



## Patient, family, and community factors associated with medication adherence among people with hypertension or diabetes: A cross-sectional analysis

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### ABSTRACT

**Background:** While suboptimal medication adherence remains an obstacle to the management of hypertension and diabetes in China, few studies have investigated associated factors with medication adherence on different dimensions simultaneously.

**Objective:** To systematically examine associated patient, family, and community factors with suboptimal medication adherence among people with hypertension and/or type 2 diabetes in China.

**Methods:** The study stratified a random sample of 622 adults aged 45 years or older with hypertension and/or type 2 diabetes from three southeast cities in China in 2019. Trained interviewers used the Morisky Green Levine Medication Adherence Scale, Self-Efficacy to Manage Chronic Disease (SEMCD) Scale, and the Family Adaptability, Partnership, Growth, Affection, and Resolve (APGAR) Scale to assess medication adherence, self-efficacy, and family function, respectively. Participants also reported their perceived satisfaction with community health services (quantity, quality, affordability, and overall acceptance). The study used the multivariable logistic regression to assess the association of patient, family, and community factors with suboptimal medication adherence.

**Results:** Among the participants, 42.9% reported suboptimal medication adherence. In the multivariable logistic regression model, male participants (odds ratio [OR] = 0.55,  $p = 0.001$ ) had higher medication adherence compared to females. Having a self-efficacy score that was lower than or equal to the sample mean was significantly associated with lower adherence (OR = 1.44,  $p = 0.039$ ). Participants unsatisfied with the affordability of community health services and medicine had lower adherence (OR = 2.18,  $p = 0.028$ ) than those neutral or satisfied. There were no significant associations between family function and medication adherence. **Conclusions:** Sex, self-efficacy, and perceived affordability of community health services were important factors associated with medication adherence. Healthcare professionals are recommended to consider multiple factors and leverage services and resources in community health centers when promoting medication adherence.

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## 1. Introduction

Suboptimal medication adherence, meaning the misalignment between patients' behaviors and healthcare professionals' recommendations for medication,<sup>1</sup> is a major reason for failures in hypertension and type 2 diabetes management.<sup>2,3</sup> The aging China witnessed an increased prevalence of hypertension from 18.8% in 2002 to 23.2% in 2012–2015 with a low blood pressure control proportion at 37.6%.<sup>4,5</sup> Facing the increased prevalence of type 2 diabetes from 10.9% in 2013 to 12.4% in 2018, 49.9% of people with diabetes failed to achieve adequate glycaemic control.<sup>6,7</sup> Since hypertension and diabetes are sometimes asymptomatic, people with hypertension and diabetes often trivialize medication adherence.<sup>8,9</sup> Medication adherence among people with hypertension and diabetes, therefore, remains suboptimal in China,<sup>10–13</sup> which leads to an elevated risk of cardiovascular diseases and higher economic costs.<sup>4,14–16</sup>

Previous studies have examined the determinants of medication adherence among Chinese patients with hypertension or type 2 diabetes. Sex, age, duration of illness, and drug regimens are common factors associated with adherence.<sup>10,11,17–20</sup> Self-efficacy may have an important influence on the management of chronic diseases as it influences patients' coping behaviors when patients face obstacles or negative experience in long-term self-disease management.<sup>21</sup> While higher social support has been related to better medication adherence,<sup>10,12,17</sup> most studies among Chinese patients reported overall patients' network support without specifically examining the special role of their family. A previous study in Nigeria showed that medication adherence were three times higher among patients with a functional family compared to those with a dysfunctional family.<sup>22</sup> Therefore, the influence of family function, defined as the family's ability to handle problems,<sup>23</sup> also deserves more studies in China.

Despite the substantial literature on medication adherence, few studies have investigated the association between community health services and medication adherence in China. In Chinese urban areas, community health centers deliver primary health services and are responsible for the management of both hypertension and diabetes, two main non-communicable chronic diseases (NCD).<sup>24,25</sup> The community health center is also an important source of medicine and offers guidance on medicine use, especially for residents aged over 60.<sup>24,26,27</sup> The lack of emphasis on community health services may miss an important resource of primary care in promoting medication adherence. The role of community health services in medication adherence among people with hypertension and diabetes, therefore, requires more examination.

The World Health Organization (WHO) emphasizes that support from family and community is necessary to help patients improve medication adherence.<sup>1</sup> The existing tendency to focus only on patient-related factors while overlooking family and community factors in medication adherence has overwhelmed patients and failed to provide patients with necessary support.<sup>1</sup> We are not aware of published studies simultaneously examining patient, family, and community factors related to medication adherence. To fill this gap, the study sets out to identify patient, family, and community factors associated with medication adherence among community residents with hypertension and/or type 2 diabetes in China based on residents' individual perceptions. The study provides a better understanding of the role of these multidimensional factors and contributes to intervention development for improving medication adherence and ultimately, patient health.

## 2. Methods

### 2.1. Study Design and Setting

This study is part of a larger longitudinal program to evaluate the influence of community factors in NCD management in urban Chinese communities.<sup>28</sup> As the first wave of data collection in this longitudinal program, a cross-sectional survey was conducted in 2019 in three

southeast cities in China: Shanghai, Kunshan, and Taicang. When choosing the communities, the program considered the community size and degree of urbanization to cover communities at different stages of economic developments. Finally, 12 communities (six from Kunshan, four from Taicang, and two from Shanghai) were selected for the survey.

### 2.2. Participants and Procedures

The survey randomly sampled participants living in each community based on the electronic record system in the community health centers. Inclusion criteria were (1) diagnosed with hypertension and/or type 2 diabetes by a health professional, (2) aged over 45 years, and (3) had lived in their communities for at least six months and expected to live in the same community for the next two years at baseline. The survey excluded participants with physical or intellectual disabilities or other interfering conditions that could affect the participants' capability to give consent and to participate in the survey, for example, people with Alzheimer's disease or people with amyotrophic lateral sclerosis that prevented them from leaving home. For participants who met the inclusion criteria, the survey conducted a stratified random sampling based on sex (male: female = 1:1) and disease diagnosis (hypertension: diabetes = 1:1). If one participant were diagnosed with both hypertension and diabetes, this participant would be included in the diabetes group.

Each participant gave their consent at enrollment. Trained research assistants used a structured questionnaire to collect information from consented participants. Demographic information included sex, age, education, marital status, and household size. When calculating household size, the analysis included both adults living with participants as well as participants themselves. As hypertension and diabetes are two main NCDs managed by community health centers, the interviewers asked the participants about their diagnosis with hypertension and/or type 2 diabetes, which was later recoded as NCD status, duration of NCD, and comorbidity as their clinical information. Although we counted participants with hypertension and diabetes in the diabetes group when calculating the patient ratio for disease diagnosis during enrolment, we decided to adopt a different grouping strategy in our analysis. When coding NCD status, we categorized participants into three mutually exclusive groups: participants with only hypertension, participants with only diabetes, and participants with both conditions. The different categorization was based on the consideration that participants with both hypertension and diabetes may face more burden in medication adherence compared to participants with only hypertension or only diabetes. For participants with both hypertension and type 2 diabetes, the survey collected the duration of both and took the longer one as duration of NCD.

### 2.3. Measurements

The study used the translated four-item Morisky Green Levine Scale (MGLS) to evaluate the participant's medication adherence.<sup>29,30</sup> The MGLS is in the public domain and has been widely used in studies to assess medication adherence.<sup>29,31</sup> The total score range is 0 to 4 where a higher score indicates higher medication adherence. The translated Chinese version MGLS has a Cronbach's  $\alpha$  of 0.749, showing high internal consistency and reliability.<sup>30</sup> Medication adherence was dichotomized into suboptimal and optimal medication adherence, where optimal medication adherence required a score of 4 ("complete adherence"). A score of 0 to 3 indicated suboptimal medication adherence.

The study used the Chinese version of the five-item Family Adaptability, Partnership, Growth, Affection, and Resolve (APGAR) Scale to measure family function.<sup>23,32</sup> The scale is in the public domain and has been widely used in other peer-reviewed studies.<sup>22,23,32</sup> The scale has high validity and reliability with a Cronbach's  $\alpha$  of 0.8 and a range of item correlation from 0.5 to 0.65.<sup>32</sup> For each question, participants can choose from "almost always", "some of the time", and "hardly ever". The

total score varies from 0 to 10, and a higher score indicates better family function. The analysis categorized the participant's family function into functional and dysfunctional, where a score of 7 and higher indicated a functional family.<sup>23</sup>

The six-item Self-Efficacy to Manage Chronic Disease (SEMCD) Scale was adopted to assess self-efficacy.<sup>33</sup> The SEMCD scale is freely available to researchers without additional requirement for permission.<sup>34</sup> The scale measures the confidence in performing self-management activities to promote health among patients with chronic diseases.<sup>33</sup> The score for the scale is the mean of the six items, and a higher score indicates higher self-efficacy, ranging from 1 to 10. The scale has a high internal consistency reliability of 0.91.<sup>33</sup> Taking the sample mean as a threshold, the analysis separated participants into two groups based on their self-efficacy score.

Based on current literature on community health services,<sup>24,26,27</sup> the survey asked participants to rate community health services in community health centers based on their individual perceptions by nine factors: (1) quantity of community health workers, (2) quantity of medicine and medical equipment, (3) quality of general service, (4) quality of NCD service, (5) convenience of service, (6) affordability of medicine/service, (7) acceptance of service, (8) quality and quantity of health education, and (9) community engagement for NCD management. For each factor, participants could choose from five options: "very unsatisfied", "unsatisfied", "neutral", "satisfied", and "very satisfied". The analysis categorized participants' responses into two levels: unsatisfied and neutral/satisfied.

#### 2.4. Data Analysis

To handle missing cases in participants' rating of community health services, the analysis used multiple imputation by chained equations (MICE) and created 25 datasets. MICE is suitable to impute categorical variables for a logistic model and has shown comparable results as multivariate normal distribution (MVN) in a simulation study.<sup>35</sup> Sex, marital status, age, household size, NCD status, duration of NCD, and comorbidity were auxiliary variables for imputation.

Descriptive analysis was used to summarize the patient, family, and community factors among the participants. Chi-squared test was used to test their associations with medication adherence. The analysis then used sex- and age-adjusted proportion of suboptimal medication adherence to evaluate the relationship between patient, family, and community factors and suboptimal medication adherence. For family and community variables, the survey collected the data based on residents' perceptions at the individual level. In other words, all variables were at the same level. Therefore, multivariable models instead of multilevel models were suitable for analysis on the association between patient, family, and community factors of interest with suboptimal medication adherence. The study also conducted a subgroup analysis by sex to see if the association between factors and medication adherence differed for males and females. A two-sided *p*-value of 0.05 or smaller was considered statistically significant in the analysis. Before multivariable models, we also conducted unadjusted logistic regression between each factor and suboptimal medication adherence (Appendix Table S1). To test the robustness of the results, the study presented the multivariable results in the Appendix Table S2 when including self-efficacy and family function as two continuous variables. The study also reported the multivariable results for complete case analysis in the Appendix Table S3. Statistical analysis was performed with STATA version 17.0 (STATA Corp, Texas, USA) and R version 4.2.2. (R Software Inc., California, USA).

### 3. Results

The study surveyed 710 participants in 2019. Two participants aged under 45 and 10 participants without either hypertension or diabetes were first excluded. Another 76 participants were excluded due to

missingness in their demographic and clinical information (*N* = 10), medication adherence (*N* = 40), family function (*N* = 25), and self-efficacy (*N* = 1). After excluding 88 participants, the final sample included 622 participants aged 45 or older, with hypertension and/or diabetes diagnosis, had lived in their communities for at least six months and expected to live in the same community for the next two years, and had complete data for analysis. The detailed process of sample selection is presented in Fig. 1.

Table 1 shows patient, family, and community factors by categories of medication adherence. Slightly less than half were males (49.0%), younger than 65 years old (48.7%), having an education level of primary school or less (48.9%). The mean of self-efficacy score was 7.96 with a standard deviation of 1.59, and 42.6% of the participants had a self-efficacy score that was lower than or equal to mean. The majority of the participants (87.5%) reported a functional family. The participants generally showed a positive attitude towards community health services but were less satisfied with community engagement for NCD management. There were 267 participants who reported suboptimal medication adherence, indicating the prevalence of suboptimal medication adherence to be 42.9%. Medication adherence was significantly associated with sex (*p* < 0.001), self-efficacy (*p* = 0.020), and perceived affordability of medicine/service (*p* = 0.004). The difference in medication adherence between participants with a functional family and those with a dysfunctional family, however, was not statistically significant (*p* = 0.538).

The sex- and age-adjusted proportion of suboptimal medication adherence are in Fig. 2. Compared to participants whose self-efficacy was lower than or equal to the mean, participants with higher self-efficacy were less likely to have suboptimal medication adherence, shown by a lower adjusted proportion of suboptimal adherence at 38.2% (95%CI = 33.2%–43.5%). A higher proportion of participants with dysfunctional family had suboptimal medication adherence (adjusted proportion = 46.4%, 95%CI = 35.5%–57.6%) compared to participants with functional family, but the difference was not statistically significant. Participants who perceived the affordability of medicine/service as neutral/satisfying rather than unsatisfying had a lower adjusted proportion of suboptimal medication adherence (adjusted proportion = 41.0%, 95%CI = 37.0%–45.2%).

In the multivariable logistic regressions for suboptimal medication adherence (Table 2), participants who reported self-efficacy that was lower than or equal to mean were more likely to have suboptimal medication adherence (OR = 1.44, 95%CI = 1.02–2.04, *p* = 0.039). While participants with dysfunctional family tended to report suboptimal medication adherence, the result was not significantly different from groups with functional family (OR = 1.04, 95%CI = 0.62–1.74, *p* = 0.892). Perceived service affordability was significantly associated with medication adherence: participants who were unsatisfied with the affordability of community health services and medicine had lower adherence (OR = 2.18, 95%CI = 1.09–4.36, *p* = 0.028). Other factors were not significantly associated with suboptimal medication adherence. (See Table 2.)

The results also found that male participants tended to have higher medication adherence compared to female participants (OR = 0.55, 95%CI = 0.39–0.77, *p* = 0.001; Table 2). Therefore, we conducted a subgroup analysis by sex. While both males and females who had lower self-efficacy reported lower medication adherence, such a correlation was only significant to males (OR = 1.74, 95%CI = 1.03–2.92; Table 3) but not females (OR = 1.21, 95%CI = 0.74–1.97). While females with dysfunctional family were more likely to have suboptimal adherence (OR = 1.41, 95%CI = 0.67–2.93), males with dysfunctional family reported higher adherence (OR = 0.80, 95%CI = 0.36–1.76). The correlation between family function and medication adherence, however, was nonsignificant for both sexes. Perceiving the affordability of community health services and medicine as unsatisfying was still associated with lower medication adherence for males (OR = 2.26, 95%CI = 0.97–7.29) and females (OR = 1.81, 95%CI = 0.67–4.90), but this

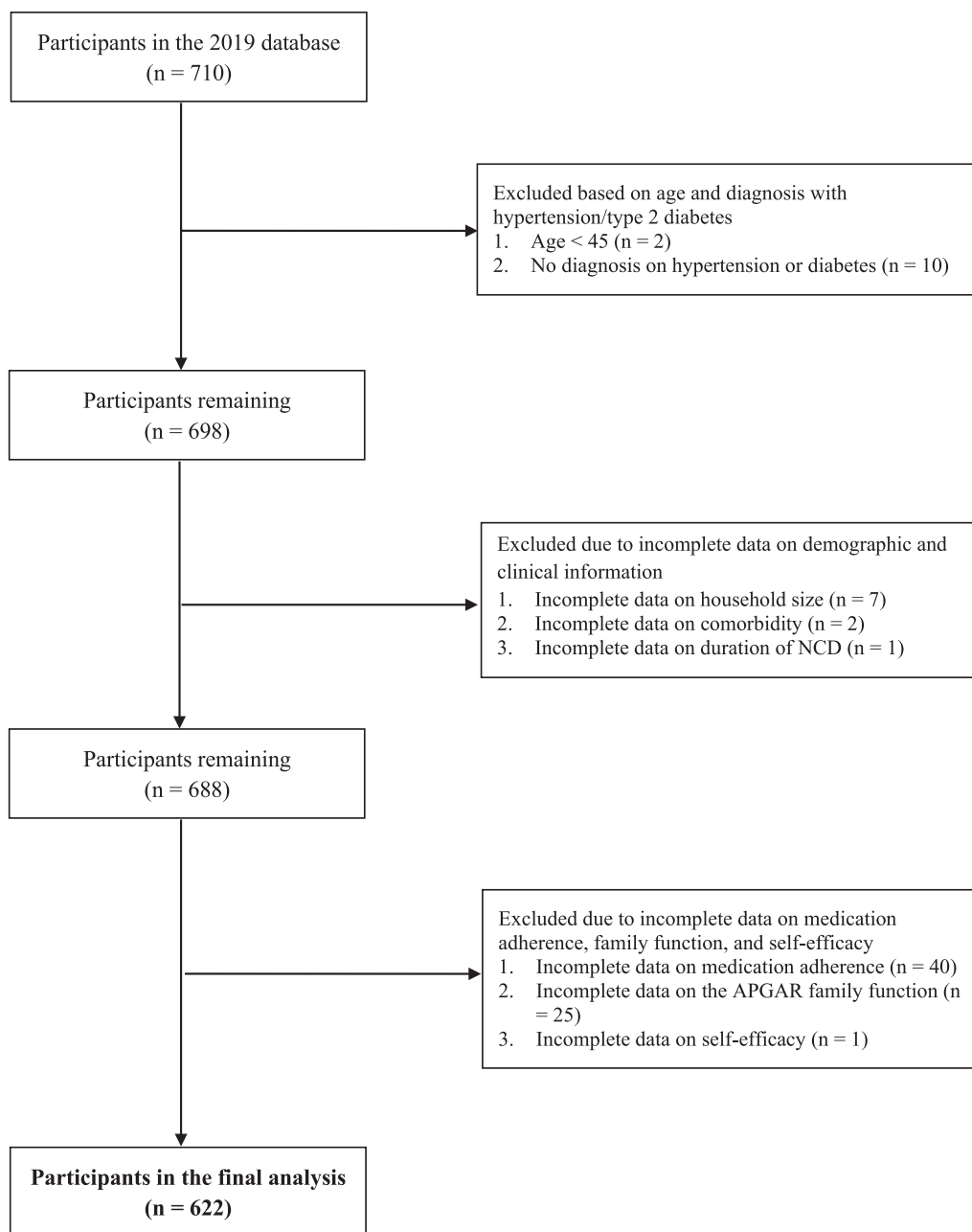


Fig. 1. Flow Chart of the Sample Selection Process.

association became nonsignificant in the subgroup analysis.

#### 4. Discussion

This study aimed to examine medication adherence and associated factors among people with hypertension and/or type 2 diabetes in Chinese urban communities. The results found that sex, self-efficacy, and perceived affordability of community health services and medicine were significantly associated with medication adherence. The study did not discover a significant association between family function and medication adherence. In the subgroup analysis, the association between self-efficacy and medication adherence was still significant to males but not females.

The suboptimal adherence prevalence of 42.9% in this study was similar to the results from previous studies among Chinese patients with hypertension or type 2 diabetes in urban areas, ranging from 34.9% to 51.4%.<sup>10,13,18,36</sup> Compared to a medication non-adherence percentage

of 79.7% among rural residents with hypertension in middle regions,<sup>17</sup> the lower medication non-adherence prevalence in this study may be explained by better economic development and health resources in eastern regions.<sup>37</sup> In the analysis, female participants were more likely to have suboptimal medication adherence, which is consistent with some previous studies.<sup>38,39</sup> The role of sex in medication adherence, however, still requires further examination as several studies reported that females have better adherence<sup>10,19</sup> while some found negligible effect of sex.<sup>12,17</sup> The subgroup analysis also suggested that sex may influence the relationship between other factors and medication adherence, calling for further studies.

Self-efficacy was significantly associated with medication adherence, which is congruent with previous studies in China.<sup>20,26,39–42</sup> The WHO also suggests that self-efficacy is an important patient-related factor associated with patients' belief and motivation for disease management, which influences long-term medication adherence.<sup>1</sup> The results suggested that future interventions should consider improving patient's self-

**Table 1**  
Description of Patient, Family, and Community Factors Among Participants with Hypertension and/or Type 2 Diabetes.

Group Characteristics	Total (N = 622)		Optimal Adherence <sup>1</sup> (N = 355)		Suboptimal Adherence <sup>1</sup> (N = 267)		P-value
<b>Patient Factors</b>							
<b>Sex, N (%)</b>							<0.001
Male	305	(49.0)	196	(55.2)	109	(40.8)	
Female	317	(51.0)	159	(44.8)	158	(59.2)	
<b>Age, N (%)</b>							0.421
45–54	75	(12.1)	38	(10.7)	37	(13.9)	
55–64	228	(36.7)	129	(36.3)	99	(37.1)	
≥ 65	319	(51.3)	188	(53.0)	131	(49.1)	
<b>Education, N (%)</b>							0.060
Primary school or less	304	(48.9)	164	(46.2)	140	(52.4)	
Junior school	196	(31.5)	110	(31.0)	86	(32.2)	
Senior school or higher	122	(19.6)	81	(22.8)	41	(15.4)	
<b>Marital status, N (%)</b>							0.647
Married	572	(92.0)	328	(92.4)	244	(91.4)	
Single/Widowed/Separated/Divorce	50	(8.0)	27	(7.6)	23	(8.6)	
<b>NCD Status<sup>2</sup>, N (%)</b>							0.321
Hypertension	266	(42.8)	161	(45.4)	105	(39.3)	
Diabetes	91	(14.6)	50	(14.1)	41	(15.4)	
Both	265	(42.6)	144	(40.6)	121	(45.3)	
<b>Duration of NCD<sup>3</sup>, N (%)</b>							0.255
< 10 Years	268	(43.1)	146	(41.1)	122	(45.7)	
≥ 10 Years	354	(56.9)	209	(58.9)	145	(54.3)	
<b>Comorbidities<sup>4</sup>, N (%)</b>							0.119
No comorbidity	376	(60.5)	224	(63.1)	152	(56.9)	
Have comorbidities	246	(39.5)	131	(36.9)	115	(43.1)	
<b>Self-efficacy<sup>6</sup>, N (%)</b>							0.020
Lower than or equal to mean	265	(42.6)	137	(38.6)	128	(47.9)	
Higher than mean	357	(57.4)	218	(61.4)	139	(52.1)	
<b>Family Factors</b>							
<b>Household Size, N (%)</b>							0.130
1–2 adults	278	(44.7)	171	(48.2)	107	(40.1)	
3–4 adults	234	(37.6)	126	(35.5)	108	(40.4)	
Over 4 adults	110	(17.7)	58	(16.3)	52	(19.5)	
<b>Family Function<sup>5</sup>, N (%)</b>							0.538
Functional	544	(87.5)	313	(88.2)	231	(86.5)	
Dysfunctional	78	(12.5)	42	(11.8)	36	(13.5)	
<b>Community Factors</b>							
<b>Quantity of Community Health Workers, N (%)</b>							0.380
Neutral/Satisfied	534	(86.0)	301	(84.8)	233	(87.3)	
Unsatisfied	88	(14.0)	54	(15.2)	34	(12.7)	
<b>Quantity of Medicine and Medical Equipment, N (%)</b>							0.962
Neutral/Satisfied	540	(86.8)	308	(86.8)	232	(86.9)	
Unsatisfied	82	(13.2)	47	(13.2)	35	(13.1)	
<b>Quality of General Service, N (%)</b>							0.405
Neutral/Satisfied	619	(99.5)	354	(99.7)	265	(99.3)	
Unsatisfied	3	(0.5)	1	(0.3)	2	(0.7)	
<b>Quality of NCD Service, N (%)</b>							0.193
Neutral/Satisfied	580	(93.6)	327	(92.1)	253	(94.8)	
Unsatisfied	42	(6.4)	28	(7.9)	14	(5.2)	
<b>Convenience of Service, N (%)</b>							0.119
Neutral/Satisfied	600	(96.5)	346	(97.5)	254	(95.1)	
Unsatisfied	22	(3.5)	9	(2.5)	13	(4.9)	
<b>Affordability of Medicine/Service, N (%)</b>							0.004
Neutral/Satisfied	574	(92.3)	337	(94.9)	237	(88.8)	
Unsatisfied	48	(7.7)	18	(5.1)	30	(11.2)	
<b>Acceptance of Service, N (%)</b>							0.840
Neutral/Satisfied	620	(99.7)	354	(99.7)	266	(99.6)	
Unsatisfied	2	(0.3)	1	(0.3)	1	(0.6)	
<b>Quality and Quantity of Health Education, N (%)</b>							0.332
Neutral/Satisfied	516	(82.8)	290	(81.7)	226	(84.6)	
Unsatisfied	106	(17.2)	65	(18.3)	41	(15.4)	
<b>Community Engagement for NCD Management, N (%)</b>							0.458
Neutral/Satisfied	420	(67.5)	244	(68.7)	176	(65.9)	
Unsatisfied	202	(32.5)	111	(31.3)	91	(34.1)	

<sup>1</sup> Medication adherence was assessed by MGLS, ranging from 0 to 4. A score of 4 was considered as optimal adherence.<sup>2</sup> NCD status described participants' diagnosis with hypertension and/or diabetes.<sup>3</sup> Duration of NCD described duration of hypertension or diabetes. For participants with both hypertension and diabetes, duration of NCD described duration of the disease whose onset was earlier.<sup>4</sup> Comorbidities described whether patients reported to have other diseases besides hypertension or diabetes, for example, chronic kidney disease and arthritis.<sup>5</sup> Family function was assessed by APGAR scale, ranging from 0 to 10. A score of 7 or higher was considered as having a functional family.

<sup>6</sup> Self-efficacy score was assessed by SEMCD, ranging from 1 to 10. Participants were separated into two groups based the sample mean. The sample mean of self-efficacy score was 7.96 with a standard deviation of 1.59.

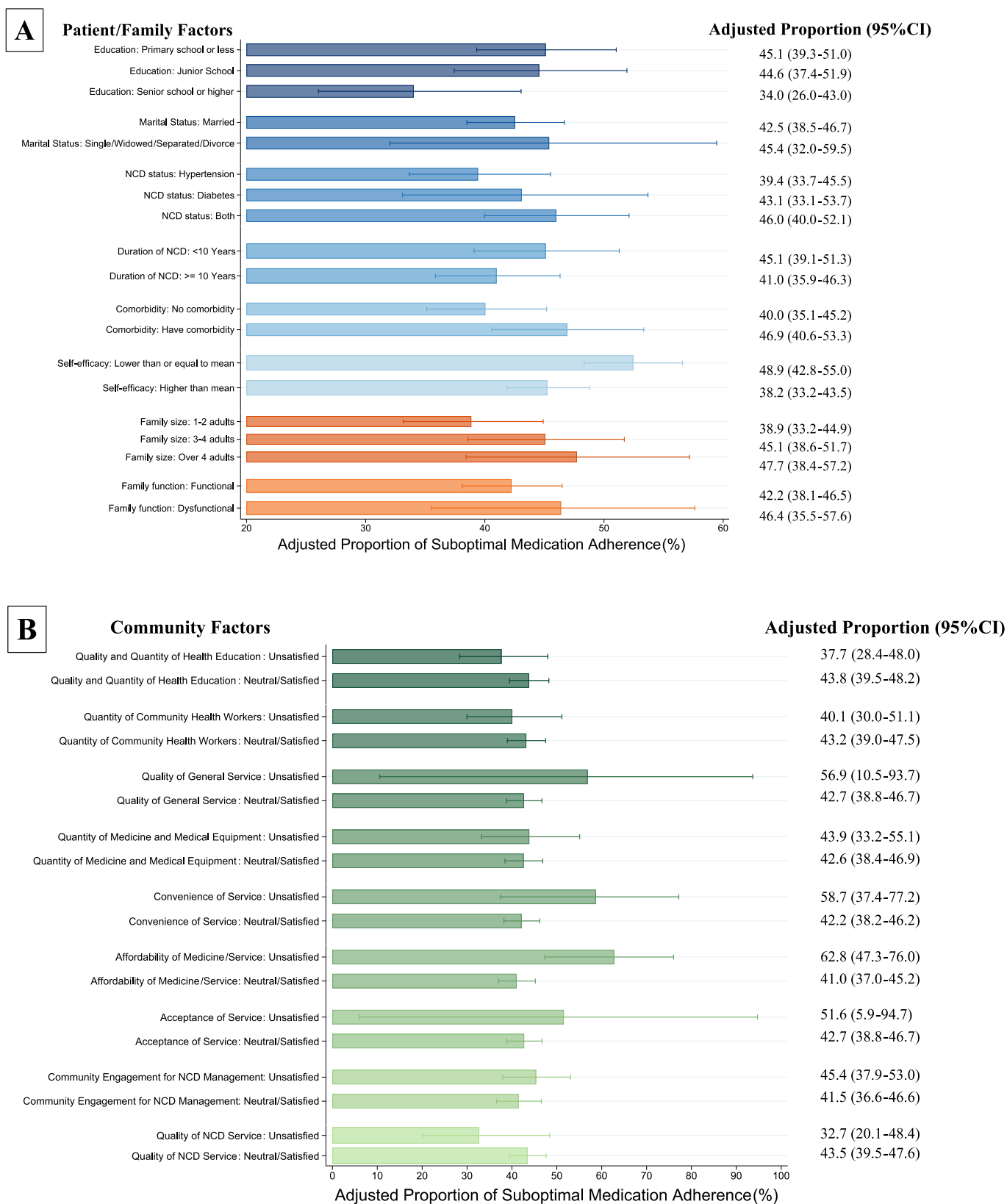


Fig. 2. Sex- and Age-adjusted Proportion of Suboptimal Medication Adherence (with 95% CI).



**Table 2**  
Multivariable Logistic Regression for Suboptimal Medication Adherence (N = 622).

Variables	Odds Ratio	95% CI	P-value
<b>Patient factors</b>			
<b>Sex</b>			
Male	0.55	0.39–0.77	<b>0.001</b>
Female	Reference		
<b>Age</b>			
45–54	1.38	0.78–2.44	0.272
55–64	1.11	0.75–1.65	0.609
≥ 65	Reference		
<b>Education</b>			
Primary school or less	Reference		
Junior school	1.10	0.73–1.65	0.656
Senior school or higher	0.66	0.41–1.07	0.092
<b>NCD Status<sup>1</sup></b>			
Hypertension	Reference		
Diabetes	1.13	0.68–1.89	0.642
Both	1.30	0.90–1.90	0.164
<b>Duration of NCD<sup>2</sup></b>			
< 10 Years	1.31	0.91–1.90	0.153
≥ 10 Years	Reference		
<b>Comorbidities<sup>3</sup></b>			
No comorbidity	Reference		
Have comorbidities	1.27	0.89–1.80	0.187
<b>Self-efficacy<sup>4</sup></b>			
Lower than or equal to mean	1.44	1.02–2.04	<b>0.039</b>
Higher than mean	Reference		
<b>Family factors</b>			
<b>Household Size</b>			
1–2 adults	Reference		
3–4 adults	1.27	0.86–1.86	0.226
Over 4 adults	1.37	0.86–2.20	0.189
<b>Family Function<sup>5</sup></b>			
Functional	Reference		
Dysfunctional	1.04	0.62–1.74	0.892
<b>Community factors</b>			
<b>Affordability of Medicine/Service</b>			
Neutral/Satisfied	Reference		
Unsatisfied	2.18	1.09–4.36	<b>0.028</b>
<b>Quality of NCD Service</b>			
Neutral/Satisfied	Reference		
Unsatisfied	0.61	0.30–1.24	0.171
<b>Convenience of Service</b>			
Neutral/Satisfied	Reference		
Unsatisfied	1.50	0.58–3.92	0.403

<sup>1</sup> NCD status described participants' diagnosis with hypertension and/or diabetes.

<sup>2</sup> Duration of NCD described duration of hypertension or diabetes. For participants with both hypertension and diabetes, duration of NCD described duration of the disease whose onset was earlier.

<sup>3</sup> Comorbidities described whether patients reported to have other diseases besides hypertension or diabetes, for example, chronic kidney disease and arthritis.

<sup>4</sup> Self-efficacy was assessed by SEMCD, ranging from 1 to 10. Participants were separated into two groups based the sample mean. The sample mean of self-efficacy score was 7.96 with a standard deviation of 1.59.

<sup>5</sup> Family function was assessed by APGAR scale, ranging from 0 to 10. A score of 7 or higher was considered as having a functional family.

efficacy in long-term medication adherence for chronic diseases. One possible approach is to reinforce patient's confidence and efficacy on disease management in the early stage of medication, as early experience is important to establish self-efficacy.<sup>43</sup> The subgroup analysis also indicated that future interventions should consider the role of sex in the association between self-efficacy and medication adherence.

Family function was not significantly associated with medication adherence, which is inconsistent with the existing literature on the role of family in medication adherence.<sup>12,22,40,44</sup> Three reasons may explain this result. First, patients may be hesitant to share their disease

**Table 3**  
Subgroup Analysis on Suboptimal Medication Adherence by Sex.

Variables	Odds Ratio (95% CI)	
	Male (N = 305)	Female (N = 317)
<b>Patient factors</b>		
<b>Age</b>		
45–54	1.45 (0.63–3.33)	1.39 (0.61–3.14)
55–64	1.08 (0.60–1.94)	1.11 (0.64–1.93)
≥ 65	Reference	Reference
<b>Education</b>		
Primary school or less	Reference	Reference
Junior school	0.90 (0.50–1.61)	1.35 (0.75–2.46)
Senior school or higher	0.62 (0.30–1.28)	0.70 (0.36–1.34)
<b>NCD Status<sup>1</sup></b>		
Hypertension	Reference	Reference
Diabetes	0.68 (0.29–1.60)	1.70 (0.85–3.37)
Both	1.13 (0.66–1.95)	1.55 (0.91–2.63)
<b>Duration of NCD<sup>2</sup></b>		
< 10 Years	1.26 (0.73–2.17)	1.38 (0.83–2.30)
≥ 10 Years	Reference	Reference
<b>Comorbidities<sup>3</sup></b>		
No comorbidity	Reference	Reference
Have comorbidities	1.27 (0.75–2.16)	1.25 (0.77–2.03)
<b>Self-efficacy<sup>4</sup></b>		
Lower than or equal to mean	<b>1.74 (1.03–2.92)</b>	1.21 (0.74–1.97)
Higher than mean	Reference	Reference
<b>Family factors</b>		
<b>Household Size</b>		
1–2 adults	Reference	Reference
3–4 adults	1.52 (0.85–2.71)	1.11 (0.66–1.88)
Over 4 adults	1.35 (0.68–2.66)	1.45 (0.73–2.89)
<b>Family Function<sup>5</sup></b>		
Functional	Reference	Reference
Dysfunctional	0.80 (0.36–1.76)	1.41 (0.67–2.93)
<b>Community factors</b>		
<b>Affordability of Medicine/Service</b>		
Neutral/Satisfied	Reference	Reference
Unsatisfied	2.26 (0.97–7.29)	1.81 (0.67–4.90)
<b>Quality of NCD Service</b>		
Neutral/Satisfied	Reference	Reference
Unsatisfied	0.36 (0.09–1.42)	0.78 (0.32–1.89)
<b>Convenience of Service</b>		
Neutral/Satisfied	Reference	Reference
Unsatisfied	1.64 (0.33–8.27)	1.45 (0.43–4.92)

<sup>1</sup> NCD status described participants' diagnosis with hypertension and/or diabetes.

<sup>2</sup> Duration of NCD described duration of hypertension or diabetes. For participants with both hypertension and diabetes, duration of NCD described duration of the disease whose onset was earlier.

<sup>3</sup> Comorbidities described whether patients reported to have other diseases besides hypertension or diabetes, for example, chronic kidney disease and arthritis.

<sup>4</sup> Self-efficacy was assessed by SEMCD, ranging from 1 to 10. Participants were separated into two groups based the sample mean. The sample mean of self-efficacy score was 7.96 with a standard deviation of 1.59.

<sup>5</sup> Family function was assessed by APGAR scale, ranging from 0 to 10. A score of 7 or higher was considered as having a functional family.

conditions with their family, leading to the lack of family participation in patients' disease management. A previous study of diabetes management in Denmark showed that some patients chose to hide or pretend their health status to promote family cohesion.<sup>9</sup> They also considered disease management as their sole responsibility and did not want to bother their family.<sup>9</sup> Similarly, Chinese patients sometimes hide their health problems due to concerns over causing possible inconvenience to their family,<sup>39</sup> which may lead to family disengagement in disease management. Second, family support could diminish with the time after diagnosis increased. Family members were usually involved in disease management when patients were first diagnosed with chronic diseases. However, as the family members and the patients adapt to the life with

NCD, they may discuss less about the diseases and patients might perceive fewer expression of supports from their family.<sup>9</sup> Moreover, a mixed-method study of medication adherence in Kenya suggested that the lack of health literacy among family members may hinder the translation of family support into better hypertension management.<sup>45</sup> Therefore, the nonsignificant association with family function may indicate missing family involvement and limited health literacy in disease management among patients with hypertension and type 2 diabetes in China. Future interventions should encourage family involvement and consider enhancing the health literacy of both patients and family members to improve medication adherence. More studies are also needed to further explore the association between family involvement and medication adherence among Chinese NCD patients in the urban areas, given that the study had a null outcome for family function.

Residents who were unsatisfied with the affordability of community health services and medicine in community health centers tended to have lower medication adherence, compared to those who were neutral or satisfied with the affordability. This echoes former findings about the influence of medical cost on medication adherence.<sup>15,46</sup> The examination of community health services filled the research gap about community health services on medication adherence. This examination points towards the emphasis on strengthening community health centers to deliver primary care and to improve NCD management.<sup>47</sup> Since the analysis tested multiple factors, we could not rule out the possibility that the significant difference between optimal and suboptimal groups was due to multiple comparisons. Future research is warranted to verify the association between perceived service affordability in community health centers and medication adherence.

The public views community health centers as an important source of drug dispensing and hypertension and diabetes management.<sup>24</sup> In one study on the utilization of community health centers, 56% of participants visited community health centers to refill medication and 65% sought professional advice.<sup>24</sup> Community health centers, therefore, can deliver community-oriented interventions and improve medication adherence through health education and services. Compared to other participants, residents with chronic diseases or older age tended to utilize community health services more frequently.<sup>24,27</sup> Former studies have reported that despite community residents' satisfaction with the convenience of community health centers and community workers' attitudes, they showed disappointment about the cost of community health services, especially the medicine price.<sup>25,27</sup> Thus, community health centers can promote medication adherence through professional health education and working with the government for price management, especially among elderly patients with chronic diseases as they were more likely to depend on community health services.<sup>24,27</sup>

The study also has several limitations. As the participants came from the urban areas in eastern cities and the sample size was not large, especially in the subsequent subgroup analysis, the conclusions have limited generalizability to other areas with different resources or even service delivery models.<sup>25,47</sup> In addition, the study was a cross-sectional survey. Therefore, it is associational and has limited value in causal inference. As the research team conducted face-to-face interviews to collect data, social desirability bias and recall bias may have led to an overestimation of medication adherence among the sample. To mitigate the biases, the team trained the interviewers to ask questions impartially and to avoid any judgment during the interview.

## 5. Conclusion

This study found a suboptimal medication adherence prevalence of 42.9% among people with hypertension and/or type 2 diabetes in China. Female participants had lower medication adherence, while participants with higher self-efficacy tended to report higher adherence. Participants who perceived service affordability as unsatisfactory had lower adherence compared to residents who reported they were neutral or satisfied with service affordability. While most participants accepted community

health services, community engagement for NCD management in community health centers was less satisfying and required more attention. Community-oriented interventions and increased communication between patients and community health workers can maximize the accessibility of community resources to patients and optimize the health outcome. The relationship between health system-related factors and medication adherence is currently understudied. More studies are needed to fill this research gap and shed light on future NCD management.

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## Ethical considerations

This project was approved by the Institutional Review Board of Duke Kunshan University (2019YANL013). We confirm that all patient/personal identifiers have been removed or disguised so the patient/person (s) described are not identifiable and cannot be identified through the details of the story. Each patient gave their consent before enrolling in the study.

## CRediT authorship contribution statement

**You Wu:** Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Shangzhi Xiong:** Writing – review & editing, Supervision, Project administration, Investigation, Conceptualization. **Gangjiao Zhu:** Writing – review & editing, Validation, Investigation, Data curation, Conceptualization. **Xinyue Chen:** Writing – review & editing, Investigation. **Mingyang Zhang:** Writing – review & editing, Investigation. **Enying Gong:** Writing – review & editing, Supervision, Conceptualization. **Chong Li:** Writing – review & editing, Funding acquisition. **Peng Jia:** Writing – review & editing. **Truls Østbye:** Writing – review & editing, Supervision, Conceptualization. **Lijing L. Yan:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.rcsop.2024.100482>.

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