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Rural–Urban Differences in Mild Cognitive Impairment Among Patients with Chronic Obstructive Pulmonary Disease in ChengDu, China

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Purpose: The rural–urban gap in sociodemographic, lifestyle, and disease-related characteristics among COPD patients is prevalent. These differences may influence the prevalence of mild cognitive impairment (MCI). This study aimed to compare the prevalence and determinants of MCI between rural and urban areas among COPD patients.

Patients and Methods: The cross-sectional study sample comprised 372 COPD patients from China. We evaluated the cognitive function and lung function, collected sociodemographic, lifestyle, and disease-related information, to compare the prevalence of MCI in rural and urban areas. Using multivariate regression analysis to examine the effects of variables to MCI.

Results: The prevalence of MCI in rural areas was higher than that in urban areas (65.4% vs 47.9%, P=0.001). The prevalence in farm laborers was almost twice as high as that of non-farm laborers in urban areas (82.6% vs 43.1%), but no significant difference in rural areas (P=0.066). However, the data were lower in subjects who insisted on long-term home oxygen therapy (39.7%, CI:27.8–51.6, P<0.001), and who with higher monthly household income (49.6%, CI:40.2–58.9) in rural areas, but no significant difference in urban areas (P=0.985 and 0.502). Multivariate logistic regression analysis indicated that participants aged 71 years and above, former smokers were at a high risk of MCI in both urban and rural areas. However, participants who slept for 6–8 hours a day, shopping frequently, or exercised for more than 2 hours a day had a lower risk of MCI in urban areas. But rural participants who insisted on long-term home oxygen therapy had a lower probability of developing MCI.

Conclusion: This study revealed that there were significant differences in MCI among COPD patients in rural and urban areas, especially in exercise, sleeping, shopping, and long-term home oxygen therapy. Medical staff should give health guidance according to the actual situation of patients with COPD.

Keywords: chronic obstructive pulmonary disease, mild cognitive impairment, urban, rural

Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disease characterized by limited airflow and incomplete reversibility, and it is associated with high morbidity and mortality.[1] A cross-sectional survey of 24% of China's population showed that the overall prevalence of COPD in 2018 was 13.6% among 66,752 adults aged >40 years, which was 5.4% higher than that in 2004.[2] COPD will seriously affect the quality of life and mental status of patients.[3]

Cognition is the set of processes that allow the brain to receive and process external information. Cognitive impairment (CI) is a frequent extrapulmonary manifestations in COPD. A previous study found mostly poor performance on cognitive tests of attention, memory, and executive functions in COPD patients.[4] Mild cognitive impairment (MCI) refers to cognitive decline without major functional impacts on activities of daily living,[5] MCI is one of the complications of COPD and refers to the impairment of one or more cognitive fields, which affects the patients' social function and quality of life.[6,7] A cross-sectional study reported a higher prevalence of MCI in individuals with COPD compared with those without COPD,[5] and the prevalence of MCI in COPD patients can be as high as 58%.[8] COPD with MCI may reduce the efficiency of treatment and self-management, which not only affects physical functioning in COPD patients but also increases mortality and disability.[9] Also, approximately

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50% of patients with MCI develop dementia within 5 years, which poses a heavy burden on families and society.[6] Therefore, the early identification of modifiable risk factors for MCI of COPD is important for preventing or delaying the onset of dementia.[10]

Environmental factors may be involved in cognitive impairment or decline. The incidences of MCI differ significantly between urban and rural, primarily due to differences in living environment, quality of life, family income, and level of education.[11] Some studies reported rural–urban differences in prevalence of MCI in elderly,[11,12] However, this difference in COPD patients has not been reported. Although a large national survey reported the prevalence of cognitive impairment in COPD patients between urban and rural areas, but this study did not describe the associated risk factors. Furthermore, this study included COPD patients in rural and urban areas across different provinces and cities.[13] However, there are obvious differences in customs, eating habits, culture, and health policies between different provinces and cities in China.[14] Therefore, the results of the study may be more suitable for explaining regional differences than rural–urban differences among COPD patients.[11] As such, it is necessary to further explore relevant differences for MCI in COPD patients between urban and rural areas.

To better analyse these differences in MCI, we selected COPD patients living in rural and urban areas under the jurisdiction of the same city. We took into account the baseline information, life style, and disease-related factors that can potentially affect cognition, and excluded potential confounding factors such as regional customs. Thus, our results provide a reference for local medical and health institutions that can help formulate targeted prevention and intervention programs.

Materials and Methods

Area Surveyed

A cross-sectional study of MCI in COPD was undertaken from March 2022 to December 2022 in Qionglai City, Chengdu, Sichuan province, China. This city has one urban area and 24 rural townships with a population of 0.6 million people. The urban population is 53.53%, and the rural population is 46.47%. This survey was conducted from Qionglai City and 11 neighbouring rural townships.

Sample Size

We used the following formula to calculate the sample size from a known population of COPD patients ($N=Z_{\alpha/2}^2\ p(1-p)/d^2$), and $Z_{a/2}$=level of confidence at 95% (1.96), p=previous prevalence of cognitive impairment in COPD patients (0.58), allowable error(d)=0.1p.[15] Based on the calculation, and Considering a 20% sample loss, the sample size of this study should have been 334 COPD patients. A total of 372 COPD patients were enrolled in our study.

Inclusion and Exclusion Criteria

Participants were selected from Qionglai Medical Center Hospital and 11 nearby township hospitals through gratuitous treatment. Suitable COPD patients were selected according to the order of admission. All adult patients of age 40 years and above with COPD, and giving written consent, were enrolled in the study. Those with severe mental illness (such as dementia or Alzheimer's disease) and active pulmonary tuberculosis were excluded. This study used the STROBE cross-sectional reporting guidelines.[16]

Data Collection

This study was divided into two stages to recruit participants: In the first stage, using convenient sampling method to recruit COPD patients in a comprehensive hospital in Qionglai city; In the second stage, 11 townships were randomly selected, and then selected participants from the hospitals in the selected 11 townships. The recruitment procedures were as follows: the investigators introduced the purpose and methods of this study to patients via telephone interview, gratuitous treatment or face-to-face communication. Then, if patients meet the inclusion and exclusion criteria of this study and were willing to join this study, they must sign informed consent. This survey was conducted by the authors and other qualified investigators who received unified training. Before the investigation, the researchers and trainers explained the purpose and significance of the study to the participants. The investigation was conducted only after obtaining the consent of each participant. All questionnaires were filled in under the guidance of the researchers. The

questionnaires were distributed, filled out, and collected on the spot. Simultaneously, the researchers verified the completeness and accuracy of each questionnaire to avoid wrong or missing data. A total of 372 COPD patients were enrolled in this study.

Measurements

Outcome Variable

MCI Assessment

The MCI assessment was conducted by standardised training and certified researchers after excluding patients with dementia. The diagnosis of dementia was carried out by doctors with standardized training and qualifications in the neurology department based on the Chinese Guidelines for Diagnosis and Treatment of Dementia and Cognitive Impairment (2018).[17] The Beijing version of Montreal Cognitive Assessment (MoCA) was used to assess MCI after excluding participants with dementia. MoCA includes eight cognitive domains: orientation, language, working memory, concentration, short-term memory, attention, executive function, and visuospatial ability, and is sensitive to screen out MCI. Considering the impact of education level on cognitive function, the MoCA score can be adjusted for years of education. One point is added to the original MoCA score if a person's education time less than 12 years. The maximum score of MoCA is 30 points, and a higher score represents a better cognition function and a score <26 indicates MCI.[18]

Covariates

The analysis included and adjusted other sociodemographic, lifestyle, and disease-related characteristics. The sociodemographic characteristics included sex, age, education level, occupation, marital status, living arrangement, monthly household income, body mass index (BMI), smoking, drinking, decision makers in family, and family history of dementia. Factors related to lifestyle included daily hours of sleep, frequent shopping (more than 3 times a week), daily hours of entertainment and daily hours of exercise. Disease-related characteristics included comorbidity (referring to combined with other chronic diseases such as hypertension and diabetes), long-term home oxygen therapy, and lung function. The lung function of participants were measured according to Global initiative for chronic obstructive lung disease (2020 REPORT),[19] we recorded forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), forced vital capacity rate of one second (FEV1/FVC), and percentage of predicted FEV1 (FEV1% pred). Lung function was divided into four degrees according to FEV1%pred: GOLD1:FEV1%pred≥80%; GOLD2: 50%≤FEV1%pred<80%; GOLD 3:30%≤FEV1%pred<50%; GOLD 4: FEV1%pred<30%, and GOLD 1 to GOLD 4 represented mild to extremely severe lung function injury.

Statistical Analyses

We used SPSS Statistics 23.0 (IBM Corp, Armonk, NY, USA) for data analysis. Continuous variables were summarised as mean with SD, while categorical variables were presented as frequencies and percentages. To compare sociodemographic, lifestyle, and disease-related characteristics between rural and urban areas, normally distributed data were tested with a *t*-test; non-normally distributed data were tested with a Mann–Whitney *U*-test, and categorical data were tested with a chi-squared test. The Chi-square test was used to compare MCI between urban and rural variables. Finally, binary logistic regression was used to analyse the risk factors of MCI in rural and urban participants. The results are reported as odds ratios (ORs) with 95% confidence intervals (CIs). A value of $P < 0.05$ was considered statistically significant. We used the Variance Inflation Factor (VIF), all less than 5, to ensure no multicollinearity between variables.

Results

Background Characteristics of the Study Population

In our study, a total of 484 patients agreed to participate in the study, including 249 and 235 in rural and urban areas, respectively. Among them, 401 completed the final effective survey (201 and 200 in rural and urban areas respectively), with an overall response rate of 82.9% (80.7% and 85.1%) for urban and rural areas respectively). A total of 29 patients (19 in rural and 10 in urban areas) were screened as dementia and excluded. Eventually, 372 patients (182 in rural and 190 in urban areas) were included (Figure 1).

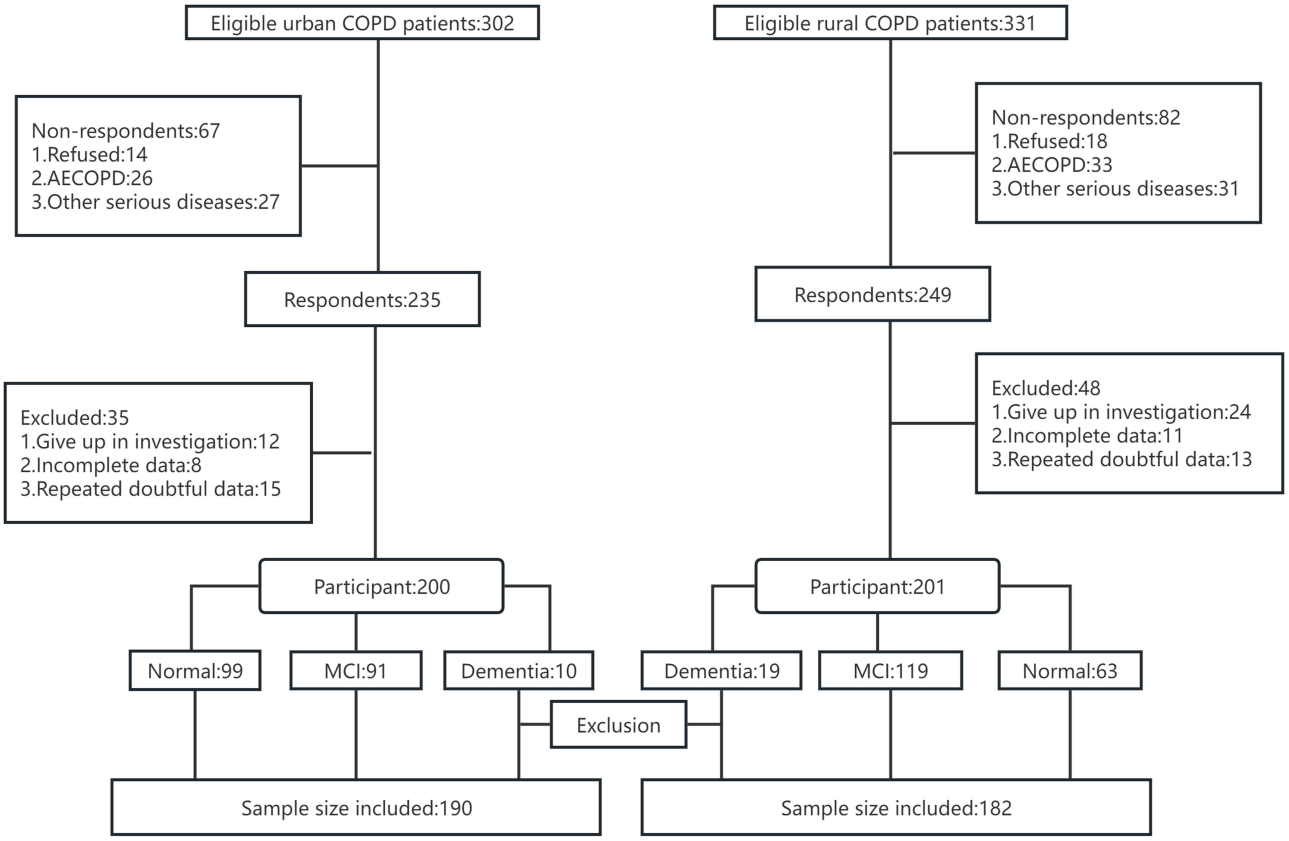

Figure 1 Flowchart of subject recruitment for the study participants.

Table 1 provides the sample distribution of the participants. Around 63.7% (CI:56.8–70.6) of the participants were male in urban areas and 67.6% (CI:60.7–74.4) of respondents in rural areas. Nearly 69.9% (CI: 65.2–74.6) of participants at an education level of junior middle school or below. This data was higher in rural areas at 95.6% (CI:92.6–98.6) compared to urban areas at 45.3% (CI:38.1–52.4) (P<0.001). 29.7% (CI:23.0–36.4) of the participants spent more than 4 hours in entertainment every day in rural areas, whereas this figure was 56.3% (CI:49.2–63.4) in urban areas (P<0.001). It was 27% higher among people whose monthly household income was less than 5000 RMB in rural (37.9%, CI:30.8–45.0) than in urban settings (10.5%, CI:6.1–14.9) (P<0.001), and the participants who insisted on long-term home oxygen therapy in urban areas were 14% higher than that in rural areas [51.6% (CI:44.4–58.7) vs 37.4% (30.3–44.5), P=0.007].

Rural–Urban Differences in Prevalence of MCI Among Individuals with COPD

As is shown in Table 2, the prevalence of MCI in rural areas was significantly higher than that in urban areas (65.4% vs 47.9%, P=0.001), and the prevalence increased with age. The prevalence was also observed to be substantially higher among individuals who were at an education level of junior middle school and below both in rural and urban areas (67.8% and 70.9%, P<0.001). Similarly, the prevalence of MCI in participants who slept less than 6 hours a day, not shopping frequently, had one and more other chronic conditions, with serious lung function injury (GOLD 3 + GOLD 4) were higher, irrespective of place of residence (all P<0.001). However, the prevalence of MCI between urban and rural participants was significantly different in certain variables. For example, the prevalence of farm laborers was almost twice as high as that of non-farm laborers in urban areas (82.6% vs 43.1%, P<0.001), but there was no significant difference in rural areas (P=0.066). However, the prevalence of MCI was lower in subjects who insisted on long-term home oxygen therapy (39.7%, CI:27.8–51.6, P<0.001), and who with higher monthly household income (49.6%, CI:40.2–58.9, P<0.001) in rural areas, but no significant difference in urban areas (P=0.985 and 0.502). Furthermore,

Table 1 Characteristics of Participants in Urban and Rural Areas

Variable	Total N=372	Percent (95% CI)	Urban N=190	Percent (95% CI)	Rural N=182	Percent (95% CI)	p-value (Urban vs Rural)
Sex							0.446
Male	244	65.6[60.7–70.4]	121	63.7[56.8–70.6]	123	67.6[60.7–74.4]	
Female	128	34.4[29.6–39.3]	69	36.3[29.4–43.2]	59	32.4[25.6–39.3]	
Age (year)							0.509
40–54	49	13.2[9.7–16.6]	26	13.7[8.8–18.6]	23	12.6[7.8–17.5]	
55–70	111	29.8[25.2–34.5]	59	31.0[24.4–37.7]	52	28.6[21.9–35.2]	
71+	212	57.0[51.9–62.0]	105	55.3[48.1–62.4]	107	58.8[51.6–66.0]	
Education level							<0.001
Junior middle school or below	260	69.9[65.2–74.6]	86	45.3[38.1–52.4]	174	95.6[92.6–98.6]	
High school or above	112	30.1[25.4–34.8]	104	54.7[47.6–61.9]	8	4.4[1.4–7.4]	
Occupation							<0.001
Farm laborer	196	52.7[47.6–57.8]	23	12.1[7.4–16.8]	173	95.1[91.9–98.2]	
Non-Farm laborer	176	47.3[42.2–52.4]	167	87.9[83.2–92.6]	9	4.9[1.8–8.1]	
Marital status							0.886
Married	315	84.7[81.0–88.4]	160	84.2[79.0–9.4]	155	85.2[80.0–90.4]	
Widowed/divorced/unmarried	57	15.3[11.6–19.0]	30	15.8[10.6–21.0]	27	14.8[9.6–20.0]	
Living arrangement							0.718
Live alone	33	8.9[6.0–11.8]	18	9.5[5.3–13.7]	15	8.2[4.2–12.3]	
Live with others	339	91.1[88.2–940]	172	90.5[86.3–94.7]	167	91.8[87.7–95.8]	
Monthly household income (RMB)							<0.001
<5000	89	23.9[19.6–28.3]	20	10.5[6.1–14.9]	69	37.9[30.8–45.0]	
≥5000	283	76.1[71.7–80.4]	170	89.5[85.1–93.9]	113	62.1[55.0–69.2]	
Smoking status							0.004
Never smoker	190	51.0[46.0–56.2]	113	59.5[52.4–66.5]	77	42.3[35.1–49.6]	
Former smoker	104	28.0[23.4–32.5]	45	23.7[17.6–29.8]	59	32.4[25.6–39.3]	
Current smoker	78	21.0[16.8–25.1]	32	16.8[11.5–22.2]	46	25.3[18.9–31.6]	
Drinking							0.727
NO	270	72.6[68.0–77.1]	136	71.6[65.1–78.1]	134	73.6[62.7–80.1]	
YES	102	27.4[22.9–32.0]	54	28.4[21.9–34.9]	48	26.4[19.9–32.8]	
Daily hours of sleep							0.612
<6	157	42.2[37.2–47.2]	78	41.1[34.0–48.1]	79	43.4[36.1–50.7]	
6–8	174	46.8[41.7–51.9]	90	47.4[40.2–54.5]	84	46.2[38.8–53.5]	
>8	41	11.0[7.8–14.2]	22	11.6[7.0–16.2]	19	10.4[6.0–14.9]	

(*Continued*)

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Table 1 (Continued).

Variable	Total N=372	Percent (95% CI)	Urban N=190	Percent (95% CI)	Rural N=182	Percent (95% CI)	p-value (Urban vs Rural)
Decision makers in family							<0.001
NO	168	45.2[40.1–50.2]	59	31.1[24.4–37.7]	109	59.9[52.7–67.1]	
YES	204	54.8[49.8–59.9]	131	68.9[62.3–75.6]	73	40.1[32.9–47.3]	
Family history of dementia							0.485
NO	353	94.9[92.6–97.1]	182	95.8[92.9–98.7]	171	94.0[90.5–97.5]	
YES	19	5.1[2.9–7.4]	8	4.2[1.3–7.1]	11	6.0[2.5–9.5]	
Daily hours of entertainment							<0.001
0	145	39.0[34.0–44.0]	56	29.5[22.9–36.0]	89	48.9[41.6–56.2]	
0–4	66	17.7[13.8–21.6]	27	14.2[9.2–19.2]	39	21.4[15.4–27.4]	
>4	161	43.3[38.2–48.3]	107	56.3[49.2–63.4]	54	29.7[23.0–36.4]	
Frequent shopping	168	45.2[40.1–50.2]	58	30.5[23.9–37.1]	110	60.4[53.3–67.6]	<0.001
NO	204	54.8[49.8–59.9]	132	69.5[62.9–76.1]	72	39.6[32.4–46.7]	
YES							
Comorbidity							0.001
No other chronic illness	209	56.2[51.1–61.2]	123	64.7[57.9–71.6]	86	47.3[39.9–54.6]	
One and more other chronic condition	163	43.8[38.8–48.9]	67	35.3[28.4–42.1]	96	52.7[45.4–60.1]	
Daily hours of exercise							<0.001
<1	113	30.4[25.7–35.1]	86	45.3[38.1–52.4]	27	14.8[9.6–20.0]	
1–2	57	15.3[11.6–19.0]	24	12.6[7.9–17.4]	33	18.1[12.5–23.8]	
>2	202	54.3[49.2–59.4]	80	42.1[35.0–49.2]	122	67.0[60.1–73.9]	
Long-term home oxygen therapy							0.007
NO	206	55.4[50.3–60.5]	92	48.4[41.3–55.6]	114	62.6[55.5–69.7]	
YES	166	44.6[39.5–49.7]	98	51.6[44.4–58.7]	68	37.4[30.3–44.5]	
FEV_1%pred							0.293
A	102	27.4[22.9–32.0]	54	28.4[21.9–34.9]	48	26.4[19.9–32.8]	
B	177	47.6[42.5–52.7]	94	49.5[42.3–56.6]	83	45.6[38.3–52.9]	
C+ D	93	25.0[20.6–29.4]	42	22.1[16.2–28.1]	51	28.0[21.4–34.6]	
BMI							0.347
<18.5	27	7.2[4.6–9.9]	16	8.4[4.4–12.4]	11	6.0[2.5–9.5]	
18.5–23.9	200	53.8[48.7–58.9]	104	54.7[47.6–61.9]	96	52.7[45.4–60.1]	
24–27.9	116	31.2[26.5–35.9]	55	28.9[22.4–35.5]	61	33.5[26.6–40.4]	
≥28	29	7.8[5.1–10.5]	15	7.9[4.0–11.8]	14	7.6[3.8–11.6]	
FVC(L), M (SD)	2.43±0.85		2.49±0.84		2.37±0.86		0.169
FEV1(L), M (SD)	1.50±0.61		1.57±0.58		1.43±0.63		0.009
FEVI/FVC(%), M (SD)	59.37±9.70		60.85±8.89		57.84±10.39		0.004

Notes: FEV1%pred: A(GOLD1):FEV1%pred≥80%;B(GOLD2): 50%≤FEV1%pred<80%; C(GOLD 3):30%≤FEV1%pred<50%; D(GOLD 4): FEV1%pred<30%.

Table 2 Prevalence of MCI Among COPD Patients by Variables in Urban and Rural Areas

Variable	Total Percent(95% CI) 56.5[51.4–61.5]	p-value	Urban Percent(95% CI) 47.9[40.7–55.1]	p-value	Rural Percent (95% CI) 65.4[58.4–72.4]	p-value
Residence		0.001				
Urban	47.9[40.7–55.1]					
Rural	65.4[58.4–72.4]					
Sex		0.124		0.370		0.248
Male	59.4[53.2–65.6]		50.4[41.4–59.5]		68.3[60.0–76.6]	
Female	50.8[42.0–59.6]		43.5[31.5–55.5]		59.3[46.4–72.2]	
Age (year)		<0.001		<0.001		<0.001
40–54	10.2[1.4–19.0]		7.7[3.3–18.7]		13.0[1.8–27.9]	
55–70	18.9[11.5–26.3]		5.1[0.7–10.9]		34.6[21.2–48.0]	
71+	86.8[82.2–91.4]		81.9[74.4–89.4]		91.6[86.2–96.9]	
Education level		<0.001		<0.001		0.001
Junior middle school or below	68.8[63.2–74.5]		70.9[61.1–80.7]		67.8[60.8–74.8]	
High school or above	27.7[19.3–36.1]		28.8[20.0–37.7]		12.5[17.1–42.1]	
Occupation		<0.001		<0.001		0.066
Farm laborer	68.9[62.3–75.4]		82.6[65.8–99.4]		67.1[60.0–74.1]	
Non-Farm laborer	42.6[35.2–50.0]		43.1[35.5–50.7]		33.3[5.1–71.8]	
Marital status		0.959		0.555		0.514
Married	56.5[51.0–62.0]		46.9[39.1–54.7]		66.5[58.9–74.0]	
Widowed/divorced/unmarried	56.1[42.9–69.4]		53.3[34.4–72.3]		59.3[39.5–79.1]	
Living arrangement		0.362		0.421		0.778
Live alone	48.5[30.5–66.5]		38.9[13.9–63.8]		60.0[31.9–88.1]	
Live with others	57.2[51.9–62.5]		49.4[41.8–57.0]		65.9[58.6–73.1]	
Monthly household income (RMB)		<0.001		0.502		<0.001
<5000	83.1[75.2–91.1]		55.0[31.1–78.9]		91.3[84.5–98.1]	
≥5000	48.1[42.2–53.9]		47.1[39.5–54.6]		49.6[40.2–58.9]	
Smoking status		<0.001		<0.001		<0.001
Never smoker	39.5[32.5–46.5]		34.5[25.6–43.4]		46.8[35.4–58.2]	
Former smoker	75.0[66.5–83.5]		66.7[52.3–81.0]		81.4[71.1–91.6]	
Current smoker	73.1[63.0–83.1]		68.8[51.8–85.7]		76.1[63.3–88.9]	
Drinking		0.907		0.714		0.724
NO	56.7[50.7–62.6]		47.1[38.6–55.6]		66.4[58.3–74.5]	
YES	55.9[46.1–65.7]		50.0[36.2–63.8]		62.5[48.3–76.7]	
Daily hours of sleep		<0.001		<0.001		<0.001
<6	77.1[70.4–83.7]		69.2[58.8–79.7]		84.8[76.7–92.9]	
6–8	42.0[34.5–49.4]		27.8[18.3–37.2]		57.1[46.3–67.9]	
>8	39.0[23.4–54.6]		54.5[31.9–77.1]		21.1[0.9–41.2]	
Decision makers in family		<0.001		<0.001		<0.001
NO	93.5[89.7–92.7]		93.2[86.6–99.8]		93.6[88.9–98.3]	
YES	26.0[19.9–32.0]		27.5[19.7–35.2]		23.3[13.4–33.2]	
Family history of dementia		0.346		0.903		0.335
NO	55.8[50.6–61.0]		47.8[40.5–55.1]		64.3[57.1–71.6]	
YES	68.4[45.4–91.4]		50.0[5.3–94.7]		81.8[54.6–109.0]	
Frequent Shopping		<0.001		<0.001		<0.001
NO	86.3[81.1–91.6]		79.3[68.6–90.1]		90.0[84.3–95.7]	
YES	31.9[25.4–38.3]		34.1[25.9–42.3]		27.8[17.2–38.4]	

(*Continued*)

Table 2 (Continued).

Variable	Total Percent(95% CI) 56.5[51.4–61.5]	p-value	Urban Percent(95% CI) 47.9[40.7–55.1]	p-value	Rural Percent (95% CI) 65.4[58.4–72.4]	p-value
Comorbidity		<0.001		<0.001		<0.001
No other chronic illness	39.7[33.0–46.4]		37.4[28.7–46.1]		43.0[32.3–53.7]	
One and more other chronic condition	77.9[71.5–84.4]		67.2[55.6–78.7]		85.4[78.2–92.6]	
Daily hours of exercise		<0.001		<0.001		<0.001
<1	70.8[62.3–79.3]		67.4[57.3–77.5]		81.5[65.8–97.1]	
1–2	77.2[66.0–88.4]		58.3[37.1–79.6]		90.9[80.6–101.3]	
>2	42.6[35.7–49.5]		23.8[14.2–33.3]		54.9[46.0–63.9]	
Long-term home oxygen therapy		<0.001		0.985		<0.001
NO	66.0[59.5–72.5]		47.8[37.4–58.2]		80.7[73.3–88.1]	
YES	44.6[36.9–52.2]		48.0[37.9–58.0]		39.7[27.8–51.6]	
FEV_1%pred		<0.001		<0.001		<0.001
A	25.5[16.9–34.1]		31.5[18.7–44.3]		18.8[7.3–30.2]	
B	61.0[53.8–68.3]		44.7[34.4–54.9]		79.5[70.7–88.4]	
C+ D	81.7[73.7–89.7]		76.2[62.8–89.6]		80.0[69.1–90.9]	
BMI		0.222		0.141		0.631
<18.5	77.8[61.0–94.5]		75.0[51.2–98.8]		81.8[54.6–109.0]	
18.5–23.9	55.0[48.0–62.0]		46.2[36.4–55.9]		64.6[54.8–74.3]	
24–27.9	54.3[45.1–63.5]		45.5[31.9–59.0]		62.3[49.8–74.8]	
≥28	55.2[35.9–74.4]		40.0[11.9–68.1]		71.4[44.4–98.5]	
FVC(L), M (SD)	2.29±0.77	0.002	2.43±0.76	0.635	2.19±0.76	<0.001
FEV1(L), M (SD)	1.36±0.55	<0.001	1.51±0.54	0.281	1.25±0.76	<0.001
FEVI/FVC(%), M (SD)	56.74±10.60	<0.001	59.02±10.40	0.126	54.99±10.46	<0.001

Notes: FEV1%pred: A(GOLD1):FEV1%pred≥80%;B(GOLD2): 50%≤FEV1%pred<80%; C(GOLD 3):30%≤FEV1%pred<50%; D(GOLD 4): FEV1%pred<30%.

among the participants who exercised for more than 2 hours a day, the prevalence rate of MCI in urban participants was only 23.8% (CI:14.2–33.3), while that in rural participants was as high as 54.9% (CI:46.0–63.9).

Facilitators and Barriers to MCI Among COPD Patients in Rural and Urban Areas

Significant variables from univariate analyses of the presence or absence of MCI in the rural and urban areas were included in a binary logistic regression model. The adjusted estimation of MCI with different socioeconomic, lifestyle, and disease-related characteristics revealed that participants aged 71 years and above, or former smokers were at a high risk of MCI both in urban and rural areas (AOR=94.477, 95% CI:7.587–1176.422 and AOR=22.020, 95% CI:2.112 −229.565; AOR=11.583; 95% CI:1.769–75.866 and AOR=5.216; 95% CI:1.323–20.563). Participants who slept for 6–8 hours a day had a lower risk of MCI in urban (AOR=0.090, 95%:0.017–0.471). Participants who shopping frequently (AOR=0.107; 95% CI:0.020–0.565) exercise for more than 2 hours a day (AOR=0.037; 95% CI:0.007–0.191) were less likely to develop MCI, especially in urban areas. Rural participants who insisted on long-term home oxygen therapy (AOR=0.133; 95% CI:0.041–0.436) had a lower probability of developing MCI (Table 3).

Discussion

To our knowledge, this is the first study to examine the difference in prevalence and influencing factors of MCI among COPD patients in rural and urban areas. According to the results of the study, there were some differences in MCI between rural and urban areas. We provide data that can act as a reference for local policymakers and medical staff.

In this study, 56.5% of participants were screened positive for MCI. The prevalence rate was similar to previous studies (63% and 58%),[20,21] The high prevalence rate of MCI in COPD patients may be related to neuronal injury caused by long-term hypoxemia, systemic inflammation, vascular-mediated brain injury, changes in cerebral perfusion caused by

Table 3 The Variables Independently Associated with MCI Both in Urban and Rural Areas

Variable	Urban		Rural	
	UOR (95% CI)	AOR(95% CI)	UOR (95% CI)	AOR(95% CI)
Age (year)				
40–54	1.00	1.00	1.00	1.00
55–70	0.643(0.101–4.097)	0.051(0.002–1.392)	3.529(0.923–13.496)	3.046(0.402–23.074)
71+	54.316***(11.812–249.754)	94.477***(7.587–1176.422)	72.593***(18.039–292.129)	22.020*(2.112–229.565)
Monthly household income (RMB)				
<5000	1.00	1.00	1.00	1.00
≥5000	0.727(0.287–1.845)	12.482*(1.476–105.563)	0.094***(0.037–0.234)	0.046***(0.010–0.215)
Smoking status				
Never smoker	1.00	1.00	1.00	1.00
Former smoker	3.795***(1.827–7.884)	11.583*(1.769–75.866)	4.970***(2.248–10.989)	5.216*(1.323–20.563)
Current smoker	4.174**(1.798–9.690)	5.285(0.984–28.384)	3.624**(1.609–8.162)	2.599(0.597–11.309)
Daily hours of sleep				
<6	1.00	1.00	1.00	1.00
6–8	0.171***(0.088–0.333)	0.090**(0.017–0.471)	0.239***(0.113–0.506)	0.561(0.148–2.122)
>8	0.533(0.203–1.403)	1.809(0.098–33.444)	0.048***(0.014–0.169)	0.627(0.094–4.166)
Decision makers in family				
NO	1.00	1.00	1.00	1.00
YES	0.028***(0.009–0.082)	0.032**(0.004–0.224)	0.021***(0.008–0.053)	0.175*(0.036–0.854)
Frequent shopping				
NO	1.00	1.00	1.00	1.00
YES	0.135***(0.065–0.280)	0.107*(0.020–0.565)	0.043***(0.019–0.096)	0.348(0.098–1.238)
Daily hours of exercise				
<1	1.00	1.00	1.00	1.00
1–2	0.676(0.267–1.710)	0.304(0.041–2.229)	2.273(0.490–10.532)	8.627(0.590–126.070)
>2	0.150***(0.076–0.298)	0.037***(0.007–0.191)	0.277*(0.098–0.779)	2.313(0.322–16.631)
Long-term home oxygen therapy				
NO	1.00	1.00	1.00	1.00
YES	1.005 (0.569–1.777)	0.804(0.221–2.922)	0.157***(0.080–0.309)	0.133**(0.041–0.436)
FEV1%pred				
A	1.00	1.00	1.00	1.00
B	1.758(0.870–3.553)	7.281*(1.246–42.530)	16.824***(6.824–41.368)	2.634(0.690–10.126)
C+ D	6.965**8(2.794–17.358)	8.885(0.827–95.441)	27.238***(9.271–80.022)	2.389(0.351–16.247)

Notes: 1.00:Reference; UOR: Unadjusted Odds Ratio; AOR: Adjusted Odds Ratio; CI:Confidence Interval. AOR: adjusted for significant variables from univariate analyses, and we also excluded significant variables with VIF greater than 5. In this study, we adjusted for age, education level, occupation, monthly household income, smoking status, daily hours of sleep, frequent shopping, comorbidity, daily hours of exercise, long-term home oxygen therapy, and FEV1%pred. ***P ≤0.001; **P≤0.005; *P≤0.05. FEV1%pred: A(GOLD1):FEV1%pred≥80%;B(GOLD2): 50%≤FEV1%pred<80%; C(GOLD 3):30%≤FEV1%pred<50%; D(GOLD 4): FEV1%pred<30%.

chronic hypoxia, or the reduction of grey matter volume.[22] These changes cause cognitive impairment in COPD patients, leading to symptoms such as slow information processing speeds, memory delays, and attention deficit.[23]

In this study, the prevalence of MCI in rural (65.4%) was significantly higher than that in urban (47.9%). Few previous studies reported the difference in the prevalence of MCI among COPD patients between urban and rural areas, but a large survey reported the difference in Chinese elderly, and the prevalence of MCI in rural areas was higher than that in urban areas (25.1% vs 17.9%).[12] This regional disparity reported here may be related to difference in the quality of life and approaches to manage COPD. Compared to urban areas, a systematic community culture has not yet been formed in most rural areas, which may lead to the lack of social interaction and cognitive stimulation among rural individuals.[24] Social interaction could improve the cognitive reserve of the elderly and reduce the risk of dementia. Moreover, it is a group activity, which not only promote communication among participants but also give them good social support and emotional comfort, and it has also been proved to be helpful in reducing the risk of MCI.[25]

This study showed that old age and smoking were risk factors for MCI in both rural and urban participants. Similar results were also observed in some previous studies.[26,27] Cognitive function will degrade with age,[28] and long-term

inhalation of nicotine can damage blood vessels, increase oxidative stress, and cause cognitive decline.[29] The content of nicotine intake may be related to the duration and the daily amount of smoking,[30] but this study did not collect these information of participants, which may be one of the reasons why former smokers were risk factors for MCI, but current smokers could not significantly predict MCI in our adjusted model. Moreover, despite the prevalence of the comorbidity between COPD and smoking, the role of smoking in cognition and brain damage in COPD-Smoking comorbidity is largely unclear. There may be a potential collinear relationship among smoking, lung function, and cognitive function in patients with COPD. The previous study and our study believed that COPD patients who were smokers had a higher risk of cognitive impairment,[31] but Zeng et al confirmed that nicotine had a protective effect on dopaminergic neurons, and presumably, nicotine may preempt a protective mechanism that buffers cognitive impairment in COPD-Smoking comorbidity.[32] Therefore, the relationship between smoking and cognitive function among COPD patients need to be further explored.

This study found that the prevalence of MCI among participants who slept less than 6 hours, was higher both in rural and urban areas, and the prevalence of MCI was low among participants shopping regularly and exercise for more than 2 hours a day. The results of adjusted multivariate regression analysis showed that urban participants who slept for 6–8 hours a day, shopping frequently and exercise for more than 2 hours a day had a lower risk of MCI, but it was not significant for rural participants. There were significant differences between rural and urban participants in living environment, lifestyle, and disease-management knowledge, which might explain these significant differences between urban and rural areas, but the mechanism of the differences needs further discussion.[11]

In this study, the incidence of MCI in participants who insisted on long-term home oxygen therapy was lower, and the incidence in participants with the most serious lung function damage were higher than others in total. Similar results were found in a previous study, which reported independent links between lung function and cognition, and impairment of lung function may lead to more serious cognitive impairment.[33] A study suggested that intermittent and persistent hypoxia may be caused by poor pulmonary dysfunction in COPD patients.[34] In the case of hypoxia, cerebral blood perfusion is reduced, which may increase ischemia in some brain areas and may lead to subcortical atrophy.[35] Hypoxia events or chronic hypoxia in the brain can also lead to the production of free radicals and neuronal damage.[36] This may be why hypoxia is one of the risk factor for cognitive impairment. Our logistic regression analysis showed that patients with COPD who insisted on long-term home oxygen therapy were less likely to suffer from MCI, especially in rural areas, and the previous study also indicated that the treatment with supplemental oxygen markedly decreased the risk of cognitive impairment.[37] However, there was no significant correlation in urban participants in our study. This may be related to the compliance with oxygen therapy or oxygen therapy equipment of rural patients with COPD.

This study has some limitations too. First, this was a cross-sectional study, and no causality can be established from this study. Second, while every effort is made to control for some confounding factors, it might be that there were some potential collinearity relationships, potential confounders, and bias between some variables, and some potential confounding factors remain were not taken into account, for example, we did not consider the quantity and duration of smoking. Third, our study could not exclude some recall bias because some self-reported data were collected. Fourth, the physical condition of several participants may not have been evaluated accurately, for example, some participants may not have visited a hospital for a comprehensive examination, and they may have provided unreliable answers when asked about comorbidities. Nevertheless, our study still provides a reference for the differences in cognitive impairment and risk factors among COPD patients in urban and rural areas.

Conclusion

In summary, the results of this study showed that the prevalence of MCI was significantly higher in rural areas than in urban areas, and the risk factors of MCI in rural and urban COPD patients were not completely the same in lifestyle and disease-related factors, especially in exercise, sleeping, shopping, and long-term home oxygen therapy. Medical staff should pay more attention to the daily activities and physical exercise for urban COPD patients, and the compliance of oxygen therapy for rural patients.

Ethical Approval

The study was approved by the Bioethics Committee of Qionglai Medical Center Hospital, China (NO,202203), and informed consent was obtained from all subjects involved in the study. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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The authors declare no conflict of interest, and the sponsors had no role in the design, execution, interpretation, or writing of the study.

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