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Unmet long-term care needs and their association with health-related quality of life among Chinese oldest-old population



Jiajun Qiao¹, Yiwei Qiao¹, Jialong Tan¹, Nuo Chen¹, Nan Peng², Zongfu Mao¹, Yali Zhao⁴, Chen Chen^{3*} and Yao Yao^{5*}

Abstract

Background Entering the age of 80 or 100, individuals' functional decline and the need for assistance in daily activities increase dramatically, resulting in an inevitable increase in unmet long-term care (LTC) needs. Understanding unmet LTC needs in late life and their association with quality of life is essential for effective health planning and resource allocation. We aim to estimate the prevalence of unmet needs for LTC and the association of unmet needs for LTC and Health-related Quality of life (HRQOL), among the Chinese oldest-old population.

Methods Data were drawn from the 2017 China Hainan Centenarian Cohort Study. All centenarians and a representative sample of individuals aged between 80 and 99 years old in Hainan province, China were included. Self-perceived unmet LTC needs were reported by the respondents. EQ-5D score was calculated from EQ-5D-3L questionnaire to measure HRQOL in this study. We conducted Tobit regression and the Ordered Probit Model to examine the cross-sectional associations between unmet needs for LTC and HRQOL.

Results 1,444 respondents (mean age 95.75 years [SD 9.13]) were included. The prevalence of unmet LTC needs was 32.69%, and it was higher in rural residents and people with economic deprivation. The results showed that oldest-old individuals with unmet needs for LTC reported lower QALY scores (β =-0.04, p < 0.01). In addition, Unmet LTC needs were significantly correlated with poorer outcomes in mobility (β =0.18, p < 0.05), self-care (β =0.19, p < 0.05), pain or discomfort (β =0.27, p < 0.01), and anxiety or depression (β =0.09, p < 0.01).

Conclusions The prevalence of unmet LTC needs was higher in China than its counterpart in high-income countries, especially among those with socio-economic deprivation. Individuals with unmet LTC needs experience lower quality-adjusted life years (QALYs) and higher levels of disabilities across multiple dimensions of health, including mobility, usual activities, self-care, pain/discomfort and depression/anxiety. These findings underscore the importance of addressing unmet LTC needs to improve the overall health outcomes and quality of life for the oldest-old population.

Keywords Unmet LTC needs, EQ-5D, Centenarian, China

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Introduction

The oldest old population (aged 80 years old and over) is projected to be more than triple by 2050 [1]. Among them, approximately 35.8 million oldest-old individuals and 110 thousand centenarians were living in China in 2020, accounting for nearly 24% of the oldest-old population worldwide [2]. With the improvements in economic development, social conditions, and medical advances, a substantial decline in the age-specific mortality of the oldest-old was witnessed in recent years, making this age group the fastest-growing age segment in China [3]. Although living a healthy and long life is a universal purpose, the complex and prolonged process of aging is not experienced with the same level of success by people [4]. As people age, they are more likely to experience functional declines and require assistance or care in their daily activities. A meta-analysis found that the prevalence of frailty for the oldest old was the highest (25%) compared to the age groups of 65-74 years (6%), and 74-84 years (15%) [5]. For the current and future older population, the burden of long-term care (LTC) has become increasingly heavy, but the LTC sector remains underdeveloped in many countries, resulting in an inevitable increase in unmet LTC needs.

Unmet LTC needs are defined when the needed assistance from another person or devices is not available or insufficient [4]. The purpose of measuring unmet LTC needs is to evaluate the gap between needs and provision, and offer a more profound picture of the LTC system performance. It has been categorized into two different concepts and types by the international literature, including general perceived unmet needs, and objective symptomspecific unmet needs [6-9]. General perceived unmet need refers to the situation when an individual could not receive self-perceived needed care at least once in the last year. Measuring this type of unmet LTC does not require information on the condition or symptom that brought the perceived need for LTC [7]. Meanwhile, the second type refers to whether the person lacks assistance in activities of daily living where he/she has difficulties, often measured in Activities of Daily Living (ADL) or instrumental Activities of Daily Living (IADL) [8, 9].

Identifying and understanding unmet LTC needs is essential for pursuing a higher quality of life in an individual's late life, since it is crucial for ensuring dignity, independence, and well-being for the older adults, enabling them to age healthily and actively. Health-related quality of life (HRQOL) is a multidimensional concept of individual's perceived position in life, informing health improvement and policy decisions [10]. It considers individual's overall quality of life, including the physical health, mental health, social well-being, functional status and perceived health. As a standardized measure of HRQOL, the European Quality of Life 5-Dimension Scale (EQ-5D) provides a valuable and multi-dimension concept of self-rated health status among older adults. With the credibility of the EQ-5D value sets, EQ-5D has been widely adopted for quality-adjusted life year (QALY) calculations for various purposes [11, 12]. Analyzing unmet LTC needs and their association with HRQOL could provide empirical evidence for the government to identify service and performance-related challenges and barriers in the LTC system.

Existing literature investigating unmet LTC needs in China mainly focused on the symptom-specific unmet needs among the older population [13-15]. There are still gaps in this literature. Firstly, limited evidence exists regarding the perceived unmet LTC needs and its relationship with HRQOL. In this study, we measure unmet LTC needs using the concept of general perceived unmet needs as it was believed that individuals were the optimal judges of whether their own needs had been met [16]. Perceived unmet needs in long-term care are often predictive of health outcomes and quality of life, as they reflect the subjective experience of care recipients, influencing their satisfaction and continued engagement with care services [17]. These perceptions can highlight discrepancies in care that objective assessments might overlook, especially in emotional and psychosocial support, which are crucial for the well-being of long-term care residents [18]. Studying perceived unmet needs thus ensures interventions address the psychosocial dimensions of care, fostering person-centered models that validate lived experiences over standardized metrics [19]. Secondly, previous studies have been widely conducted to understand the factors influencing HRQOL among diverse populations [20-22]. Yet very few studies target the oldest old population and centenarians who are likely to demand more long-term care in their late life. For instance, impairment in hearing and vision is particularly prominent in this population, but no study has paid attention to this group of persons.

We contribute to the literature by focusing on general subjective unmet needs for LTC in and how they vary among the oldest-old individuals. We aim to investigate the prevalence of unmet LTC needs and the association between unmet LTC needs and HRQOL, among the oldest old and centenarians in China.

Methods

Study design and population

This study drew data from the baseline wave (conducted from 2014 to 2017) of the China Hainan Centenarian Cohort Study (CHCCS), which collected all centenarians and a representative sample of individuals who were 80–100 in Hainan province. Being the southernmost province of China, Hainan has the highest percentage (20.52/100,000) of centenarians among all Chinese

provinces [23, 24]. The survey contained extensive information on respondents' demographic and socioeconomic statuses, health and health services utilization, LTC needs and the types of long-term needs they received.

A complete sampling for centenarians was conducted according to the household registration data provided by the Civil Affairs Bureau. We dropped centenarians who declined to participate, were unable to participate due to dementia or paralysis, did not meet the age verification, died before the interview and participants with more than 25% missing data. For the respondents who were 80-99 years old, stratified random sampling was adopted by age, gender, geographic location and population density. 1,798 oldest old individuals were recruited into this survey. We dropped 153 individuals with missing data for the variables included in the regressions. Among the 1,645 respondents who were available with complete information, 201 individuals neither reported a need for assistance in any ADL or IADL domains, nor did they indicate a need for assistance in performing daily activities in the self-reported question. In the end, we included the remaining 1,444 individuals who were in need of LTC in the analysis.

Information for each participant was collected from a self-reported questionnaire with a face-to-face interview, interdisciplinary examinations and a laboratory analysis. A detailed description of the sampling method and data collection process was documented in another study [25].

The ethics approval was from the Ethics committee of the Chinese People's Liberation Army General Hospital (Beijing, China). All participants provided written informed consent before the information was collected.

Measurement of unmet needs for LTC

Unmet needs for LTC were the key interest in this study, which evaluated the gap between needs and provision for the LTC. To begin with, we identified individuals in need of LTC by employing Lawton's Instrumental Activities of Daily Living (IADLs) [26] and Barthel's Activities of Daily Living (ADLs) assessments [27]. These surveys encompass 8 IADL domains (such as using a telephone, doing laundry, household chores, cooking, shopping, transportation, managing finances, and medication management) and 10 ADLs (covering grooming, bathing, toileting, bowel and bladder control, dressing, feeding, stair climbing, chair transfer, and mobility on level surfaces). The respondent who self-reported a need for assistance in any of these ADL or IADL tasks was considered to have an LTC need. We excluded those who did not need any assistance in ADL or IADL tasks.

Subsequently, within the subset of the individuals who had LTC needs, we derived the dependent variable, denoting an indicator of unmet needs, from their self-reported responses to the question: "Do you require assistance for daily activities of daily living?" The response options included: (1) "I don't need any assistance," (2) "I need assistance, but no one provided it," and (3) "I need assistance, and I received it." We constructed a binary variable to indicate whether the individual had an unmet LTC need. Specifically, it was assigned the value 0 if the respondent selected answers 1) or 3), and the value 1 if the respondent chose the second answer to the question. This was an overall description of the current LTC situation self-reported by the respondents, and the answer did not indicate the provision of care for a specific ADL or IADL domain. Thus, we considered this was a general perceived unmet need.

Measurement of Health-related quality of life

Health-related quality-adjusted life years (QALYs) were determined using the EQ-5D-3L questionnaire, which requires respondents to assess their current health across five domains: mobility, self-care, usual activities, pain/ discomfort, and anxiety/depression. In this questionnaire, each domain has three response levels: '1' indicating no problems, '2' indicating moderate problems, and '3' suggesting severe problems. It is assumed that a response of '1' across all domains correlates with a higher perceived quality of life, representing a state closer to perfect health. The QALY index, ranging from 0 (death) to 1 (perfect health), is calculated based on these responses, utilizing the Chinese Time-Trade-Off value set to represent health states quantitatively [28]. The QALYs ranged from 0 to 1, with 0 indicating death and 1 indicating perfect health. More detailed information on the calculation of QALYs of the oldest old population was described in another study [29].

Socio-demographic and health-related variables

Two groups of covariates included in the analyses were socio-demographic factors and health related variables. For socio-demographic variables, we investigated age, gender, rural-urban residency, education, marital status, the number of leisure activities, whether the respondent has a regular social and family contact. Age was considered a categorical variable in the statistical description (80-85, 86-95, 96-105, and >105 years) and a continuous variable in the regression analysis. Gender was a binary variable with 1 indicating male and 0 indicating female. The dummy variable, illiterate, was constructed to reflect respondents' educational attainment because more than half of the oldest-old respondents did not go to school at all during their school-age period. A dummy variable indicating rural-urban residency was generated directly from the related question. Marital status was categorized into three dummy variables: married, widowed and single. The number of leisure activities was determined from the questionnaire, where respondents were

asked to select from more than 15 leisure activities (multiple choice), such as reading, playing cards, planting, having pets, social activities, etc. This variable was then treated as a continuous variable. Two binary variables were generated to indicate whether the respondent had regular contact with friends and family members to seek help each month.

A dummy variable indicating whether the individual was living alone was generated. To further investigate the living arrangements, we also further classified the individuals who were not living alone and constructed a set of binary variables, including living with children but not with the spouse, living with the spouse and children, living with the spouse but not with any child, living with grandchildren but not with the spouse or any child, living with other family members, and living in a nursing home.

For health-related variables, we included functional disabilities, number of drugs taken per day, vision impairment, hearing impairment, sleep quality, and sleep quality. ADL and IADL scores were calculated according to the responses to the questionnaires. IADL scores ranged from 0 to 8 with lower scores indicating higher dependency. An early warning of functional decline would be reflected by the IADL scale [30]. The ADL scores ranged from 0 to 100, with lower scores implying a higher level of disability. We generated two dummy variables indicating whether the respondent had IADL disability or ADL disability. If the respondent needed help in more than 6 domains in IADL or 3 domains in ADL, he/she would be classified as IADL disability or ADL disability respectively. Since the IADL and ADL were collinear, we did not include the IADL indicator in the regression. Number of drugs taken per day was generated as a continuous variable. Three dummy variables indicating the self-reported sleep quality were generated also according to the response to the questionnaire. Vision and hearing impairments were dummy variables indicating whether the respondent had any problem that affected daily life and cannot be corrected to a normal level.

Statistical analysis

We conducted both descriptive and Tobit regressions in this study. Firstly, mean values and standard deviations for continuous variables, numbers and percentages for categorical variables were presented by LTC status and for the whole sample. The significance of the differences between groups of LTC status was tested using t-tests for continuous variables and chi-squared tests for categorical variables. Secondly, we mapped out the prevalence of problems in each domain of ADLs and IADLs for the oldest old and centenarian population. Then, since QALYs ranged from 0 to 1 and censored at 1, we conducted Tobit regressions to analyze the association between unmet LTC needs and QALY score. Besides, to explore the relationship between unmet LTC needs and the five EQ-5D dimensions, we conducted Ordered Probit regressions, which were suitable for analyzing the levels of problems reported in the five EQ-5D dimensions. For the sensitivity analysis, the Propensity Score Matching (PSM) method, specifically using nearest neighbor matching with a caliper of 0.05, was utilized to align the group with unmet LTC needs and the group without, prior to conducting the regression analyses.

Results

Socio-demographic characteristics of the study samples

A total of 1,444 participants were included (Table 1). The mean age of the respondents was 95.75 years, with over 60% aged over 96 years old. 23.89% of the sample were male, and 80.61% lived in rural areas. Only 12.26% of the participants completed elementary school, leaving 87.74% of them illiterate. Most of the respondents were widowed (73.29%), while 25.75% were married with their partners still living. On average, each respondent engaged in at least one type of leisure activity. However, individuals without unmet LTC needs participated in more leisure activities than those with unmet LTC needs (1.08 vs. 0.88, p < 0.01). 62.44% of the respondents reported they did not have a regular social contact, but 92.56% of them had regular family contacts.

Regarding the patterns in living arrangements for oldest-old and centenarians, 84.97% of the sample were living with other people at home, while 14.40% of them were living alone, 0.62% of them were living in a nursing home. Among the respondents who were living at home with family members, 73.89% of them were living with one or more children or/and grandchildren, or/and greatgrandchildren, but not with a spouse. 3.60% of them were living with their spouse alone. A small number of them (2.70% of all respondents) were living with a spouse and one or more children, grandchildren or great-grandchildren. Another 3.67% lived with grandchildren or greatgrandchildren, but not with their children. The remaining 1.11% of the respondents were living with other relatives other than the above-mentioned family members.

Health-related variables

As for the health need variables, the mean IADL score was 2.90, and 87.05% of the respondents had problems in more than 6 domains of IADL activities. Using transportation independently was the domain that most respondents reported problems (86.06%). 81.69% of them did not use the telephone at all. 77.60% of them were completely unable to shop independently. The percentage of the sample who needed to have meals prepared and served was 69.01%, followed by the responsibility for own medications (55.83%), housekeeping (52.78%), ability to handle finances (44.44%) and laundry (41.20%) (Fig. 1.).

Table 1 Characteristics of the oldest-old population

· · · · · · · · · · · · · · · · · · ·	All respondents with LTC Needs	Unmet needs = 0	Unmet needs = 1	<i>p</i> -value
N	1444	972 (67.31%)	472 (32.69%)	
QALYs, mean (SD)	0.73 (0.23)	0.75 (0.23)	0.68 (0.22)	< 0.001
Age, mean (SD)	95.75 (9.13)	94.21 (9.29)	98.91 (7.90)	< 0.001
Age group, N (%)				< 0.001
80–85 years old	334 (23.13%)	279 (28.70%)	55 (11.65%)	
86–95 years old	237 (16.41%)	181 (18.62%)	56 (11.86%)	
96–105 years old	751 (52.01%)	452 (46.50%)	299 (63.35%)	
>105 years old	122 (8.45%)	60 (6.17%)	62 (13.14%)	
Gender, N (%)				0.199
Female	1,099 (76.11%)	730 (75.10%)	369 (78.18%)	
Male	345 (23.89%)	242 (24.90%)	103 (21.82%)	
Residence, N (%)				0.009
Urban	280 (19.39%)	207 (21.30%)	73 (15.47%)	
Rural	1,164 (80.61%)	765 (78.70%)	399 (84.53%)	
Education level, N (%)				< 0.001
Educated	177 (12.26%)	139 (14.30%)	38 (8.05%)	
Illiterate	1,267 (87.74%)	833 (85.70%)	434 (91.95%)	
Marital status, N (%)				< 0.001
Single	14 (0.96%)	10 (0.99%)	4 (0.89%)	
Married	372 (25.75%)	287 (29.56%)	85 (18.04%)	
Widowed	1058 (73.29%)	675 (69.45%)	383 (81.07%)	
No. of leisure activities, mean (SD)	1.01 (0.94)	1.08 (0.93)	0.88 (0.94)	< 0.001
Regular social contacts				
Yes	542 (37.56%)	392 (40.33%)	150 (31.84%)	
No	902 (62.44%)	580 (59.67%)	322 (68.16%)	< 0.001
Regular family contacts				
Yes	1337 (92.56%)	887 (91.22%)	450 (95.29%)	< 0.001
No	107 (7.44%)	85 (8.78%)	22 (4.71%)	
Living alone (%)				0.139
Yes	208 (14.40%)	133 (13.68%)	75 (15.89%)	
No	1236 (85.60%)	839 (86.32%)	397 (84.11%)	
Living Arrangements (%)				0.128
Living with children but not with the spouse	1,067 (73.89%)	709 (72.94%)	358 (75.85%)	
Living with the spouse and children	39 (2.70%)	31 (3.19%)	8 (1.69%)	
Living with the spouse but not with children	52 (3.60%)	38 (3.91%)	14 (2.97%)	
Living with grandchildren	53 (3.67%)	43 (4.42%)	10 (2.12%)	
Living with other relatives	16 (1.11%)	11 (1.13%)	5 (1.06%)	
Living alone	208 (14.40%)	133 (13.68%)	/5 (15.89%)	
Living in a nursing home	9 (0.62%)	/ (0./2%)	2 (0.42%)	
ADL score, mean (SD)	81.81 (22.96)	83.12 (22.86)	/9.11 (22.95)	0.002
ADL disability, N (%)	500 (0.6 570/)			< 0.001
No	528 (36.57%)	405 (41.67%)	123 (26.06%)	
Yes	916 (63.43%)	567 (58.33%)	349 (/3.94%)	0.001
IADL score, mean (SD)	2.90 (2.51)	3.24 (2.53)	2.19 (2.31)	< 0.001
IADL disability, N (%)	107 (12050()	146 (15 020/)	41 (0 (00))	< 0.001
NO	127 (12.95%)	146 (15.02%)	41 (8.69%)	
Yes	1,257 (87.05%)	820 (84.98%)	431 (91.31%)	0.007
No. of drugs per day, mean (SD)	0.43 (0.86)	0.48 (0.92)	0.33 (0.70)	0.007
No	1 156 (80 06%)	072 (01 670/)	222 (70 5 50%)	< 0.001
Voc	1,130 (00.00%) 288 (10.04%)	020 (04.07 %)	333 (70.33%) 130 (20 45%)	
Vision impairment N (%)	200 (19.9470)	147 (13.33%)	139 (29.43%)	< 0.001
	1 107 (76 66%)	781 (80 35%)	326 (69 07%)	< 0.00 I
	1,107 (70.0070)	/01 (00.00/00)	520 (07.0770)	

Table 1 (continued)

	All respondents with LTC Needs	Unmet needs = 0	Unmet needs = 1	<i>p</i> -value
Yes	337 (23.34%)	191 (19.65%)	146 (30.93%)	
Sleep quality				< 0.001
Good Sleep quality	492 (34.04%)	361 (37.09%)	131 (27.74%)	
Normal Sleep quality	799 (55.30%)	523 (53.85%)	275 (58.28%)	
Poor Sleep quality	154 (10.66%)	88 (9.06%)	66 (13.98%)	



1a.

1b.

Fig. 1 Distribution of oldest old population by IADL and ADL disabilities

The average score of ADL was 81.81, while 63.43% of them needed help in more than 3 domains of ADL activities. 3.39% of the sample was classified as a total dependency (with a score of 0-20); 15.58% were classified as a severe dependency (with a score of 21-60). 34.90% were in moderate dependency (with a score of 61-90), while 46.12% were independent (with a score of 91-100). As for ADLs, stairs (59.51%), transfers from bed to chair and back (45.59%), mobility on level surfaces (32.94%) and toilet use (30.68%) were the top 4 domains that respondents self-reported that they needed help (Fig. 1.).

In addition, 23.34% of the respondents had a vision impairment and 19.94% had a hearing impairment. The average QALYs for all respondents who needed LTC were 0.73.

Prevalence for unmet needs for LTC

As shown in Table 1, the prevalence of unmet needs for LTC was 32.69%. Significant differences in prevalence were found across individuals' socio-demographic characteristics, living arrangements, and health-need factors. Figure 2. presented the prevalence of unmet LTC needs by socio-demographic characteristics. The prevalence

was more than 3 times higher in those who were over 105 years old than in those who were 80–85 years old (50.82% vs. 16.47%). The prevalence of unmet LTC needs was higher in those who were illiterate, living in rural areas, living alone, with a higher level of ADL or IADL disability, with vision and hearing impairments, and with lower QALYs.

Association between unmet needs for LTC and HRQOL

Column 1 of Table 2 presented the results from the Tobit regression analysis for unmet long-term care (LTC) needs and quality-adjusted life years (QALYs). The findings indicated that individuals with unmet needs reported lower QALY scores (β =-0.04, p < 0.01), after accounting for socio-demographic characteristics and health need variables. Additionally, the results showed that urban residence compared to rural residence (β =-0.03, p < 0.1), individuals who were living alone (β =0.02, p < 0.1), individuals with functional disabilities (β =0.03, p < 0.01), vision impairment (β =-0.03, p < 0.05), and hearing impairment (β =-0.05, p < 0.01), taking fewer drugs per day (β =-0.03, p < 0.01), engaging in more types of leisure activities (β =0.05, p < 0.01), and having good sleep



Fig. 2 Prevalence of unmet LTC needs by socio-demographic characteristics

quality (β = 0.05, *p* < 0.01) were significantly associated with higher QALYs.

Column 2 to 6 of Table 2 presented the results from the Ordered Probit regression for unmet LTC needs and the five EQ-5D dimensions. The outcome variable is categorized as follows: 1 (no problem), 2 (moderate problem), and 3 (severe problem). The coefficients were as follows: the mobility dimension ($\beta = 0.18$, p < 0.05), selfcare dimension ($\beta = 0.19$, p < 0.05), pain or discomfort dimension ($\beta = 0.27$, p < 0.01), and anxiety or depression dimension ($\beta = 0.09$, p < 0.01). The coefficients from the ordered Probit regressions are not marginal effects, so their magnitudes cannot be interpreted as the marginal impact of the explanatory variables on the dependent variable. However, the signs of the coefficients indicate the direction of the relationship. A positive sign indicates a negative relationship between the risk factors and the outcome variables, meaning that higher values of the explanatory variable are associated with more severe problems. The results showed that oldest-old adults with unmet LTC needs reported higher levels of disabilities in all the five EQ-5D dimensions. Regression results on the matched sample from PSM also hold, and consistent from the baseline results (see supplementary Table 1).

Discussion

This study investigated the self-reported unmet needs for LTC and their associations with sociodemographic characteristics, and health-related factors for the oldest old and centenarians in China. We identified a significant association between unmet LTC needs and EQ-5D.

Our findings indicated that 32.69% of the respondents had unmet LTC needs. Despite the definition of unmet needs being slightly different and the population in our study being generally older than the sample in those studies, this figure was greater than its counterpart in some high-income countries, where the unmet LTC ranged from 1% in the adult population in 2007 (Belgium and Slovenia) to 26% (Latvia, Poland, Sweden and Hungary) [31]. Additionally, the prevalence was higher than what was reported in a systematic review, which indicated that on average 25.1% of older people had unmet needs in LTC [32]. The difference was not unexpected given that LTC is primarily the responsibility of families rather than governments in China. In our sample, there were very few individuals receiving formal care. Most respondents (99.38%) used informal care for their LTC needs. It was also observed in other Chinese studies on a variety of age groups [33]. According to the literature, it is more likely for old persons living in countries where the primary responsibility for long-term care lies with the family to have unmet long-term care needs than those living in countries where the government takes the majority of responsibility [34].

In addition, we identified disparities in sociodemographic characteristics: the prevalence of unmet needs was higher in respondents who were male, less educated, living in rural areas and had poor social connection. This was in line with prior studies for old people in China and across the world, including both high-income and LMICs [13, 35–37]. In general, unmet LTC needs were associated with economic and social deprivation. Respondents with lower socio-economic status may tend to live in

	(1)	(2)	(3)	(4)	(5)	(6)
	QALYs	Mobility	Selfcare	Usual activities	Pain/ Discomfort	Depression/ Anxiety
Unmet LTC needs	-0.04***	0.18**	0.19**	0.09	0.27***	0.09***
	(0.01)	(0.08)	(0.09)	(0.08)	(0.08)	(0.04)
Age	-0.00	0.01	-0.01	0.01***	-0.01	-0.04***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)
Male	0.01	-0.09	0.07	0.00	-0.08	-0.02
(ref=female)	(0.01)	(0.10)	(0.11)	(0.10)	(0.10)	(0.13)
Rural	-0.03*	0.18	0.24**	0.12	0.12	0.36**
(ref=Urban)	(0.01)	(0.11)	(0.12)	(0.11)	(0.10)	(0.15)
Illiterate	0.02	-0.29**	-0.26*	-0.20	0.15	-0.24
	(0.02)	(0.13)	(0.14)	(0.13)	(0.13)	(0.17)
Marital status (ref=single)						
Married	0.03	0.01	-0.16	0.32	-0.58*	-0.28
	(0.06)	(0.32)	(0.38)	(0.38)	(0.32)	(0.42)
Widowed	-0.06	0.56*	0.27	0.76**	-0.38	-0.05
	(0.06)	(0.32)	(0.38)	(0.38)	(0.32)	(0.41)
No. of Leisure activities	0.05***	-0.32***	-0.38***	-0.30***	-0.03	-0.32***
	(0.01)	(0.05)	(0.06)	(0.05)	(0.05)	(0.07)
Regular social contacts	0.02*	-0.09	-0.11	-0.17**	-0.06	-0.05
5	(0.01)	(0.08)	(0.09)	(0.08)	(0.08)	(0.10)
Regular family contacts	0.01	0.03	-0.03	-0.13	0.01	-0.32**
- /	(0.02)	(0.15)	(0.13)	(0.13)	(0.14)	(0.16)
Living alone	0.02*	-0.08	-0.14	-0.19*	0.02	0.12*
(ref=living with others)	(0.01)	(0.10)	(0.12)	(0.11)	(0.10)	(0.06)
ADL disability	0.03***	-0.26***	-0.27***	-0.22****	-0.08****	-0.04***
	(0.00)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
No. of drugs per day	-0.03***	0.11**	0.10**	0.04	0.24***	0.13**
	(0.01)	(0.04)	(0.05)	(0.04)	(0.04)	(0.05)
Hearing impairment	-0.05***	0.28**	0.34***	0.23**	0.08	0.31***
	(0.01)	(0.11)	(0.11)	(0.10)	(0.10)	(0.12)
Vison	-0.03**	0.15	0.17*	0.17*	0.05	0.17
impairment						
	(0.01)	(0.10)	(0.10)	(0.10)	(0.10)	(0.12)
Sleep quality						
(ref = bad sleep quality)	0.05***	0.22**	0.05	0.10	0.0 c***	0 < 7***
Good sleep quality	0.05	-0.32	0.05	-0.10	-0.36	-0.67
A	(0.02)	(0.13)	(0.14)	(0.13)	(0.13)	(0.15)
Normal sleep quality	0.01	-0.19	0.20	-0.02	-0.02	-0.28
	(0.02)	(0.13)	(0.13)	(0.12)	(0.12)	(0.14)
_cons	0.21					
,	(0.10)					
/	0.00***					
var(e.qaly)	0.03					
	(0.00)	***	= o o***	o o /***	***	***
CUTI		-4.31	-5.29	-2.84	-1./4	-3.89
		(0./4)	(0.80)	(U./2)	(0.66)	(0.85)
cut2		-1.01	-2.20	0.08	0.80	-1.85
		(0.70)	(0.75)	(0.69)	(0.65)	(0.85)
N	1444	1444	1444	1444	1444	1444

Table 2 Association between unmet LTC needs and HRQOL

Standard errors in parentheses

 $p^* < 0.1, p^* < 0.05, p^* < 0.01$

smaller households and are more likely to be single or widowed thus informal care may be less readily available to them. Particularly, the nationwide rural-to-urban migration was started in the 1980s as a distinct labour market phenomenon due to China's economic transition [38]. It implied that the children and grandchildren of the rural respondents in our study may be geographically distant from them and less likely to live with them and provide informal care. Ensuring equal access to equal needs was part of the objective of the policy agenda for China and most of the developed economies. It implies that no differences should be existed in the LTC needs by socioeconomic conditions, gender and ethnicity. China may have a great challenge in dealing with the unmet LTC needs in the rural area because, on one hand, informal care is less readily available for rural residents as we mentioned. On the other hand, it is more difficult to develop formal care services because of the geographical dispersion of rural residents, unreliable access to resources, and inadequate policy attention [39].

The correlation between unmet needs and HRQOL appeared consistently robust across different studies. A scoping review analyzing 53 studies showed that unmet care needs were associated with unfavorable outcomes for patients [40]. In a longitudinal study in Korea, the findings showed that individuals lacking adequate healthcare need services related to economic hardship had lower scores in EQ-5D and EQ-VAS indices compared to those without such unmet healthcare needs [41]. Consistent with previous studies, our study showed unmet needs were associated with lower HRQOL among oldest-old people. The global under-supply in addressing unmet needs contributes to the underuse of services and the expansion of disparities in healthcare access and outcomes [42], leading to a lower overall quality of life among older adults.

Our findings identified the multi-dimensions of EQ-5D and explored its relationship with unmet needs for LTC, presenting that increased issues for mobility, self-care, pain/discomfort, and depression were associated with more unmet LTC needs. Previous studies revealed that unmet healthcare needs were associated with a higher likelihood of exhibiting symptoms of depression [43–45]. Despite the growing attention to care needs in late-life depression, there is limited knowledge about the realworld mental health care services provided, addressing the importance of addressing these needs and providing specific and tailored care effectively [44, 46]. Additionally, our study identified significant relationships between unmet LTC needs and pain or discomfort, suggesting that multiple interventions, including nonpharmacologic and pharmacological strategies, should be utilized for pain management to address these unmet needs [47, 48]. It is essential to integrate healthcare services to prevent or reverse the loss of mobility and self-care ability to help adults maintain independence.

Based on the information on respondents' living arrangements, informal care provided by children or spouses was almost the exclusive type of LTC received by the oldest old and centenarians in China. A tiny proportion of them used institutional care or formal (paid) care. Firstly, it is partly because of the Chinese culture that children have the obligation to support their parents in their old age both financially and physically (providing informal care). A majority of them prefer to live with their family members in their old age, especially the old generation. Secondly, the development of home-care services and institutional care in China is still in its infancy, so they are not readily available and affordable for most families. Literature has provided shreds of evidence that informal care had adverse effects on carers, including adverse health effects and even increased mortality risks [49, 50]. In addition, it would also decrease the labour supply from the carers because of the provision of informal care, leading to high personal and societal costs [51]. Although our results found that living with children or grandchildren without any formal carer was less likely to report unmet LTC needs, this type of LTC was not sustainable in the era of a rapidly aging population with longer life expectancy. Furthermore, as a consequence of China's one-child policy and the declining fertility in recent years, most families would face the problem that two children (husband and wife) need to take care of four disabled parents at some point. The kinship-based familiar structure and informal care pattern could not last and support the current older generation. China faces a great challenge to formulate a programmatic and sustainable LTC system.

Our study has several limitations. Firstly, the data were drawn exclusively from Hainan Province, which is not nationally representative. This restricts the generalizability of our findings to the broader oldest-old population across the country. Secondly, it was difficult to reveal a causal relationship since we only have one wave of data, although we performed PSM to reduce the selection bias. Further studies should employ longitudinal designs to better ascertain causality and consider including diverse geographical areas to enhance the representativeness and applicability of the results. Thirdly, our survey only collected data from individuals regarding whether their LTC needs have been met in general terms. Further studies could enhance this approach by employing more detailed and specific metrics to assess various aspects of LTC needs, such as emotional, social, and physical support.

Conclusions

The proportion of respondents who had unmet LTC needs was higher than its counterparts in high-income countries, especially for rural residents and people with economic deprivation. Our study highlights the significant impact of unmet LTC needs on the health and HRQOL of the oldest-old adults. The results from the Tobit regression and ordered probit regressions demonstrate that individuals with unmet LTC needs experience lower OALYs and higher levels of disabilities across multiple dimensions of health. Key factors such as urban versus rural residence, functional disabilities, vision and hearing impairments, medication usage, living arrangements, leisure activities, and sleep quality were all significantly associated with QALY scores. These findings underscore the importance of addressing unmet LTC needs to improve the overall health outcomes and quality of life for the oldest-old population. Addressing these needs through targeted interventions and policies could help mitigate the negative impacts and enhance the wellbeing of this vulnerable group. The findings of this study provided evidence and analysis on the unmet needs of LTC for vulnerable populations, which may have implications for other LMICs with rapidly aging populations.

Abbreviations

LTC	Long-term care
HRQO	L Health-related Quality of life
SD	Standard deviation
EQ-5D	European Quality of Life 5-Dimension Scale
ADL	Activities of Daily Living
IADL	Instrumental Activities of Daily Living
QALYs	Quality-adjusted life years
CHCCS	China Hainan Centenarian Cohort Study

Supplementary Information

The online version contains supplementary material available at https://doi.or g/10.1186/s12955-025-02375-x.

Supplementary Material 1

Acknowledgements

We sincerely appreciate all the participants of CHCCS.

Author contributions

JQ and CC conceptualized study. JQ performed the statistical analyses and drafted the manuscript. YZ and YY collected the data. YQ, JT, NC and NP cleaned the data and performed the data analysis. JT, CC, YQ, YY, ZM and YZ contributed to the interpretations of results and revised the manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability

The data underlying this article are available from the Chinese People's Liberation Army General Hospital. But restrictions apply to the availability of the data, which were used under license for the current study, and so are not publicly available. It is possible to obtain the datasets used and analysed during the current study from the corresponding author upon reasonable request and with permission of the Chinese People's Liberation Army General Hospital.

Declarations

Ethical approval and consent to participate

The ethics approval was from the Ethics committee of the Chinese People's Liberation Army General Hospital (Beijing, China), and the work was conducted in accordance with the Declaration of Helsinki. All participants provided written informed consent before the information was collected.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 11 July 2024 / Accepted: 23 April 2025 Published online: 13 May 2025

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