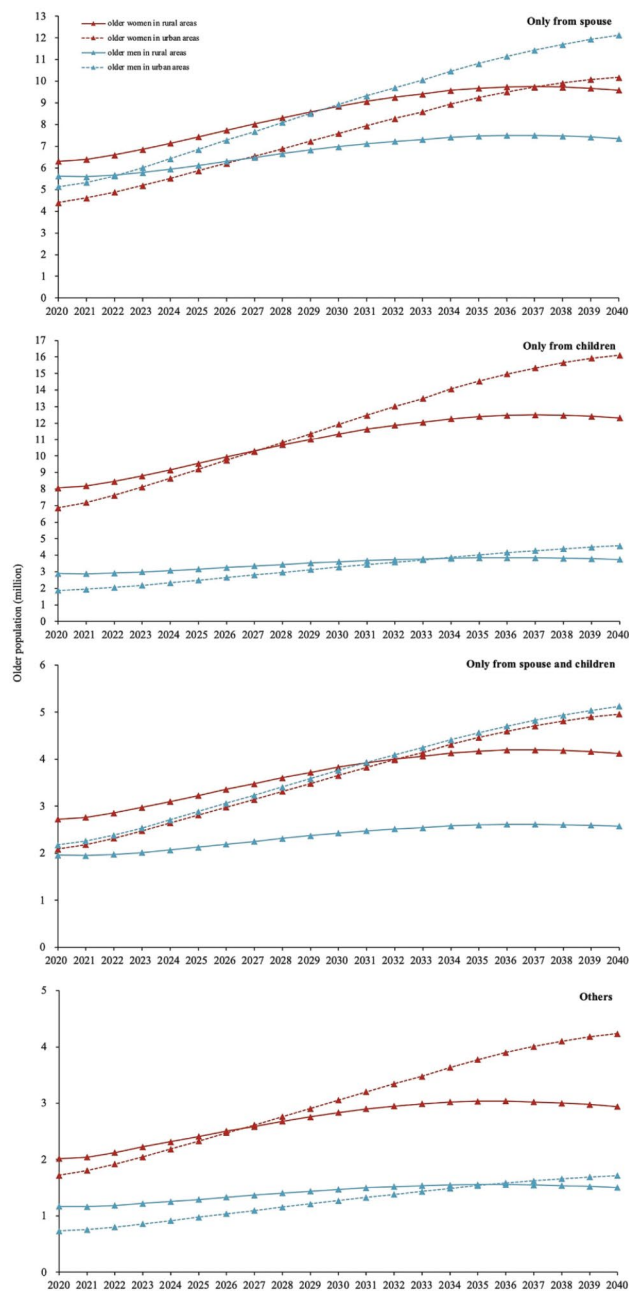


**Fig. 5** The informal care intensity needs of the older adults in urban and rural areas from 2020 to 2040

informal care would increase faster than the economic growth rate. From 2020 to 2040, the cost of informal care in urban areas will always be higher than that in rural areas, and the gap will gradually increase. The chi-square goodness of fit test was used to test the microsimulation

model, and there was no difference between the predicted results of the model and the actual results in CHARLS 2013 ( $P > 0.05$ ) (Table S11).

In the sensitivity analysis, this study assumed that the “9073” policy would be fully implemented throughout



**Fig. 6** The informal care source needs of the older adults in urban and rural areas from 2020 to 2040

the country and that the alternative model of formal and informal care achieves its ideal state (Table S12). “9073” policy refers to the fact that 90% of the older adults are cared for at home with the assistance of socialized services, 7% are cared for through the purchase of community care services (day-care), and 3% are centrally housed in nursing institutions. In 2020, with the full implementation of the “9073” policy, the number of older people receiving informal care was 54.08 million, which was reduced by 1.27 million compared with the non-full

implementation of the “9073” policy. By 2040, fully implementing the “9073” policy could reduce the number of people by 3.1753 million. Therefore, the promotion of the “9073” policy in China is helpful to reduce the informal care needs of older adults and reduce the care burden.

### Discussion

In 2040, the number of older adults receiving low, medium and high-intensity care in China will be 38.60 million, 22.89 million and 41.69 million, respectively, which is 1.72 times, 1.84 times and 2.00 times that of 2020, respectively. Among different care intensities, the proportion of older adults receiving high-intensity care was the highest. Since the disability rate of old women is higher than that of old men, and the average life expectancy of old women is longer, the need for informal care intensity of old women is much higher than that of old men [22]. The rapid growth of the number of older adults receiving high-intensity care will inevitably increase the human and economic burden of family care, and the spouses who bear the responsibility of high-intensity care will experience more serious physical decline and psychological burden pressure [23, 24]. When the spouse is unable to provide care due to severe disability, the responsibility and stress of caregiving may be transferred to the adult children. Then, high-intensity informal care could lead to a decline in the employment rate of adult children [25]. At the other end of the scale, a falling share of the working-age population and pressure on public pensions have prompted governments to implement incentives to delay retirement. The community- and home-based care model has become an important measure to alleviate the current dilemma. This model can not only control the care costs related to population aging, but also respect the wishes of the older adults to live with their families.

There were significant differences in the needs of informal care sources among the older adults in different regions and genders. Due to the rapid growth of the total number of disabled older adults in urban areas, the demand for informal care sources of urban older adults is higher than that of rural older adults in 2040. Older men are more dependent on care provided by their spouses, and older women are more dependent on care provided by their adult children, which is consistent with previous studies [26]. Influenced by Confucian filial piety culture, women usually play the role of main family caregivers, who undertake more housework and care tasks and are more likely to provide informal care [27–29]. It is worth noting that in 2040, the number of urban and rural older people receiving the fourth source of informal care (other relatives and community day care centers) was 4.44 million and 5.95 million, respectively, an increase of 39% and 143% compared with 2020, indicating that more and

**Table 1** The informal care costs for the older adults in urban and rural areas from 2020 to 2040 (billion yuan)

Year	Rural area			Urban area			Total
	Mild disability	Moderate disability	Severe disability	Mild disability	Moderate disability	Severe disability	
2020	56.39	53.40	45.79	119.52	128.49	86.72	490.31
2021	56.54	54.07	46.36	125.44	134.90	91.40	508.71
2022	57.22	55.17	47.44	132.19	142.21	97.63	531.87
2023	58.44	56.50	48.50	139.97	150.11	104.06	557.57
2024	60.46	58.49	49.98	149.67	160.18	111.61	590.39
2025	62.66	60.76	51.75	159.59	170.93	119.92	625.60
2026	64.96	63.17	53.70	169.46	181.96	128.59	661.84
2027	67.31	65.65	55.69	179.34	193.04	137.46	698.48
2028	69.44	67.99	57.66	188.61	203.66	146.34	733.70
2029	71.63	70.32	59.52	198.33	214.67	155.25	769.73
2030	73.66	72.41	61.12	208.00	225.42	164.20	804.80
2031	75.62	74.35	62.54	217.80	236.22	173.28	839.81
2032	77.32	76.03	63.71	227.09	246.61	182.23	872.99
2033	78.58	77.21	64.50	235.97	255.57	190.43	902.25
2034	80.25	79.21	66.42	246.47	267.45	201.54	941.34
2035	81.28	80.62	67.80	255.82	277.83	211.41	974.75
2036	81.87	81.75	69.05	263.97	287.59	220.86	1,005.09
2037	82.04	82.59	70.15	270.79	296.47	229.53	1,031.57
2038	81.79	83.03	70.93	276.63	304.05	237.44	1,053.87
2039	81.22	83.21	71.59	281.41	310.90	244.47	1,072.79
2040	80.31	83.10	72.03	284.52	316.83	249.86	1,086.65

more older adults are seeking care sources outside the family. With the miniaturization of family structure, the care ability of relatives other than spouses and children is continuously weakened, and the fourth source of care (other) can be supplemented by community day care centers and pension institutions [15]. Therefore, this study could provide a theoretical basis for the number and human resource allocation of urban and rural old adults care institutions and community day care centers in the future.

In 2040, the total informal care cost for the disabled older adults in China will reach 1,086.65 billion Yuan, which is 2.22 times of that in 2020. At present, there are few studies on the cost of informal care for the disabled older adults, but some scholars have calculated the cost of informal care for a single disease. Heesoo [30] estimated the average cost of stroke-related informal care in China to be 10,612 yuan per person through two models. The informal care cost will not only increase the family economic burden, but also damage the subjective well-being of caregivers [31]. Therefore, the government should accelerate the promotion of long-term care insurance system, expand its coverage, and improve the standard of disability subsidy, so as to alleviate the financial burden of family care. The “9073” policy plans to provide community older adults care services for 7% of the older population. However, formal care services are still used by the older adults who can afford them rather than those who need them, and a large number of vacant

beds in nursing homes. As a result, the “9073” policy cannot effectively alleviate the demand pressure of informal care. Therefore, China should establish an objective and fair disability assessment system for community care services and promote the fair accessibility of formal care resources [32].

This study is one of the first to use a dynamic micro-simulation model to predict the informal care needs of Chinese older adults. This study has the following innovation. First, this study included the variables of household registration and children’s financial support with Chinese characteristics in the enabling factors, and considered the impact of the aging environment on the informal care needs. The included variables were more in line with China’s national conditions, making the results more reasonable and reliable. Secondly, the multi-state Markov model was used to simulate the dynamic changes of individual health status, which made the prediction results of each health status of the older adults more accurate. Finally, this study divided the older adults groups according to household registration, gender and age, and considered the differences between older adults groups with different characteristics, which made the research results closer to reality. However, this study has several limitations. Firstly, the process of urban-rural migration is complex, and this study cannot simulate the process of individual urban-rural migration in the process of dynamic changes in health status [10]. Secondly, there is a lack of detailed data on the mortality of chronic



diseases and comorbidities. In this study, the impact of chronic diseases and malignant tumors on the change of individual health status was not considered in the transition process of different health states, which may lead to low mortality in the older adults [33–35]. Third, although this study obtains the annual older adults population aged 60 years through the population mortality rate, and assumes that the older adults is in an independency state, it does not consider the impact of other factors such as diseases and living environment on their health status, which leads to the health status of the older population aged 60 years is better than the actual situation.

## Conclusion

From 2020 to 2040, China will usher in a bonus period of silver economy, that is, the substantial growth of informal care needs will promote the development of formal care service industry. Due to the differences in economic levels between urban and rural areas, development priorities in urban and rural areas are different, and the excessive growth of informal care costs should be controlled. Urban areas should focus on accelerating the construction of nursing institutions and community day-care services, and rural areas should focus on the construction of basic care facilities, especially the accessibility of sitting toilets and running water. Reasonable economic subsidies or tax incentives can be provided to family caregivers to reduce the opportunity costs they give up in order to care for the older adults. Finally, the subsidy standard for the disabled older adults should be improved and the coverage of subsidy policy should be expanded, so as to enhance the purchasing power of the older adults for formal care services and reduce the informal care intensity and manpower need of the older adults [31, 36].

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-024-19747-5>.

Supplementary Material 1

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## Author contributions

Liangwen Zhang and Shuyuan Shen planned the study, performed all statistical analyses, and drafted the manuscript. Liangwen Zhang and Wenzheng Zhang assisted with statistical analyses and contributed to revising the manuscript. Ya Fang supervised and critically revised the manuscript. All authors have read and approved the final version of the manuscript.

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## Data availability

The datasets analyzed during the current study are publicly available in the CHARLS repository at <http://charls.pku.edu.cn/en>.

## Declarations

### Ethics approval and consent to participate

The current study is a secondary analysis of the de-identified China Health and Retirement Longitudinal Study (CHARLS) public data. The original CHARLS was approved by the Ethical Review Committee of Peking University, and all participants signed the informed consent at the time of participation.

### Consent for publication

Not applicable.

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### Competing interests

The authors declare no competing interests.

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