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Determinants of Inappropriate Admission of Elderly People in County-Level Hospitals: A Cross-Sectional Study in Rural China

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1 **Determinants of Inappropriate Admission of Elderly People in**
 2 **County-Level Hospitals: A Cross-Sectional Study in the Rural China**

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26 **Abstract**

27 **Objective** The purpose of this paper is to investigate the characteristics and
28 determinants of inappropriate admission to hospital of elderly people in rural China.

29 **Design** A cross-sectional study was conducted, wherein a comparison between elderly
30 and non-elderly groups was conducted.

31 **Setting** The survey was conducted on the largest county-level general hospitals in
32 four counties in central and western China.

33 **Participants** A total of 652 rural patients admitted in hospitals were surveyed, of
34 which 230 were elderly patients who were over 60 years old and 422 non-elderly
35 patients who were under 60 years old.

36 **Primary measures** The Chinese version of the appropriateness evaluation protocol
37 was used to evaluate the inappropriate admission rates. The interactive regression
38 models based on the relationship of age (elderly and non-elderly) with other factors
39 and binary logistic regression models were used in the analysis of the specific factors
40 and determinants of the inappropriate admission of elderly people.

41 **Result** The inappropriate admission rate for rural elderly was 30%, which was lower
42 than that of non-elderly people (40.8%). Compared with the non-elderly group,

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4 43 women in the elderly group (OR=0.33) had a lower incidence of inappropriate
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6 44 admission, and elderly people with chronic diseases (OR=3.33) were more prone to
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8 45 inappropriately admitted than non-elderly people with chronic diseases. The binary
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10 46 logistic regression analysis shows that county, gender (OR=0.49), age (OR=0.94),
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12 47 department and response to doctor's admission request are the determinants of the
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14 48 inappropriate admission of elderly patients.

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18 49 **Conclusion** The inappropriate admission rate of elderly people in this study is higher
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20 50 than that reported by other studies. We found that gender and chronic disease are the
21
22 51 specific factors that are specific to non-elderly people. County, gender, age,
23
24 52 department and response to a doctor's admission request have substantial influence on
25
26 53 the inappropriate admission of elderly in rural China.

54 **Strengths and limitation of this study**

- 55 1. To the best of our knowledge, this is the first in-depth study of the inappropriate
56 admission of elderly people in rural areas in China.
- 57 2. The inclusion of non-elderly people for comparative analysis emphasised the
58 specificity of the inappropriate hospital admission of elderly people.
- 59 3. In the search for determinants of inappropriate admission to the elderly, social
60 demographics, objective admission status and subjective cognitive status were all
61 included.
- 62 4. This cross-sectional study design cannot determine the causal relationship
63 between the inappropriate hospital admission of elderly people and related factors.

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4 64 5. The appropriateness evaluation protocol applicable to the entire population may
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6 65 not be the best tool for evaluating the inappropriate admission of elderly people.
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66 **Introduction**

67 Aging is a severe challenge facing the Chinese society today. At the end of 2017,
68 China's elderly population aged 60 years and above was 241 million, accounting for
69 17.3% of the total population ^[1]. In recent years, the utilization of health services for
70 rural elderly population in China has increased sharply. The rate of hospitalization for
71 the elderly has increased from 12.7% in 2003 to 21.5% in 2013 ^[2]. The high
72 hospitalization rate of the elderly in rural areas suggests the inappropriate use of
73 elderly hospitalization services ^[3], and the inappropriate admission rate of people over
74 60 years in rural areas in China has reached 23.2% ^[4]. The rationality of the elderly's
75 health demand has become a major concern in the supply of health services in China.
76 Inappropriate admission refers to the unnecessary hospitalization of patients ^[5,6],
77 which is one of the main forms of excessive demand for hospitalization services ^[7].
78 Some special national conditions in China determine that the reason for the
79 inappropriate admission of elderly people in rural areas in China differs from that in
80 other countries. On the one hand, primary health care is backward in rural areas in
81 China, especially family doctor system, which remains far from perfect. Hence,
82 patients lack the correct guidance for their first visit. The cognitive levels of elderly
83 patients age decrease with age ^[8]. This condition makes them prone to cognitive
84 deviation and affects the rationality of their hospitalization behaviours. On the other

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3 85 hand, China's institutional endowment system remains imperfect, and hospitalization
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6 86 services have become the main sources of nursing services for the elderly. Elderly
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8 87 people frequently suffer from chronic diseases and poor health, and thus urgently
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11 88 require nursing services^[9]. The appropriateness of hospitalization behaviour for the
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14 89 purpose of obtaining nursing services is also affected.
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16 90 In recent years, the Chinese government has adopted various reform measures that are
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18 91 aimed at guiding patients seeking correct medical care; these measures include the
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21 92 implementation of basic medical insurance payment reform^[10], hierarchical medical
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24 93 system and family doctor contracted services. However, inappropriate inpatient
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26 94 service utilization for the elderly remains a problem in rural areas in China. The main
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28 95 reason is that the determinants of the inappropriate admission of elderly people to
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31 96 hospitals in these areas have not been clearly defined.
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33 97 Inappropriate admission not only wastes health resources but also further increases the
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36 98 economic burden of the elderly in rural areas. It also increases the risk of
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38 99 hospital-acquired infections in elderly people, thereby compromising patient safety
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41 100 and health^[11,12]. Therefore, identifying the determinants of inappropriate
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44 101 hospitalization is a useful approach for the formulation of targeted interventions that
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46 102 can reduce inappropriate hospital admission rates and improve the efficiencies and
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48 103 qualities of hospitalization services.
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51 104 The international study on the inappropriate admission of the elderly is mainly
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54 105 focused on the evaluation of the rate, characteristics and impact factors of
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56 106 inappropriate admission in hospitals. Influencing factors are mainly considered from

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3 107 the perspective of individual characteristics and supplier side. The analysis of
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6 108 individual characteristics generally focuses on diseases and severity of illness in
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8 109 hospitalised elderly patients. Gamper et al. ^[13] found that elderly people with chronic
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11 110 diseases are more likely to be inappropriately admitted. Menand et al. ^[14] found that
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13 111 the severity of illness and mention of a cardiac disease are associated with the
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16 112 inappropriate admission of people aged 80 years. The analysis of influencing factors
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18 113 from the supplier side mainly focuses on the decision-making of medical service
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21 114 providers and primary health care. Aida et al. ^[15] showed that the inappropriate
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23 115 admission of elderly people over 65 years old in southern Italy is mainly influenced
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26 116 by conservative admission treatment decision, which is made by doctors or hospital
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28 117 managers to avoid the risk of medical accidents. Mytton et al. ^[16] found that, in the
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31 118 United Kingdom, the inappropriate admission of elderly people to the emergency
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33 119 departments of hospitals depends on the quality of doctor admission decisions and the
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36 120 capacities of community health services.

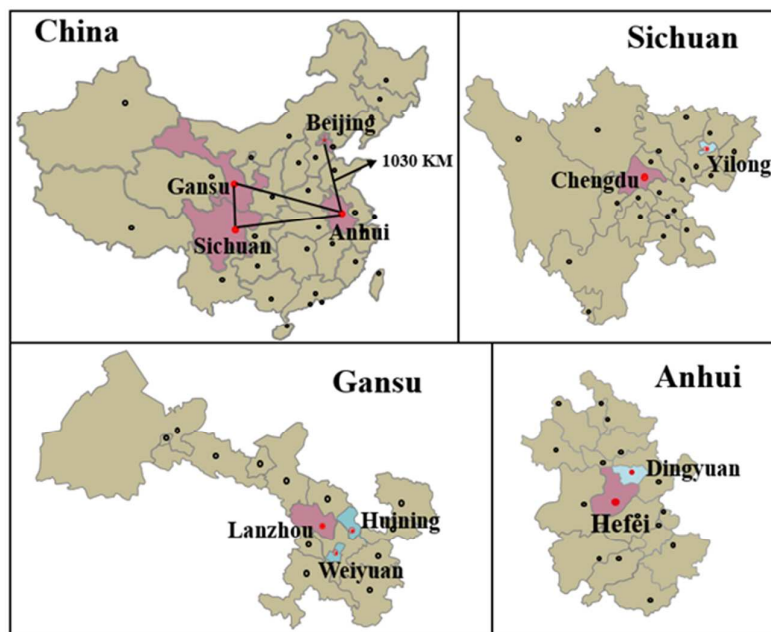
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38 121 The perceptions of elderly people about diseases, hospitalization cost, compliance
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41 122 with doctors' admission requirements and other aspects are rarely included in the
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43 123 analysis of influencing factors, and the comprehensive consideration of both supply
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46 124 and demand factors are often undermined in most studies. Presently, although the
47
48 125 inappropriate admission of the elderly in rural areas in China has been studied ^[4], the
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51 126 analysis only covered the descriptive analysis phase, and the effect of the factors
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53 127 remains unclear. Thus, the factors affecting the inappropriate admission of elderly in
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56 128 rural areas in China should be further discussed. Based on China's special national

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3 129 conditions, we assume that the subjective perception bias of the elderly is the key
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6 130 factor of their inappropriate admission. Therefore, by identifying the rate of
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9 131 inappropriate admission of rural elderly in China, we studied the determinants of
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11 132 inappropriate admission of elderly people.
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13 133 This study aims to identify the determinants of inappropriate admission of elderly
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15 134 people to hospitals in the rural areas of China from the perspective of supply and
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18 135 demand and to provide targeted strategies for the intervention and control of the
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21 136 hospitalization behaviours of elderly people.
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24 137 **Methods**

25 26 27 138 **Setting and participants**

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29 139 This cross-sectional study was conducted in 2017, and cluster random sampling was
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31 140 adopted. Four counties in central and western China, namely, Dingyuan in Anhui
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33 141 Province, Huining and Weiyuan in Gansu Province and Yilong in Sichuan Province,
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35
36 142 were selected as sample counties (Fig. 1). The counties in eastern China were not
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38
39 143 included because most counties are shifting to the urban district level through rapid
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41 144 economic and social development. The largest county-level general hospital in each
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43 145 county was surveyed, and the respondents were hospitalised patients in rural
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46 146 households who were grouped into the elderly group (aged 60 years and older) and
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49 147 non-elderly groups (under 60 years old).
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[Figure 1]

150 We believe that the differentiated compensation for the New Rural Cooperative
 151 Medical System (NRCMS) in different regions may have an influence on the
 152 inappropriate admission of elderly people to hospitals. All participants are covered by
 153 NRCMS, and the reimbursement policies in the four counties were similar,
 154 particularly those regarding the reimbursement of outpatient and inpatient. The
 155 NRCMS reimbursement policies in the survey areas are shown in Table 1.

156 **Table 1** NRCMS reimbursement policies in the survey areas in 2017

County	R ₀		R ₁						APL(RMB)
	township hospitals		township hospitals			county hospitals			
	RR	APL(RMB)	Deductible	RR	PL(RMB)	Deductible	RR	PL(RMB)	
Yilong	60%	120	100	90%	-	400	75%	-	180000
Huining	60%	300	150	90%	3000	500	85%	20000	80000
Dingyuan	45%	150	150	90%	-	620	85%	-	200000
Weiyuan	90%	110	150	80%	3000	500	70%	15000	80000

157 Note: R₀, Reimbursement of Outpatient; R₁, Reimbursement of Inpatient.

158 RR, Reimbursement ratio; APL, Annual payment limitation; PL, payment limitation of each time.

157

158 **Sampling and data collection**

159 For the calculation of sample size, it is estimated that the inappropriate admission rate
160 P of in rural areas is 25%, the absolute tolerance $\delta=0.035$ and the confidence level is
161 95% ($\alpha=0.05$):

$$162 N = Z_{\alpha/2}^2 \times P(1 - P) / \delta^2 = 1.96^2 \times 0.25 \times (1 - 0.25) / 0.035^2 = 588$$

163 Through a cluster sampling method, 170 rural patients in each county hospital were
164 randomly selected. The responses were obtained through the use of questionnaire
165 surveys, and their medical records were collected after they were discharged. To
166 ensure the integrity of the data for each indicator, we excluded the unqualified sample
167 records. Of the 680 records collected, 652 valid records were finally retained,
168 including 230 for the elderly and 422 for the non-elderly.

169 **Measurement**

170 With the consent of the hospital and the patients, a structured questionnaire survey
171 was used, which included inquiries about demographic characteristics and subjective
172 cognitive indicators. Their medical records were extracted for the collection of
173 objective admission statuses and evaluation of the appropriateness of admission.

174 **Records appropriateness evaluation**

175 The appropriateness evaluation protocol (AEP)^[17] is widely used in the evaluation of
176 the appropriateness of admission. Yingchun^[18] developed an identification tool,
177 R-AEP, that is suitable for the appropriateness of admission to hospitals operating in
178 rural areas in China. The tool is based on the existing international AEP and provides
179 a methodological basis of evaluation.

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4 180 The R-AEP criteria were used in the evaluation of the appropriateness of admission in
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6 181 652 cases. The evaluation was performed by professionally trained personnel. The
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8 182 R-AEP criteria are based on the value of the medical record. Therefore, all R-AEP
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11 183 related indicators were extracted, and their actual values were compared with standard
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13 184 values. The record for indicator actual values that match with the standard value was
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16 185 considered appropriate. Medical records with all relevant values that did not meet the
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18 186 AEP criteria were considered as inappropriate admission.

187 **Variables**

188 The outcome variable was the appropriateness of admission to the hospital, with
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24 188 The outcome variable was the appropriateness of admission to the hospital, with
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26 189 appropriate admission = 0 and inappropriate admission = 1.

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28 190 The independent variables mainly include demographic characteristics (e.g., county,
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31 191 gender and age), subjective cognitive status (e.g., response to doctor's admission
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33 192 request (RTDAR), disease severity, affordability to hospitalization costs, comparison
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35
36 193 of inpatient and outpatient reimbursement(CORR) and hospitalization convenience)
37
38 194 and objective admission status (e.g., department, disease, health status and diagnosis
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40
41 195 of chronic diseases (DOCD))

196 **Statistics analysis**

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46 197 The demographic characteristics, subjective cognitive status and objective admission
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48 198 status were processed via Epidata 3.2. Diseases were categorised using the
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51 199 International Classification of Diseases 10th revision (ICD-10).

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53 200 IBM SPSS Statistics 22.0 was used for statistical analysis. The *t* test and Person's
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55
56 201 chi-square test were used in the analysis of the distribution characteristics of

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4 202 inappropriate admission of the elderly. For the 652 respondents, the interactive
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6 203 logistic regression model based on the relationship of age (elderly and non-elderly)
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9 204 with other factors was adopted for the analysis of the specific factors affecting the
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11 205 inappropriate admission of elderly people in comparison with those affecting the
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13 206 inappropriate admission of non-elderly people. Taking the appropriateness of
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16 207 admission as the dependent variable, we directly included the main effect of the
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18 208 independent variable to the regression model, and the interaction effect was screened
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21 209 into the model by stepwise regression. Finally, the model was formed.

$$\begin{aligned}
 \text{Logit}(P) = & \beta_0 + \beta_1 \text{County} + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Disease} + \beta_5 \text{Department} + \beta_6 \text{DOCD} \\
 & + \beta_7 \text{Health status} + \beta_8 \text{RTDAR} + \beta_9 \text{Severity} + \beta_{10} \text{CORR} + \beta_{11} \text{Affordability} \\
 & + \beta_{12} \text{Hospitalization convenience} + \beta_{13} \text{Age} \times \text{Gender} + \beta_{14} \text{Age} \times \text{DOCD} + \varepsilon
 \end{aligned}$$

210 For 230 elderly respondents, binary logistic regression analysis was used for the
211 identification of the determinants of the inappropriate admission of the elderly. The
212 patient admission rationality was the dependent variable, and the independent variable
213 was selected using the stepwise regression. The regression model is as follows:

$$\text{Logit}(P) = \beta_0 + \beta_1 \text{County} + \beta_2 \text{Age} + \beta_3 \text{Gender} + \beta_4 \text{Department} + \beta_5 \text{RTDAR} + \beta_6 \text{Affordability} + \varepsilon$$

215 **Research Ethics**

216 The research methods and investigation tools in this study were approved by the
217 Ethics Committee of Tongji Medical College, Huazhong University of Science and
218 Technology (IORG No: IORG0003571). The patient information were not disclosed
219 before the analysis.

220

221 **Result**222 *Selected characteristics of the study population*

223 The study included 652 admitted patients, of which 230 were elderly patients. The
224 selected characteristics of the study population are shown in Tables 2 and 3. In this
225 study, the average age of the elderly was 70.73 ± 7.841 years, and 53.6% were female
226 patients. The average age of non-elderly patients was 28.33 ± 21.34 years, and 49.3%
227 were female patients. Most of the elderly patients were hospitalised in internal
228 medicine (79.1%) and were admitted because of circulatory diseases (43.9%). Only
229 43.9% of the elderly patients were in good health, and the majority of the patients
230 have chronic diseases (74.3%). Older patients had a higher expectation of admission
231 and always think that their respective diseases are serious. The number of elderly
232 patients who considered the reimbursement of inpatient was higher than that of
233 outpatient, which account for only 43.9% of the elderly respondents. Only 32.2% of
234 elderly patients thought that they can fully pay for the hospitalization, and 49.6%
235 considered that hospitalization is inconvenient.

236 Of the 230 elderly patients surveyed, 69 were inappropriately admitted, with the rate
237 of 30%, which was lower than that of non-elderly patients (40.7%). The inappropriate
238 admission rate of elderly people in Dingyuan was the highest (51.8%), whereas the
239 lowest was in Yilong (14.5%); the difference between the two counties was
240 statistically significant ($\chi^2=22.8, P<0.001$).

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4 241 *Characteristics of inappropriate admission to the elderly*

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6 242 The objective admission indicators of elderly patients (Table 2) show no significant
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8 243 difference in the distribution of admission appropriateness among gender, age,
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10 244 department, disease, health status and diagnosis of chronic diseases. For the
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12 245 non-elderly group, a younger age correspond to higher inappropriate admission rate
13
14 246 ($P<0.001$). Moreover, pediatric patients with the highest inappropriate admission rate
15
16 247 ($\chi^2=55.742$, $P<0.001$) and patients with chronic diseases are more likely to be
17
18 248 inappropriately admitted ($\chi^2=9.092$, $P=0.003$).

19
20
21 249 The characteristics of inappropriate admission under patients' subjective perceptions
22
23 250 is indicated in Table 3. The inappropriate admission rate of elderly patients varies with
24
25 251 the different comparison of the reimbursement of inpatient and outpatient ($\chi^2=11.8$,
26
27 252 $P=0.003$). The number of elderly patients who think that the reimbursement of
28
29 253 inpatient is higher than that of outpatient had the highest rate of inappropriate
30
31 254 admission (43.9%). Moreover, the affordability of older patients to hospitalization
32
33 255 costs was significantly associated with inappropriate admission ($\chi^2=9.52$, $P=0.009$).
34
35 256 Elderly patient who can fully afford the hospitalization cost had the highest
36
37 257 inappropriate admission rate (37.8%). No statistical difference was found in the
38
39 258 distribution of admission appropriateness of the elderly among the response to
40
41 259 doctor's admission request, the disease severity and hospitalization convenience.

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43 260 In the non-elderly group, patients who decided to be admitted to hospitals on their
44
45 261 own had a higher inappropriate admission rate than those whose decision was made
46
47 262 by someone else ($\chi^2=14.258$, $P=0.007$). Patients who think that the reimbursement of

263 inpatient is higher than that of outpatient had the highest rate of inappropriate
 264 admission ($\chi^2=11.542$, $P=0.003$), and the results were consistent with those in the
 265 elderly group.

266 **Table 2 The Distribution of Inappropriate Admission Characteristics of patients**
 267 **according to the medical records**

Variable	elderly				non-elderly			
	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P
All	230	161(70.0)	69(30.0)		422	250(59.2)	172(40.8)	
County								
Yilong	62(27.0)	53(85.5)	9(14.5)	<0.001	95(22.5)	64(67.4)	31(32.6)	<0.001
Huining	61(26.5)	48(78.7)	13(21.3)		92(21.8)	65(70.7)	27(29.3)	
Dingyuan	56(24.3)	27(48.2)	29(51.8)		120(28.4)	47(39.2)	73(60.8)	
Weiyuan	51(22.2)	33(64.7)	18(35.3)		115(27.3)	74(64.3)	41(35.7)	
Gender								
Male	109(47.4)	71(65.1)	38(34.9)	0.127	214(50.7)	133(62.1)	81(37.9)	0.218
Female	121(52.6)	90(74.4)	31(25.6)		208(49.3)	117(56.3)	91(43.8)	
Age, Mean \pm SD ^a	70.73 \pm 7.841	70.9 \pm 7.566	70.20 \pm 7.305	0.485*	28.33 \pm 21.34	33.47 \pm 19.332	24.33 \pm 22.600	<0.001*
Department								
Internal medicine	182(79.1)	125(68.7)	57(31.3)	0.155	149(35.3)	97(65.1)	52(34.9)	<0.001
Surgery	34(14.8)	28(82.4)	6(17.6)		70(16.6)	62(88.6)	8(11.4)	
Peadiatric	0(0.0)	0	0		154(36.5)	59(38.3)	95(61.7)	
Others	14(6.1)	8(57.1)	6(42.9)		49(11.6)	32(65.3)	17(34.7)	
Disease category								
Circulatory disease	101(43.9)	70(39.3)	32(30.7)	0.271	88(20.9)	54(61.4)	34(38.6)	0.084
Respiratory disease	18(7.8)	15(83.3)	3(16.7)		77(18.2)	47(61.0)	30(39.0)	
Digestive disease	23(10.0)	14(60.9)	9(39.1)		60(14.2)	33(55.0)	27(45.0)	
Urinary disease	5(2.2)	4(80.0)	1(20.0)		20(4.7)	15(75.0)	5(25.0)	
Endocrinology diseases	16(7.0)	9(56.3)	7(43.8)		18(4.3)	12(66.7)	6(33.3)	
Bones and muscles	6(2.6)	3(50.0)	3(50.0)		17(4.0)	8(47.1)	9(52.9)	
Injury and poisoning	10(4.3)	10(100.0)	0(0.0)		22(5.2)	19(86.4)	3(13.6)	
Symptoms and signs	38(16.5)	26(68.4)	12(31.6)		62(14.7)	33(53.2)	29(46.8)	
Others	13(5.7)	10(76.9)	15(23.1)		58(13.7)	29(50.0)	29(50.0)	
Health status								
Good	101(43.9)	71(70.3)	30(29.7)	0.98	324(76.8)	183(56.5)	141(43.5)	0.101
General	108(47.0)	75(69.4)	33(30.6)		83(19.7)	56(67.5)	27(32.5)	
Poor	21(9.1)	15(71.4)	6(28.6)		15(3.6)			
DOCD								
Yes	171(74.3)	117(68.4)	54(31.6)	0.414	179(42.4)	91(50.8)	88(49.2)	0.003

No 59(25.7) 44(74.6) 15(25.4) 243(57.6) 159(65.4) 84(34.6)

Note: DOCD, Diagnosis of chronic diseases. ^a SD, Standard deviation. * T text.

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Table 3 Distributions of characteristics of appropriateness admission under the subjective perception of patients

Variable	elderly				non-elderly			
	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P-value	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P-value
RTDAR								
No doubt	63(27.4)	90(56.3)	70(43.8)	0.119	160(37.9)	46(73.0)	17(27.0)	0.007
Doubt	17(7.4)	16(59.3)	11(40.7)		27(6.4)	16(94.1)	1(5.9)	
Expected	124(53.9)	124(65.3)	66(34.7)		190(45.0)	84(67.7)	40(32.3)	
Family requirements	13(5.7)	8(80.0)	2 (20.0)		10(2.4)	8(61.5)	5(38.5)	
Others	13(5.7)	12(34.3)	23(65.7)		35(8.3)	7(53.8)	6(46.2)	
Disease severity								
Light	8(3.5)	39(58.2)	28(41.8)	0.546	67(15.9)	7(87.5)	1(12.5)	0.697
General	46(20.0)	63(56.3)	49(43.8)		112(26.5)	32(69.6)	14(30.4)	
Serious	176(76.5)	148(60.9)	95(39.1)		243(57.6)	122(69.3)	54(30.7)	
Comparison of R ₀ and R ₁								
R ₀ >R ₁	62(27.0)	37(80.4)	9(19.6)	0.003	46(10.9)	54(87.1)	8(12.9)	0.003
R ₁ <R ₀	101(43.9)	101(53.2)	89(46.8)		190(45.0)	64(56.1)	37(43.9)	
Unknown	67(29.1)	112(60.2)	74(39.8)		186(44.1)	43(70.9)	24(29.1)	
Affordability								
Difficult	73(31.7)	37(61.7)	23(38.3)	0.009	60(14.2)	61(83.6)	12(16.4)	0.842
Reluctantly	83(36.1)	124(57.9)	90(42.1)		214(50.7)	54(65.1)	29(34.9)	
Fully payable	74(32.2)	89(60.1)	59(39.9)		148(35.1)	46(62.2)	28(37.8)	
Hospitalization convenience								
Yes	116(50.4)	169(60.8)	109(39.2)	0.085	278(65.9)	75(64.7)	41(35.3)	0.368
No	114(49.6)	81(56.3)	63(43.8)		144(34.1)	86(75.4)	28(24.6)	

Note: RTDAR, Response to Doctor's Admission Requirement.

RO, Reimbursement of Outpatient; RI, Reimbursement of Inpatient.

274 ***Determinants of inappropriate admission to hospital for elderly people***

275 Logistic regression based on the interaction of age elderly and non-elderly group) and

276 other factors shows that the interaction between age and gender and between age and

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3 277 chronic disease both had influence on patients' inappropriate admission to hospital.
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6 278 Compared with non-elderly patients, the risk of inappropriate admission of female
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8 279 elderly patients was lower (OR=0.33), and elderly patients with chronic disease were
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11 280 more likely to be inappropriately admitted to hospital (OR=3.33).
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Table 5 Logistic Regression Analysis Based on the Interaction of Age and Other Factors (n=652)

Variable	COR(95%CI)	AOR(95%CI) †	Variable	COR(95%CI)	AOR(95%CI) †
County(ref:Yilong) ^{#*}			Health status(ref:Good)		
Huining	1.04(0.62 to 1.72)	1.29(0.68 to 2.44)	General	0.68(0.47 to 0.98)	0.82(0.50 to 1.33)
Dingyuan	4.03(2.52 to 6.43)	5.99(3.08 to 11.68)	Poor	0.57(0.27 to 1.22)	0.83(0.33 to 2.06)
Weiyuan	1.16(0.99 to 2.61)	1.85(0.98 to 3.48)	RTDAR(ref:No doubt) [#]		
Age(ref: non-elderly) ^{#*}	0.62(0.44 to 0.88)	1.35(0.59 to 3.10)	Doubt	0.59(0.29 to 1.20)	0.6(0.26 to 1.39)
Gender(ref: male) [*]	1.01(0.74 to 1.39)	1.64(1.03 to 2.63)	Expected	0.80(0.56 to 1.14)	0.82(0.53 to 1.27)
Disease category(ref:Circulatory disease) [#]			Family requirements	0.68(0.27 to 1.73)	0.73(0.25 to 2.09)
Respiratory disease	1.02(0.61 to 1.71)	0.83(0.43 to 1.58)	Others	2.39(1.26 to 4.52)	1.91(0.89 to 4.09)
Digestive disease	1.46(0.86 to 2.48)	2.84(1.44 to 5.58)	Disease severity(ref:Light)		
Urinary disease	0.60(0.23 to 1.58)	1.04(0.32 to 3.39)	General	1.05(0.60 to 1.85)	1.05(0.51 to 2.15)
Endocrinology diseases	1.81(0.56 to 2.51)	1.43(0.60 to 3.45)	Serious	0.88(0.53 to 1.45)	1.28(0.66 to 2.50)
Bones and muscles	2.08(0.87 to 4.98)	1.45(0.52 to 4.06)	Comparison of R ₀ and R ₁ (ref:R ₀ >R ₁) [#]		
Injury and poisoning	0.20(0.06 to 0.67)	0.99(0.24 to 4.13)	R ₁ <R ₀	4.09(2.32 to 7.21)	2.13(1.08 to 4.21)
Symptoms and signs	1.33(0.81 to 2.18)	1.63(0.91 to 2.93)	Unknown	3.38(1.90 to 6.02)	1.62(0.80 to 3.27)
Others	1.57(0.90 to 2.73)	1.30(0.64 to 2.64)	Affordability(ref:Difficult) ^{#*}		
Department(ref:Internal medicine) ^{#*}			Reluctantly	1.87(1.19 to 2.94)	1.14(0.66 to 1.96)
Surgery	0.32(0.17 to 0.58)	0.11(0.05 to 0.25)	Fully payable	1.80(1.13 to 2.89)	1.84(1.05 to 3.24)
Pediatric	3.28(2.20 to 4.88)	4.26(1.94 to 9.35)	Hospitalization convenience(ref:Yes)	0.89(0.64 to 1.23)	1.25(0.84 to 1.88)
Others	1.17(0.67 to 2.05)	1.16(0.59 to 2.29)	Age×Gender (ref:non-elderly×male) ^{#*}	0.53(0.34 to 0.82)	0.33(0.15 to 0.73)
DOCD(ref:No) ^{#*}	1.40(1.02 to 1.93)	0.32(0.16 to 0.65)	Age×DOCD(ref:non-elderly×No) [*]	0.55(0.30 to 1.02)	3.33(1.23 to 9.04)

Note: [#]Univariate regression analysis $p<0.05$, ^{*}Logistic Regression Analysis $p<0.05$

†Adjusted for all other covariates listed in the table

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AOR, adjusted OR; COR, crude OR.

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282 The results of the binary logistic regression for elderly patients are shown in Table 4.
 283 Taking Yilong as the reference group, rural elderly patients in Dingyuan had a higher
 284 risk of inappropriate admission to hospital (OR=9.74). A higher age corresponds to a
 285 lower possibility of inappropriate admission (OR=0.94). Elderly people in the surgery
 286 department are less likely to be admitted to hospital inappropriately (OR=0.21). For
 287 the subjective cognition of elderly patients, our study showed that only patients who
 288 have doubts about the doctor's admission requirement but decided to be hospitalised
 289 after communication with the doctor were the least likely to be admitted
 290 inappropriately (OR=0.07).

291 **Table4 logistic regression analysis of inappropriate admission of elderly (n = 230)**

Variable	COR(95%CI)	AOR(95%CI) †
County(ref: Yilong)*		
Huining	1.60(0.63 to 4.06)	0.67(0.21 to 2.07)
Dingyuan	6.33(2.63 to 15.25)	9.74(3.30 to 28.41)
Weiyuan	3.21(1.29 to 7.98)	3.36(1.08 to 10.46)
Age(years)	0.99(0.95 to 1.03)	0.94(0.90 to 0.99)
Gender (ref: male)*	0.64(0.36 to 1.14)	0.49(0.25 to 2.98)
Department (ref:internal medicine)*		
Surgery	0.47(0.18 to 1.20)	0.21(0.07 to 0.61)
Others	1.65(0.55 to 4.96)	1.49(0.35 to 6.27)
RTDAR (ref: No doubt)*		
Doubt	0.17(0.02 to 1.38)	0.07(0.01 to 0.76)
Expected	1.29(0.66 to 2.52)	0.87(0.39 to 1.96)
Family requirements	1.69(0.49 to 5.89)	1.48(0.34 to 6.34)
Others	2.32(0.68 to 7.89)	4.14(0.94 to 18.24)
Affordability(ref: difficult)#		
Reluctantly	2.73(1.27 to 5.87)	1.69(0.68 to 4.20)
Complete	3.09(1.42 to 6.73)	2.84(1.13 to 7.17)

Note: forward stepwise : $\alpha_{\text{entry}}=0.1$, $\alpha_{\text{removal}}=0.15$

#Univariate regression analysis $p<0.05$, *Logistic Regression Analysis $p<0.05$

†Adjusted for all other covariates listed in the table

AOR, adjusted OR; COR, crude OR.

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293 **Discussion**

294 *Inappropriate admission of elderly in rural China*

295 In this study, the inappropriate admission rate of patients over 60 year old in rural
296 areas in China is 30%, which is generally higher than that reported of 27% in the UK
297 ^[19], 9.8% in Italy^[15], 9.2% in Switzerland^[20] and 8.8% in France^[14]. Yan et al.^[21]
298 found that the inappropriate admission rate of patients over 60 years in rural areas in
299 China was 14.3%, which was also lower than the results of this study. This result may
300 be attributed to the differences among the studies with regard to health service system,
301 geographical environment or study period. These studies were mainly concerned on
302 elderly people of different age groups and in different admission departments. The
303 inappropriate admission rate of elderly patients (30%) was lower than that of
304 non-elderly patients (40.8%) probably because the body functions of elderly patients
305 are worse than those of non-elderly patients. Moreover, an elderly person presents
306 more obvious and serious symptoms at the onset of a disease and is thus more likely
307 to be inappropriately admitted.

308 *Characteristics of elderly patients who were hospitalised inappropriately*

309 Significant differences were found in the distribution of inappropriate admission
310 among elderly patients across different counties. Among the four surveyed areas,
311 Dingyuan had the highest rate of inappropriate admission, whereas Yilong has the
312 lowest. It may be related to the differences in health policies, geographical

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4 313 environment and customs between the counties. Elderly patients who can fully afford
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6 314 the hospitalization costs had the highest inappropriate admission rate. It may be
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8 315 caused by economic difficulties that restrict the utilization of health services for
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10 316 elderly patients in rural areas in China ^[22], and elderly patients who can afford
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12 317 hospitalization expenses are less subjected to economic constraints of health services;
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14 318 to pursue higher quality medical services, they often choose inpatient services,
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16 319 thereby increasing their likelihood of inappropriate admission. Our research proves
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18 320 that elderly people who have a correct understanding of medical insurance
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20 321 reimbursement have higher inappropriate admission rates, probably because the
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22 322 medical insurance reimbursement policy has promoted the excessive release of
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24 323 hospitalization services demand for elderly patients ^[23].

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30 324 ***Determinants of inappropriate admission for elderly people***

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32 325 Gender and chronic diseases are the specific factors affecting the inappropriate
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34 326 admission of elderly people. Compared with non-elderly patients, the tendency of
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36 327 female elderly patients for inappropriate hospitalization was less obvious. Moreover,
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38 328 the risk of inappropriate admission of elderly patients with chronic disease was higher,
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40 329 which is consistent with the findings of Gamper, probably because relative to
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42 330 non-elderly people, elderly people are less aware of the disease. Moreover, a perfect
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44 331 chronic disease management is lacking in rural areas in China. When the symptoms of
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46 332 chronic diseases appear, it is easier for elderly earlier to misjudge the disease and
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48 333 blindly choose to be admitted to a hospital.

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50 334 The logistic regression shows that the risk of inappropriate admission varies across
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3 335 different counties in China's rural areas. The health policy in different counties,
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6 336 especially the medical insurance policy, plays a key role in the inappropriate
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8 337 admission of elderly patients. A large gap exists between the outpatient and
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11 338 hospitalization compensation in the survey area. Especially at county-level hospitals,
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13 339 the general outpatient reimbursement is not covered, hence, elderly people in rural
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15 340 areas prefer hospitalization and get more medical expense reimbursement. Dingyuan
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17 341 has the highest risk of inappropriate admission for elderly patients, which may be
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19 342 caused by its high level of reimbursement policy of the NRCMS. In 2017, the
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21 343 reimbursement ratio of NRCMS in Dingyuan county-level hospital was 85%, and the
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23 344 annual payment limitation of each inpatient could reach 200 thousand RMB, which
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25 345 was higher than that of Yilong and Weiyuan. Although the reimbursement ratio of
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27 346 NRCMS and the annual payment limitation of each inpatient in Yilong are higher than
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29 347 that of Weiyuan, the risk of inappropriate admission of elderly patients in Weiyuan
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31 348 was higher, may be because the greater impact of its geographical environment.
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33 349 Yilong is located in low hills and has a convenient mode of transportation, whereas
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35 350 Weiyuan is located in high mountainous area, where the terrain is complex and the
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37 351 traffic is inconvenient, which make it more difficult for elderly patients to travel and
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39 352 make them choose to be admitted for treatment convenience [24].
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42 353 Gender and age also had an impact on the inappropriate admission of elderly people
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44 354 in rural areas in China. Compared with female elderly patients, the inappropriate
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46 355 admission tendency of male elderly patients is more obvious. This observation is
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48 356 probably caused male patients by the generally higher status in the family and society
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4 357 of male elderly patients than females ^[25], and their health status receives more
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6 358 attention, which makes them willing to use hospitalization to ensure the treatment
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8 359 effect and resulting in inappropriate admission. With increasing age, elderly patients
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10 360 are less likely to be admitted inappropriately. This result is consistent with that of
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13 361 other studies ^[26]. The reason is mainly because older patients have severely reduced
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15 362 their body functions, and their disease are more serious; hence, inappropriate
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18 363 admission is relatively rare.

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20 364 The department was also a key factor in the inappropriate admission of elderly
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23 365 patients. Compared with surgery, medical patients are more prone to inappropriate
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25 366 admissions (the inappropriate admission rate of 31.3%), which is consistent with the
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28 367 results of Ferrero ^[27]. This observation might be caused by two reasons: On the one
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30 368 hand, many surgical-related indicators are included in the original evaluation
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33 369 indicators in AEP ^[28], which improves the rationality of surgical patient admission. On
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35 370 the other hand, most elderly patients suffer from chronic diseases, making internal
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38 371 medicine departments easily selected for treatment. However, the performance
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40 372 appraisal of Chinese hospital is always directly linked to departmental income.
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43 373 However, the internal medicine income is significantly lower than that of surgery,
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45 374 which causes physicians to produce a more induced demand in pursuit of
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47 375 departmental income ^[29]. In addition, the hospital lacks admission standards for the
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50 376 severity of the disease, and the intensity of medical services required. These factors
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53 377 have increased the possibility of inappropriate admission to the elderly.

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55 378 The response of rural elderly patients to hospital admission requirements directly

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4 379 affects the appropriateness of admission. Elderly patients who had doubts about the
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6 380 doctor's admission requirements and communicated with the doctor before deciding to
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8 381 enter the hospital have a significantly less possibility of being admitted
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11 382 inappropriately. The influence of this factor on the appropriateness of hospitalization
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13 383 in rural elderly is mainly reflected in two points. Firstly, Chinese rural areas have not
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15 384 established a perfect 'family doctor first' consultation mechanism, and rural elderly
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17 385 patients lack the guidance of the first diagnosis and the correct understanding of their
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19 386 disease. Cultural degree is low especially for the elderly patients in rural areas in
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21 387 China, which makes their judgment of the disease entirely dependent on the clinician.
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25 388 For doctors' admission requirements, if elderly patients communicate with doctors
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27 389 effectively, understand their own disease condition and make admission decisions
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29 390 accordingly, inappropriate admission tendency of elderly patients is significantly
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31 391 reduced. Secondly, the doctor's request for admission to the patient is not only based
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33 392 on the judgment of the patient's basic condition but also with the factors of medical
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35 393 accident risk aversion, departmental income, etc. ^[30,31]. Clinical decision-making of
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37 394 doctors under various factors meets the appropriate admission requirements of elderly
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39 395 patients becomes a key point affecting the rationality of patients' admission, which
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41 396 was proved by Aida bianco and Mytton.
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48 397 **Conclusion**

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51 398 In this study, the rate of inappropriate admission of elderly patients in the rural
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53 399 county-level medical institutions in China's is relatively higher than any of the results
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4 400 reported by other studies. Gender and chronic diseases are the specific factors
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6 401 affecting the appropriateness of admission of elderly patients in rural areas in China.
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8 402 County, age, gender, department and the response to the doctor's admission
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10 403 requirements are the determinants of the inappropriate admission of elderly patients.
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13 404 As indicated by our results, some pertinent policy recommendations were pursued.
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15 405 Firstly, the NRCMS management department should adjust the reimbursement ratio of
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17 406 hospitalization and outpatient according to actual inspections and increase the ratio of
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19 407 outpatient reimbursement to a certain extent, reducing unnecessary hospitalization
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21 408 needs. Secondly, medical institutions need to establish a performance appraisal system
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23 409 with medical quality and patient satisfaction as the core, and an admission criteria for
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25 410 the severity of the disease and the intensity of required medical services should also
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27 411 be established, thereby constraining the inappropriate hospitalization behaviour of
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29 412 older patients in different departments. Thirdly, China's rural areas need to establish a
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31 413 family doctor service based on the concept of health management and provide the
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33 414 services of health management ^[32], medical consultation and guidance for elderly
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35 415 patients to improve their cognition of the disease and reduce the leading position of
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37 416 the doctor's decision in the process of admission and the inappropriate admission rate.
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417 **Limitation**

418 This study have two limitations. Firstly, the cross-sectional study design could not
419 determine the causal relationship between unreasonable admission and related factors
420 in elderly patients. Secondly, no unified identification standard exists for the
421 inappropriate admission of elderly patients in the current studies ^[33], making the

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3 422 identification of inappropriate admission dependent on the AEP. The AEP applicable
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6 423 to the entire population may not be the best tool for evaluating the inappropriate
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8 424 admission of elderly patients ^[18, 34, 35].

10 425 **Competing interests**

13 426 The authors declare no competing interests.

16 427 **Authors' contributions**

18 428 X-M.H, H-X.G and Y.Z participated in the conception and design of the manuscript.

20 429 X-M.H and H-X.G contributed equally to the development of this research study.. Y.Z,

22 430 H-M.L, D.S, J-J.C and D.J participated in the data collection and statistical analysis.

24 431 Y-C.C helped draft, review and revise the manuscript. All authors gave their approval

26 432 to publish this version of the manuscript.

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36 436 **Disclosure**

38 437 This work has never been published or presented at any time in the past.

40 438 **Provenance and peer review**

42 439 This work is not commissioned and is externally peer reviewed.

44 440 **Data sharing statement**

46 441 The anonymised dataset can be requested by sending an email to the corresponding

48 442 author.

Reference:

443

- 444 1. National Bureau of Statistics of China. Statistical Communiqué of the People's Republic of China
445 on the 2017 National Economic and Social Development [N]. China Information Daily,
446 2018-03-01 (003).
- 447 2. Center for Health Statistics and Information. An Analysis Report of National Health Services
448 Survey in China, 2013 [M]. Peking Union Medical College Press, 2015.
- 449 3. Restuccia, J.; Shwartz, M.; Ash, A.; Payne, S. High hospital admission rates and inappropriate
450 care. *Health affairs (Project Hope)* 1996, 15, 156-163. 'doi': 10.1377/hlthaff.15.4.156
- 451 4. Xiaona Gao, Yingchun Chen, Zhaoqun Chu, Lijing Zhang. Analysis of characteristic excessive
452 demand for elderly inpatient service and causes covered by NRCMS [J]. *Chinese Journal of*
453 *Hospital Administration*, 2015(4):279-282. 'doi': 10.3760/cma.j.issn.1000-6672.2015.04.011
- 454 5. Lavis, J.N.; Anderson, G.M. Appropriateness in health care delivery: Definitions, measurement
455 and policy implications. *CAN MED ASSOC J* 1996, 154, 321-328.
- 456 6. Payne, S.M. Identifying and managing inappropriate hospital utilization: a policy synthesis.
457 *HEALTH SERVICES* 1987, 22, 709-769.
- 458 7. Campbell, J. Inappropriate admissions: thoughts of patients and referring doctors. *J R Soc Med*
459 2001, 94, 628-631. 'doi': 10.1177/014107680109401206
- 460 8. World Health Organization. China country assessment report on ageing and health [R].2016.
- 461 9. Jinghong Chen. Research on Demand and Utilization of Health Service among the Elderly in Rural
462 Areas under the Background of Ageing[D] Peking Union Medical College,2012.
- 463 10. XIE Chun-yan, HU Shan-lian, SUN Guo-zhen, et al. Exploration and Experience of Provider
464 Payment System Reform in China [J]. *Chinese Health Economics*, 2010,29(05):27-29.
465 'doi':10.3969/j.issn.1003-0743.2010.05.008
- 466 11. Creditor M C. Hazards of hospitalization of the elderly[J]. *Annals of Internal Medicine*, 1993,
467 118(3):219-223. 'doi': 10.7326/0003-4819-118-3-199302010-00011
- 468 12. Fusco M, Buja A, Piergentili P, et al. Individual and hospital-related determinants of potentially
469 inappropriate admissions emerging from administrative records.[J]. *Health Policy*, 2016,
470 'doi':120(11):1304-1312. 10.1016/j.healthpol.2016.09.015
- 471 13. Gamper G, Wiedermann W, Barisonzo R, et al. Inappropriate hospital admission: interaction
472 between patient age and co-morbidity[J]. *Internal & Emergency Medicine*, 2011, 6(4):361-367.
473 'doi':10.1007/s11739-011-0629-0
- 474 14. Menand E, Lenain E, Lazarovici C, et al. French multicenter evaluation of the appropriateness of
475 admission to the emergency department of the over-80s[J]. *Journal of Nutrition Health & Aging*,
476 2015, 19(6):1-7. 'doi':10.1007/s12603-015-0489-9
- 477 15. Bianco A, Pileggi C, Rizza P, et al. An assessment of inappropriate hospital bed utilization by
478 elderly patients in southern Italy[J]. *Aging Clinical & Experimental Research*, 2006,
479 18(3):249-256. 'doi':10.1007/BF03324656
- 480 16. Mytton O T, Oliver D, Mirza N, et al. Avoidable acute hospital admissions in older people[J].
481 *British Journal of Health Care Management*, 2013, 18(11):597-603.
482 'doi':10.12968/bjhc.2012.18.11.597
- 483 17. Gertman P M, Restuccia J D. The appropriateness evaluation protocol: a technique for assessing
484 unnecessary days of hospital care.[J]. *Medical Care*, 1981, 19(8):855-71.
485 'doi':10.1097/00005650-198108000-00005

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3
4 486 18. Yingchun Chen, Excessive demand for inpatient service in rural areas [M]. 科学出版社, 2014.
- 5 487 19. Leah V, Adams J. Assessment of older adults in the emergency department.[J]. Nursing Standard,
6 488 2010, 24(46):42. 'doi': 10.7748/ns2010.07.24.46.42.c7911
- 7
8 489 20. Ingold B B, Yersin B, Wietlisbach V, et al. Characteristics associated with inappropriate hospital
9 490 use in elderly patients admitted to a general internal medicine service[J]. Aging Clinical &
10 491 Experimental Research, 2000, 12(6):430-438. 'doi':10.1007/BF03339873
- 11 492 21. Zhang, Y., et al., Determinants of Inappropriate Admissions in County Hospitals in Rural China: A
12 493 Cross-Sectional Study. Int J Environ Res Public Health, 2018. 15(6).
13 494 'doi':10.3390/ijerph15061050
- 14
15 495 22. CHEN Fang-wu, YANG Xu-li, LIU Jie. Analysis on the situation of health service utilization and
16 496 its influencing factors among aged people[J].Modern Preventive Medicine,2007(16):3083-3085.
17 497 'doi':10.3969/j.issn.1003-8507.2007.16.037
- 18
19 498 23. HU HONG-Wei, LUAN Wen-jing, LI Jia-yi. Medical insurance, health Services Utilization and
20 499 Excessive Demands for Medical Services—The Impact of Medical Insurance on Utilization of
21 500 Health Service of the elderly [J]. Journal of Shanxi Finance and Economics University,
22 501 2015,37(05):14-24. 'doi':10.13781/j.cnki.1007-9556.2015.05.002
- 23
24 502 24. Yan Z, Chen Y, Xiang Z, et al. Current level and determinants of inappropriate admissions to
25 503 township hospitals under the new rural cooperative medical system in China: a cross-sectional
26 504 study[J]. BMC Health Services Research, 2014, 14(1):649. 'doi':10.1186/s12913-014-0649-3
- 27
28 505 25. TANG Yong-xia, LUO Wei-guo. Investigation on Family Status of Women in Poor Rural
29 506 Areas—With Tongwei County in Dingxi of Gansu as an Example [J]. Journal of University of
30 507 Science and Technology Beijing (Social Sciences Edition), 2014, 30(4):46-55.
31 508 'doi':10.3969/j.issn.1008-2689.2014.04.007
- 32
33 509 26. Tavakoli N, Hosseini Kasnavieh S M, Yasinzadeh M, et al. Evaluation of Appropriate and
34 510 Inappropriate Admission and Hospitalization Days According to Appropriateness Evaluation
35 511 Protocol (AEP).[J]. Archives of Iranian Medicine, 2015, 18(7):430-434.
- 36
37 512 27. Ferrero, B.O.; Sanchez, M.L.; Corredera, R.C.; Uriarte, A.E.; de Miguel, D.L.V.F. Inappropriate
38 513 admissions to the Department of Internal Medicine evaluated by the AEP (Appropriateness
39 514 Evaluation Protocol). An Med Interna 1998, 15, 674-675.
- 40
41 515 28. Mozes, B.; Schiff, E.; Modan, B. Factors affecting inappropriate hospital stay. Quality assurance
42 516 in health care : the official journal of the International Society for Quality Assurance in Health
43 517 Care 1991, 3, 211-217. 'doi': 10.1093/intqhc/3.3.211
- 44
45 518 29. Gan C H, Zhou X, Zheng R G. Imperfect Information, Supplier-induced Demand and Quality of
46 519 Health Service[J]. Journal of Finance & Economics, 2007.
47 520 'doi':10.3969/j.issn.1001-9952.2007.08.009
- 48
49 521 30. Yip, W.C.; Hsiao, W.; Meng, Q.; Chen, W.; Sun, X. Realignment of incentives for health-care
50 522 providers in China. LANCET 2010, 375, 1120-1130. 'doi':10.1016/S0140-6736(10)60063-3
- 51
52 523 31. Osinaike, B.B.; Olusanya, O. Inappropriate Intensive Care Unit admissions: Nigerian doctors'
53 524 perception and attitude. NIGER J CLIN PRACT 2016, 19, 721-724.
54 525 'doi':10.4103/1119-3077.181354
- 55
56 526 32. Purdy S, Griffin T. Reducing hospital admissions[J]. Bmj, 2008, 336(7634):4-5.
57 527 'doi':10.1136/bmj.39394.402465.BE
- 58
59 528 33. Thwaites R, Glasby J, Le M N, et al. Room for one more? A review of the literature on

- 1
2
3 529 'inappropriate' admissions to hospital for older people in the English NHS.[J]. Health & Social
4 530 Care in the Community, 2017, 5(1):309-15. 'doi':10.1111/hsc.12281
5 531 34. Sánchez-García S, Juárez-Cedillo T, Mould-Quevedo J F, et al. The hospital appropriateness
6 532 evaluation protocol in elderly patients: a technique to evaluate admission and hospital stay[J].
7 533 Scandinavian Journal of Caring Sciences, 2010, 22(2):306-313.
8 534 'doi':10.1111/j.1471-6712.2007.00528.x ·
9 535 35. Cardona-Morrell M, Jch K, Brabrand M, et al. What is inappropriate hospital use for elderly
10 536 people near the end of life? A systematic review[J]. European Journal of Internal Medicine, 2017.
11 537 'doi': 10.1016/j.ejim.2017.04.014
12 538 36. Liu W, Yuan S, Wei F, et al. Reliability and Validity of the Chinese Version Appropriateness
13 539 Evaluation Protocol[J]. Plos One, 2015, 10(8):e0136498. 'doi': 10.1371/journal.pone.0136498
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17 **Figure Legend**

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19 **Figure 1.** Investigation map of rural residents in China.
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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2,3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	10
		(b) Describe any methods used to examine subgroups and interactions	11
		(c) Explain how missing data were addressed	
		(d) If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	12
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest	12
Outcome data	15*	Report numbers of outcome events or summary measures	14,15
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	16,17 14,15
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	16
Discussion			
Key results	18	Summarise key results with reference to study objectives	18—22
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	23
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18—22
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	24

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Determinants of Inappropriate Admission of Elderly People in County-Level Hospitals: A Cross-Sectional Study in Rural China

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Primary Subject Heading:	Health policy

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1 **Determinants of Inappropriate Admission of Elderly People in**
2 **County-Level Hospitals: A Cross-Sectional Study in Rural China**

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11 25 Yingchun Chen, chenyingchun@hust.edu.cn
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15 26 **Abstract**
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18 27 **Objective** The purpose of this paper is to investigate the characteristics and
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21 28 determinants of inappropriate admission to hospital of elderly people in rural China.
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24 29 **Design** A cross-sectional study was conducted, wherein a comparison between elderly
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26 30 and non-elderly groups was conducted.
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29 31 **Setting** The survey was conducted on the largest county-level general hospitals in
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31 32 four counties in central and western China.
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34 33 **Participants** A total of 652 rural patients admitted in hospitals were surveyed, of
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36 34 which were divided into two groups according to age: elderly group (N=230, age \geq 60),
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38 35 and non-elderly group (N=422, age $<$ 60).
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41 36 **Primary measures** The Chinese version of the appropriateness evaluation protocol
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43 37 was used to evaluate the inappropriate admission rates. The interactive regression
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45 38 models based on the relationship of age (elderly and non-elderly) with other factors
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47 39 and binary logistic regression models were used in the analysis of the specific factors
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49 40 and determinants of the inappropriate admission of elderly people.
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53 41 **Result** The inappropriate admission rate for rural elderly was 30%, which was lower
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55 42 than that of non-elderly people (40.8%). Compared with the non-elderly group,
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4 43 women in the elderly group (OR=0.33, 95%CI: 0.15-0.73) had a lower incidence of
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7 44 inappropriate admission, and elderly people with chronic diseases (OR=3.33, 95%CI:
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9 45 1.23 -9.04) were more prone to inappropriately admitted than non-elderly people with
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12 46 chronic diseases. The binary logistic regression analysis shows that county, age
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14 47 (OR=0.94, 95%CI: 0.90 -0.99), gender (OR=0.49, 95%CI: 0.25 -2.98), department
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17 48 and response to doctor's admission request were the determinants of the inappropriate
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20 49 admission of elderly patients.

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22 50 **Conclusion** The inappropriate admission rate of elderly people in rural China was
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25 51 high. We found that gender and chronic disease are the specific factors that were
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28 52 specific to non-elderly people. County, age, gender, department and response to a
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31 53 doctor's admission request had substantial influence on the inappropriate admission of
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34 54 elderly in rural China.

35 36 37 55 **Strengths and limitation of this study**

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40 56 1. To the best of our knowledge, this is the first in-depth study of the inappropriate
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42 57 admission of elderly people in rural areas in China.
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45 58 2. The inclusion of non-elderly people for comparative analysis emphasised the
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47 59 specificity of the inappropriate hospital admission of elderly people.
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50 60 3. In the search for determinants of inappropriate admission to the elderly, social
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52 61 demographics, objective admission status and subjective cognitive status were all
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55 62 included.
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58 63 4. This cross-sectional study design cannot determine the causal relationship
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64 between the inappropriate hospital admission of elderly people and related factors.

65 5. The appropriateness evaluation protocol applicable to the entire population may

66 not be the best tool for evaluating the inappropriate admission of elderly people.

67 **Introduction**

68 Aging is a severe challenge facing the Chinese society today. At the end of 2017,

69 China's elderly population aged 60 years and above was 241 million, accounting for

70 17.3% of the total population [1]. In recent years, the rate of hospitalisation for the

71 elderly in rural China has increased from 12.7% in 2003 to 21.5% in 2013 [2], which

72 suggests that the utilization of health services for rural elderly population in China has

73 increased sharply. And the inappropriate admission rate of people over 60 years in

74 rural China has reached 23.2% [3]. The inappropriateness of the elderly's health

75 demand has become a major concern in the supply of health services in China.

76 Inappropriate admission refers to the unnecessary hospitalisation of patients [4,5],

77 which is one of the main forms of excessive demand for hospitalisation services [6].

78 Some special national conditions in China determine that the reason for the

79 inappropriate admission of elderly people in rural China differs from that in other

80 countries. On the one hand, primary health care is backward in rural China, especially

81 family doctor system, which remains far from perfect. Hence, elderly patients lack the

82 correct guidance for their first visit although their cognitive levels decrease with age

83 [7] On the other hand, China's institutional endowment system remains imperfect, and

84 hospitalisation services have become the main sources of nursing services for the

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4 85 elderly who suffer from chronic diseases and poor health^[8]. Both of these aspects are
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7 86 related to the inappropriate admission behavior of the elderly. In recent years, the
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10 87 Chinese government has adopted various reform measures that are aimed at guiding
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12 88 patients seeking correct medical care; these measures include the implementation of
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14 89 basic medical insurance payment reform^[9], hierarchical medical system and family
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17 90 doctor contracted services. However, inappropriate inpatient service utilization for the
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20 91 elderly remains a problem in rural China.

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22 92 Inappropriate admission not only wastes health resources but also further increases the
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25 93 economic burden of the elderly in rural areas. It also increases the risk of hospital-
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28 94 acquired infections in elderly people, thereby compromising patients safety and health
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31 95 ^[10,11]. Therefore, identifying the determinants of inappropriate hospitalisation is a
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33 96 useful approach for the formulation of targeted interventions that can reduce
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36 97 inappropriate hospital admission rates and improve the efficiencies and qualities of
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39 98 hospitalisation services.

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41 99 The international study on the inappropriate admission of the elderly is mainly
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44 100 focused on the evaluation of the rate, characteristics and impact factors of
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47 101 inappropriate admission in hospitals. Influencing factors are mainly considered from
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50 102 the perspective of individual characteristics and supplier side. The comprehensive
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52 103 consideration of both supply and demand factors are often undermined in most
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55 104 studies. The analysis of individual characteristics generally focuses on diseases and
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57 105 severity of illness in hospitalised elderly patients. Gamper et al.^[12] found that elderly
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60 106 people with chronic diseases are more likely to be inappropriately admitted. Menand

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4 107 et al. ^[13] found that the severity of illness and mention of a cardiac disease are
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6 108 associated with the inappropriate admission of people aged 80 years. The analysis of
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9 109 influencing factors from the supplier side mainly focuses on the decision-making of
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12 110 medical service providers and primary health care. Aida et al. ^[14] showed that the
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14 111 inappropriate admission of elderly people over 65 years old in southern Italy is mainly
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17 112 influenced by conservative admission treatment decision, which is made by doctors or
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20 113 hospital managers to avoid the risk of medical accidents. Mytton et al. ^[15] found that,
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22 114 in the United Kingdom, the inappropriate admission of elderly people to the
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25 115 emergency departments of hospitals depends on the quality of doctor admission
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28 116 decisions and the capacities of community health services. Presently, there were rarely
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31 117 researches concerning about the inappropriate admission of the elderly in China ,and
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33 118 the only study's analysis only covered the descriptive analysis phase, and the effect of
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36 119 the factors remains unclear. We assume that the appropriateness of admission of
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38 120 elderly people is influenced by both the supply and demand sides.
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41 121 Therefore, we aims to identify the rate and determinants of inappropriate admission of
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44 122 elderly people to hospitals in rural China from the perspective of supply and demand
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47 123 and to provide targeted strategies for the intervention and control of the
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49 124 hospitalisation behaviours of elderly people.
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51 125 **Methods**

52 126 **Setting and participants**

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55 127 This cross-sectional study was conducted in 2017, and cluster random sampling was
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4 128 adopted. Four counties in central and western China, namely, Dingyuan in Anhui
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6 129 Province, Huining and Weiyuan in Gansu Province and Yilong in Sichuan Province,
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9 130 were selected as sample counties. The counties in eastern China were not included
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12 131 because most counties are shifting to the urban district level through rapid economic
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14 132 and social development. The largest county-level general hospital in each county was
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17 133 surveyed, and the respondents were hospitalised patients in rural households who
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20 134 were grouped into the elderly group (aged 60 years and older) and non-elderly groups
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23 135 (under 60 years old).

24 25 136 **Sampling and data collection**

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28 137 For the calculation of sample size, it is estimated that the inappropriate admission rate
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30 138 P of in rural areas is 25%, the absolute tolerance $\delta=0.035$ and the confidence level is
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33 139 95% ($\alpha=0.05$):

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36 140 N=Z_{\alpha/2}^2 \times P(1 - P) / \delta^2 = 1.96^2 \times 0.25 \times (1-0.25) / 0.035^2 = 588$$

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38 141 Through a cluster sampling method, 170 rural patients in each county hospital were
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41 142 randomly selected. The responses were obtained through the use of questionnaire
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43 143 surveys, and their medical records were collected after they were discharged. To ensure
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46 144 the integrity of the data for each indicator, we excluded the unqualified sample records.
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49 145 Of the 680 records collected, 652 valid records were finally retained, including 230 for
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52 146 the elderly and 422 for the non-elderly.

53 54 147 **Measurement**

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57 148 With the consent of the hospital and the patients, a structured questionnaire survey was
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60 149 used, which included inquiries about demographic characteristics and subjective

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4 150 cognitive indicators. Their medical records were extracted for the collection of
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7 151 objective admission statuses and evaluation of the appropriateness of admission.
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9 152 **Variables**

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12 153 The outcome variable was the appropriateness of admission to the hospital, with
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14 154 appropriate admission = 0 and inappropriate admission = 1.

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17 155 The independent variables mainly include demographic characteristics (e.g., county,
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20 156 gender and age), subjective cognitive status (e.g., response to doctor's admission
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22 157 request (RTDAR), disease severity, affordability to hospitalisation costs, comparison of
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25 158 inpatient and outpatient reimbursement (CORR) and hospitalisation convenience)
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28 159 and objective admission status (e.g., department, disease, health status and diagnosis of
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30 160 chronic diseases (DOCD)). Among the above variables, gender, age, subjective
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33 161 cognitive, disease, health status and DOCD are from the demand's perspective, while
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36 162 county, RTDAR, affordability to hospitalisation costs, CORR, hospitalisation
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39 163 convenience, department and DOCD can also directly or indirectly reflect the influence
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41 164 of the supplier on the inappropriate admission of the elderly.

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44 165 **Records appropriateness evaluation**

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46 166 The appropriateness evaluation protocol (AEP) ^[16] is widely used in the evaluation of
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49 167 the appropriateness of admission. Yingchun Chen ^[17] developed an identification tool,
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52 168 R-AEP, which is suitable for the appropriateness of admission to hospitals operating in
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55 169 rural China (Additional file1 for details).

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57 170 The R-AEP criteria were used in the evaluation of the appropriateness of admission in
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59 171 652 cases. The evaluation was performed by professionally trained personnel. These

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4 172 highly trained personnel were professionals in health policy research, all of whom
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6 173 received Ph.D. degrees and committed to making fair judgments on records in a strictly
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9 174 standard manner. The R-AEP criteria were are based on the value of the medical record.
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12 175 Therefore, all R-AEP related indicators were extracted, and their actual values were
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14 176 compared with standard values. The record for indicator actual values that match with
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17 177 the standard value was considered appropriate. Medical records with all relevant values
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20 178 that did not meet the AEP criteria were considered as inappropriate admission. The
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23 179 specific case evaluation process was as follows: 1) Evaluating each medical record by
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25 180 two experts; 2) Comparing the consistency of the results of the two experts; 3) Cases
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28 181 with inconsistent results from two experts were sent to a third party and were evaluated
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31 182 by a third party; 4) Comparing the results of admission appropriateness made by a third
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34 183 party with the previous results and making the final judgment about appropriateness of
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36 184 patient admission.

185 **Statistics analysis**

186 The demographic characteristics, subjective cognitive status and objective admission
187 status were processed via Epidata 3.2. Diseases were categorised using the International
188 Classification of Diseases 10th revision (ICD-10).
189 IBM SPSS Statistics 22.0 was used for statistical analysis. The *t* test and Person's chi-
190 square test were used in the analysis of the distribution characteristics of inappropriate
191 admission of the elderly. For the 652 respondents, the interactive logistic regression
192 model based on the relationship of age (elderly and non-elderly) with other factors was
193 adopted for the analysis of the specific factors affecting the inappropriate admission of

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4 194 elderly people in comparison with those affecting the inappropriate admission of non-
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6 195 elderly people. Taking the appropriateness of admission as the dependent variable, we
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9 196 directly included the main effect of the independent variable to the regression model,
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12 197 and the interaction effect was screened into the model by stepwise regression. Finally,
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15 198 the model was formed.

17 199 $Logit (P) = \beta_0 + \beta_1 County + \beta_2 Age + \beta_3 Gender + \beta_4 Disease + \beta_5 Department + \beta_6 DOCD$
18
19
20 200 $+ \beta_7 Health\ status + \beta_8 RTDAR + \beta_9 Severity + \beta_{10} CORR + \beta_{11} Affordability$
21
22
23 201 $+ \beta_{12} Hospitalization\ convenience + \beta_{13} Age \times Gender + \beta_{14} Age \times DOCD + \varepsilon$

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25 202 For 230 elderly respondents, binary logistic regression analysis was used for the
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28 203 identification of the determinants of the inappropriate admission of the elderly. The
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31 204 patient admission appropriateness was the dependent variable, and the independent
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34 205 variable was selected using the stepwise regression. The regression model is as follows:

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36 206 $Logit (P) = \beta_0 + \beta_1 County + \beta_2 Age + \beta_3 Gender + \beta_4 Department + \beta_5 RTDAR + \beta_6 Affordability + \varepsilon$

37 38 207 **Patient and public involvement**

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41 208 Patients were not involved in the development of the study. The results were
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44 209 applicable for publication in a peer-reviewed journal. There is no plan to specifically
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47 210 disseminate the findings to study participants.

48 49 211 **Research Ethics**

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52 212 The research methods and investigation tools in this study were approved by the
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55 213 Ethics Committee of Tongji Medical College, Huazhong University of Science and

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4 214 Technology (IORG No: IORG0003571). The patient information was not disclosed
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7 215 before the analysis.
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10 216 **Result**

11 12 13 217 *Selected characteristics of the study population*

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16 218 The study included 652 admitted patients, of which 230 were elderly patients (average
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18 219 age: 70.73 years old, female: 52.6%), and 422 were non-elderly patients (average age:
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20 220 28.33 years old, female: 49.3%). The sampling rates in each hospital were 0.53% in
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22
23 221 Yilong (samplers in annual hospitalizations in 2017: 157 in 29461), 0.54% in Huining
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25 222 (153 in 28101), 0.28% in Dingyuan (176 in 62096) and 1.41% in Weiyuan (166 in
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27
28 223 11734). The selected characteristics of the study population are shown in Tables 1 and
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30
31 224 2. Most of the elderly patients were hospitalized in internal medicine (79.1%) and were
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33 225 admitted because of circulatory diseases (43.9%). Only 43.9% of the elderly patients
34
35 226 were in good health, and the majority of the patients have chronic diseases (74.3%).
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37 227 Older patients had a higher expectation of admission and always think that their
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39 228 respective diseases are serious. The number of elderly patients who considered the
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41 229 reimbursement of inpatient was higher than that of outpatient, which account for only
42
43 230 43.9% of the elderly respondents. Only 32.2% of elderly patients thought that they can
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45 231 fully pay for the hospitalisation, and 49.6% considered that hospitalisation is
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47 232 inconvenient.
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49 233 Of the 230 elderly patients surveyed, 69 were inappropriately admitted, with the rate of
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51 234 30%, which was lower than that of non-elderly patients (40.8%). The inappropriate
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4 235 admission rate of elderly people in Dingyuan was the highest (51.8%), whereas the
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6 236 lowest was in Yilong (14.5%); the difference between the four counties was statistically
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9 237 significant ($\chi^2=22.8$, $P<0.001$).

12 238 *Characteristics of inappropriate admission to the elderly*

14 239 The objective admission indicators of elderly patients (Table 1) show no significant
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17 240 difference in the distribution of admission appropriateness among gender, age,
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20 241 department, disease, health status and diagnosis of chronic diseases. For the non-elderly
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23 242 group, a younger age correspond to higher inappropriate admission rate ($P<0.001$).
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25 243 Moreover, pediatric patients with the highest inappropriate admission rate ($\chi^2=55.742$,
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27
28 244 $P<0.001$) and patients with chronic diseases are more likely to be inappropriately
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31 245 admitted ($\chi^2=9.092$, $P=0.003$).

33 246 The characteristics of inappropriate admission under patients' subjective perceptions is
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36 247 indicated in Table 2. The inappropriate admission rate of elderly patients varies with the
37
38
39 248 different comparison of the reimbursement of inpatient and outpatient ($\chi^2=11.8$,
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41 249 $P=0.003$). The number of elderly patients who think that the reimbursement of inpatient
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44 250 is higher than that of outpatient had the highest rate of inappropriate admission (43.9%).
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46 251 Moreover, the affordability of older patients to hospitalisation costs was significantly
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49 252 associated with inappropriate admission ($\chi^2=9.52$, $P=0.009$). Elderly patients who
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52 253 affords the hospitalisation cost difficult had the lowest inappropriate admission rate
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55 254 (38.3%). No statistical difference was found in the distribution of admission
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58 255 appropriateness of the elderly among the response to doctor's admission request, the
59
60 256 disease severity and hospitalisation convenience.

257 In the non-elderly group, patients who decided to be admitted to hospitals on their own
 258 had a higher inappropriate admission rate than those whose decision was made by
 259 someone else ($\chi^2=14.258, P=0.007$). Patients who think that the reimbursement of
 260 inpatient is higher than that of outpatient had the highest rate of inappropriate admission
 261 ($\chi^2=11.542, P=0.003$), and the results were consistent with those in the elderly group.

262 **Table 1 The distribution of inappropriate Admission characteristics of patients according**
 263 **to the medical records**

Variable	elderly				non-elderly			
	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P
All	230	161(70.0)	69(30.0)		422	250(59.2)	172(40.8)	
County								
Yilong	62(27.0)	53(85.5)	9(14.5)	<0.001	95(22.5)	64(67.4)	31(32.6)	<0.001
Huining	61(26.5)	48(78.7)	13(21.3)		92(21.8)	65(70.7)	27(29.3)	
Dingyuan	56(24.3)	27(48.2)	29(51.8)		120(28.4)	47(39.2)	73(60.8)	
Weiyuan	51(22.2)	33(64.7)	18(35.3)		115(27.3)	74(64.3)	41(35.7)	
Gender								
Male	109(47.4)	71(65.1)	38(34.9)	0.127	214(50.7)	133(62.1)	81(37.9)	0.218
Female	121(52.6)	90(74.4)	31(25.6)		208(49.3)	117(56.3)	91(43.8)	
Age, Mean±SD ^a	70.73±7.841	70.9±7.566	70.20±7.305	0.485*	28.33±21.34	33.47±19.332	24.33±22.600	<0.001*
Department								
Internal medicine	182(79.1)	125(68.7)	57(31.3)	0.155	149(35.3)	97(65.1)	52(34.9)	<0.001
Surgery	34(14.8)	28(82.4)	6(17.6)		70(16.6)	62(88.6)	8(11.4)	
Peadiatric	0(0.0)	0	0		154(36.5)	59(38.3)	95(61.7)	
Others	14(6.1)	8(57.1)	6(42.9)		49(11.6)	32(65.3)	17(34.7)	
Disease category								
Circulatory disease	101(43.9)	70(39.3)	32(30.7)	0.271	88(20.9)	54(61.4)	34(38.6)	0.084
Respiratory disease	18(7.8)	15(83.3)	3(16.7)		77(18.2)	47(61.0)	30(39.0)	
Digestive disease	23(10.0)	14(60.9)	9(39.1)		60(14.2)	33(55.0)	27(45.0)	
Urinary disease	5(2.2)	4(80.0)	1(20.0)		20(4.7)	15(75.0)	5(25.0)	
Endocrinology diseases	16(7.0)	9(56.3)	7(43.8)		18(4.3)	12(66.7)	6(33.3)	
Bones and muscles	6(2.6)	3(50.0)	3(50.0)		17(4.0)	8(47.1)	9(52.9)	
Injury and poisoning	10(4.3)	10(100.0)	0(0.0)		22(5.2)	19(86.4)	3(13.6)	
Symptoms and signs	38(16.5)	26(68.4)	12(31.6)		62(14.7)	33(53.2)	29(46.8)	
Others	13(5.7)	10(76.9)	15(23.1)		58(13.7)	29(50.0)	29(50.0)	
Health status								
Good	101(43.9)	71(70.3)	30(29.7)	0.98	324(76.8)	183(56.5)	141(43.5)	0.101

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3	General	108(47.0)	75(69.4)	33(30.6)		83(19.7)	56(67.5)	27(32.5)
4	Poor	21(9.1)	15(71.4)	6(28.6)		15(3.6)		
5	DOCD							
6	Yes	171(74.3)	117(68.4)	54(31.6)	0.414	179(42.4)	91(50.8)	88(49.2)
7	No	59(25.7)	44(74.6)	15(25.4)		243(57.6)	159(65.4)	84(34.6)

10 Note: DOCD, Diagnosis of chronic diseases. ^aSD, Standard deviation. * T text.

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12 **264 Table 2 Distributions of characteristics of appropriateness admission under the subjective**
13 **265 perception of patients**

15 Variable	16 elderly				17 non-elderly			
	18 N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P- value	N (column %)	Appropriate N(line %)	Inappropriate N(line%)	P- value
19 RTDAR								
20 No doubt	63(27.4)	90(56.3)	70(43.8)	0.119	160(37.9)	46(73.0)	17(27.0)	0.007
21 Doubt	17(7.4)	16(59.3)	11(40.7)		27(6.4)	16(94.1)	1(5.9)	
22 Expected	124(53.9)	124(65.3)	66(34.7)		190(45.0)	84(67.7)	40(32.3)	
23 Family requirements	13(5.7)	8(80.0)	2 (20.0)		10(2.4)	8(61.5)	5(38.5)	
24 Others	13(5.7)	12(34.3)	23(65.7)		35(8.3)	7(53.8)	6(46.2)	
25 Disease severity								
26 Light	8(3.5)	39(58.2)	28(41.8)	0.546	67(15.9)	7(87.5)	1(12.5)	0.697
27 General	46(20.0)	63(56.3)	49(43.8)		112(26.5)	32(69.6)	14(30.4)	
28 Serious	176(76.5)	148(60.9)	95(39.1)		243(57.6)	122(69.3)	54(30.7)	
29 Comparison of R ₀ and R ₁								
30 R ₀ >R ₁	62(27.0)	37(80.4)	9(19.6)	0.003	46(10.9)	54(87.1)	8(12.9)	0.003
31 R ₁ >R ₀	101(43.9)	101(53.2)	89(46.8)		190(45.0)	64(56.1)	37(43.9)	
32 Unknown	67(29.1)	112(60.2)	74(39.8)		186(44.1)	43(70.9)	24(29.1)	
33 Affordability								
34 Difficult	73(31.7)	37(61.7)	23(38.3)	0.009	60(14.2)	61(83.6)	12(16.4)	0.842
35 Reluctantly	83(36.1)	124(57.9)	90(42.1)		214(50.7)	54(65.1)	29(34.9)	
36 Fully payable	74(32.2)	89(60.1)	59(39.9)		148(35.1)	46(62.2)	28(37.8)	
37 Hospitalisation								
38 convenience								
39 Yes	116(50.4)	169(60.8)	109(39.2)	0.085	278(65.9)	75(64.7)	41(35.3)	0.368
40 No	114(49.6)	81(56.3)	63(43.8)		144(34.1)	86(75.4)	28(24.6)	

41 Note: RTDAR, Response to Doctor's Admission Requirement.

42 RO, Reimbursement of Outpatient; RI, Reimbursement of Inpatient.

43 **266 Determinants of inappropriate admission to hospital for elderly people**

44 **267 Logistic regression based on the interaction of age (elderly and non-elderly group) and**

45 **268 other factors shows that the interaction between age and gender and between age and**

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4 269 chronic disease both had influence on patients' inappropriate admission to hospital
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7 270 (table3). Compared with non-elderly, the risk of inappropriate admission of female
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9 271 elderly was lower (OR=0.33, 95%CI: 0.15-0.73), and elderly with chronic disease were
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12 272 more likely to be inappropriately admitted to hospital (OR=3.33, 95%CI: 1.23 -9.04).
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273 **Table 3 Logistic regression analysis based on the interaction of age and other factors (n=652)**

Variable	COR(95%CI)	AOR(95%CI) †	Variable	COR(95%CI)	AOR(95%CI) †
County(ref:Yilong) **			Health status(ref:Good)		
Huining	1.04(0.62 to 1.72)	1.29(0.68 to 2.44)	General	0.68(0.47 to 0.98)	0.82(0.50 to 1.33)
Dingyuan	4.03(2.52 to 6.43)	5.99(3.08 to 11.68)	Poor	0.57(0.27 to 1.22)	0.83(0.33 to 2.06)
Weiyuan	1.16(0.99 to 2.61)	1.85(0.98 to 3.48)	RTDAR(ref:No doubt)#		
Age(ref: non-elderly) **	0.62(0.44 to 0.88)	1.35(0.59 to 3.10)	Doubt	0.59(0.29 to 1.20)	0.6(0.26 to 1.39)
Gender(ref: male)*	1.01(0.74 to 1.39)	1.64(1.03 to 2.63)	Expected	0.80(0.56 to 1.14)	0.82(0.53 to 1.27)
Disease category(ref:Circulatory disease)#			Family requirements	0.68(0.27 to 1.73)	0.73(0.25 to 2.09)
Respiratory disease	1.02(0.61 to 1.71)	0.83(0.43 to 1.58)	Others	2.39(1.26 to 4.52)	1.91(0.89 to 4.09)
Digestive disease	1.46(0.86 to 2.48)	2.84(1.44 to 5.58)	Disease severity(ref:Light)		
Urinary disease	0.60(0.23 to 1.58)	1.04(0.32 to 3.39)	General	1.05(0.60 to 1.85)	1.05(0.51 to 2.15)
Endocrinology diseases	1.81(0.56 to 2.51)	1.43(0.60 to 3.45)	Serious	0.88(0.53 to 1.45)	1.28(0.66 to 2.50)
Bones and muscles	2.08(0.87 to 4.98)	1.45(0.52 to 4.06)	Comparison of R ₀ and R ₁ (ref:R ₀ >R ₁)#		
Injury and poisoning	0.20(0.06 to 0.67)	0.99(0.24 to 4.13)	R ₁ <R ₀	4.09(2.32 to 7.21)	2.13(1.08 to 4.21)
Symptoms and signs	1.33(0.81 to 2.18)	1.63(0.91 to 2.93)	Unknown	3.38(1.90 to 6.02)	1.62(0.80 to 3.27)
Others	1.57(0.90 to 2.73)	1.30(0.64 to 2.64)	Affordability(ref:Difficult) **		
Department(ref:Internal medicine) **			Reluctantly	1.87(1.19 to 2.94)	1.14(0.66 to 1.96)
Surgery	0.32(0.17 to 0.58)	0.11(0.05 to 0.25)	Fully payable	1.80(1.13 to 2.89)	1.84(1.05 to 3.24)
Pediatric	3.28(2.20 to 4.88)	4.26(1.94 to 9.35)	Hospitalisation convenience(ref:Yes)	0.89(0.64 to 1.23)	1.25(0.84 to 1.88)
Others	1.17(0.67 to 2.05)	1.16(0.59 to 2.29)	Age×Gender (ref:non-elderly×male)**	0.53(0.34 to 0.82)	0.33(0.15 to 0.73)
DOCD(ref:No) **	1.40(1.02 to 1.93)	0.32(0.16 to 0.65)	Age×DOCD(ref:non-elderly×No)*	0.55(0.30 to 1.02)	3.33(1.23 to 9.04)

Note: #Univariate regression analysis $p < 0.05$, *Logistic Regression Analysis $p < 0.05$
†Adjusted for all other covariates listed in the table

AOR, adjusted OR; COR, crude OR.

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275 The results of the binary logistic regression for elderly patients are shown in Table 4.
 276 Taking Yilong as the reference group, rural elderly patients in Dingyuan had a higher
 277 risk of inappropriate admission to hospital (OR=9.74, 95%CI: 3.30-28.41). A higher
 278 age corresponds to a lower possibility of inappropriate admission (OR=0.94, 95%CI:
 279 0.90-0.99). Elderly people in the surgery department are less likely to be admitted to
 280 hospital inappropriately (OR=0.21, 95%CI: 0.07-0.61). For the subjective cognition of
 281 elderly patients, our study showed that only patients who have doubts about the doctor's
 282 admission requirement but decided to be hospitalised after communication with the
 283 doctor were the least likely to be admitted inappropriately (OR=0.07, 95%CI:0.01-0.76).

284 **Table 4 logistic regression analysis of inappropriate admission of elderly (n = 230)**

Variable	COR(95%CI)	AOR(95%CI) †
County(ref: Yilong)*		
Huining	1.60(0.63 to 4.06)	0.67(0.21 to 2.07)
Dingyuan	6.33(2.63 to 15.25)	9.74(3.30 to 28.41)
Weiyuan	3.21(1.29 to 7.98)	3.36(1.08 to 10.46)
Age(years) *	0.99(0.95 to 1.03)	0.94(0.90 to 0.99)
Gender (ref: male)*	0.64(0.36 to 1.14)	0.49(0.25 to 2.98)
Department (ref:internal medicine)*		
Surgery	0.47(0.18 to 1.20)	0.21(0.07 to 0.61)
Others	1.65(0.55 to 4.96)	1.49(0.35 to 6.27)
RTDAR (ref: No doubt)*		
Doubt	0.17(0.02 to 1.38)	0.07(0.01 to 0.76)
Expected	1.29(0.66 to 2.52)	0.87(0.39 to 1.96)
Family requirements	1.69(0.49 to 5.89)	1.48(0.34 to 6.34)
Others	2.32(0.68 to 7.89)	4.14(0.94 to 18.24)
Affordability(ref: difficult)#		
Reluctantly	2.73(1.27 to 5.87)	1.69(0.68 to 4.20)
Complete	3.09(1.42 to 6.73)	2.84(1.13 to 7.17)

Note: forward stepwise : $\alpha_{\text{entry}}=0.1$, $\alpha_{\text{removal}}=0.15$

#Univariate regression analysis $p<0.05$, *Logistic Regression Analysis $p<0.05$

†Adjusted for all other covariates listed in the table

AOR, adjusted OR; COR, crude OR.

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286 **Discussion**

287 By the descriptive analysis and logistic regression analysis, we studied the
288 characteristic and determinants of inappropriate admission of elderly people in rural
289 China. According to our results, we would try to find out the reasons for the
290 inappropriate admission of the elderly people in rural China from the perspective of
291 supply and demand by discussing the determinant factors of it. And our study would
292 also try to give some suggestions for the Chinese government to control the
293 inappropriate admission of the elderly, and provide the new observations for
294 researchers in this field.

295 *Inappropriate admission of elderly in rural China*

296 In this study, the inappropriate admission rate of patients over 60 year old in rural areas
297 in China is 30%, which is generally higher than that reported of 27% in the UK [18],
298 9.8% in Italy^[14], 9.2% in Switzerland^[19] and 8.8% in France^[13]. Yan et al.^[20] found that
299 the inappropriate admission rate of patients over 60 years in rural areas in China was
300 14.3%, which was also lower than the results of this study. This result may be attributed
301 to the differences among the studies with regard to health service system, geographical
302 environment or study period. These studies were mainly concerned on elderly people
303 of different age groups and in different admission departments. The inappropriate
304 admission rate of elderly patients (30%) was lower than that of non-elderly patients
305 (40.8%) probably because the body functions of elderly patients are worse than those

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4 306 of non-elderly patients. Moreover, an elderly person presents more obvious and serious
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6 307 symptoms at the onset of a disease and is thus less likely to be inappropriately admitted.
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9 308 ***Characteristics of elderly patients who were hospitalised inappropriately***

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11 309 Significant differences were found in the distribution of inappropriate admission among
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14 310 elderly patients across different counties. Among the four surveyed areas, Dingyuan
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17 311 had the highest rate of inappropriate admission, whereas Yilong has the lowest. It may
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19 312 be related to the differences in health policies, geographical environment and customs
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22 313 between the counties. Elderly patients who affords the hospitalisation costs difficult had
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24 314 the lowest inappropriate admission rate. It may be caused by economic difficulties that
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27 315 restrict the utilization of health services for elderly patients in rural areas in China [21].
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30 316 Our research proves that elderly people who have a correct understanding of medical
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32 317 insurance reimbursement have higher inappropriate admission rates, probably because
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35 318 the medical insurance reimbursement policy has promoted the excessive release of
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38 319 hospitalisation services demand for elderly patients [22].
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40 320 ***Determinants of inappropriate admission for elderly people***

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43 321 Gender and chronic diseases are the specific factors affecting the inappropriate
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45 322 admission of elderly people. Compared with non-elderly patients, the tendency of
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48 323 female elderly patients for inappropriate hospitalisation was less obvious. Moreover,
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51 324 the risk of inappropriate admission of elderly patients with chronic disease was higher,
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53 325 which is consistent with the findings of Gamper, probably because relative to non-
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56 326 elderly people, elderly people are less aware of the disease. Moreover, a perfect chronic
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59 327 disease management is lacking in rural areas in China. When the symptoms of chronic
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4 328 diseases appear, it is easier for elderly earlier to misjudge the disease and blindly choose
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7 329 to be admitted to a hospital.

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9 330 The logistic regression shows that the risk of inappropriate admission varies across
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11 331 different counties in China's rural areas. The health policy in different counties,
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14 332 especially the medical insurance policy, plays a key role in the inappropriate admission
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17 333 of elderly patients (the NRCMS reimbursement policies in the survey areas in 2017 was
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19 334 shown in additional file 2). A large gap exists between the outpatient and hospitalisation
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22 335 compensation in the survey area. Especially at county-level hospitals, the general
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25 336 outpatient reimbursement is not covered, hence, elderly people in rural areas prefer
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28 337 hospitalisation and get more medical expense reimbursement. Dingyuan has the highest
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30 338 risk of inappropriate admission for elderly patients, which may be caused by its high
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33 339 level of reimbursement policy of the NRCMS. In 2017, the reimbursement ratio of
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35 340 NRCMS in Dingyuan county-level hospital was 85%, and the annual payment
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38 341 limitation of each inpatient could reach 200 thousand RMB, which was higher than that
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41 342 of Yilong and Weiyuan. Although the reimbursement ratio of NRCMS and the annual
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44 343 payment limitation of each inpatient in Yilong are higher than that of Weiyuan, the risk
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47 344 of inappropriate admission of elderly patients in Weiyuan was higher, may be because
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50 345 the greater impact of its geographical environment. Yilong is located in low hills and
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53 346 has a convenient mode of transportation, whereas Weiyuan is located in high
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56 347 mountainous area, where the terrain is complex and the traffic is inconvenient, which
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59 348 make it more difficult for elderly patients to travel and make them choose to be admitted
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349 for treatment convenience^[23].

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4 350 Gender and age also had an impact on the inappropriate admission of elderly people in
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6 351 rural areas in China. Compared with female elderly patients, the inappropriate
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9 352 admission tendency of male elderly patients is more obvious. This observation is
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11 353 probably caused male patients by the generally higher status in the family and society
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14 354 of male elderly patients than females ^[24], and their health status receives more attention,
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17 355 which makes them willing to use hospitalisation to ensure the treatment effect and
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19 356 resulting in inappropriate admission. With increasing age, elderly patients are less likely
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22 357 to be admitted inappropriately. This result is consistent with that of other studies ^[25].
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25 358 The reason is mainly because older patients have severely reduced their body functions,
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27 359 and their disease are more serious; hence, inappropriate admission is relatively rare.
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30 360 The department was also a key factor in the inappropriate admission of elderly patients.
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32 361 Compared with surgery, medical patients are more prone to inappropriate admissions
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35 362 (the inappropriate admission rate of 31.3%), which is consistent with the results of
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38 363 Ferrero ^[26]. This observation might be caused by two reasons: On the one hand, many
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40 364 surgical-related indicators are included in the original evaluation indicators in AEP ^[27],
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43 365 which improves the rationality of surgical patient admission. On the other hand, most
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45 366 elderly patients suffer from chronic diseases, making internal medicine departments
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48 367 easily selected for treatment. However, the performance appraisal of Chinese hospital
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50 368 is always directly linked to departmental income. However, the internal medicine
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53 369 income is significantly lower than that of surgery, which causes physicians to produce
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56 370 a more induced demand in pursuit of departmental income ^[28]. In addition, the hospital
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59 371 lacks admission standards for the severity of the disease, and the intensity of medical
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4 372 services required. These factors have increased the possibility of inappropriate
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7 373 admission to the elderly.

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9 374 The response of rural elderly patients to hospital admission requirements directly
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11 375 affects the appropriateness of admission. Elderly patients who had doubts about the
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14 376 doctor's admission requirements and communicated with the doctor before deciding to
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17 377 enter the hospital have a significantly less possibility of being admitted inappropriately.

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19 378 The influence of this factor on the appropriateness of hospitalisation in rural elderly is
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22 379 mainly reflected in two points. Firstly, Chinese rural areas have not established a perfect
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25 380 'family doctor first' consultation mechanism, and rural elderly patients lack the guidance
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28 381 of the first diagnosis and the correct understanding of their disease. Cultural degree is
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30 382 low especially for the elderly patients in rural areas in China, which makes their
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33 383 judgment of the disease entirely dependent on the clinician. For doctors' admission
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36 384 requirements, if elderly patients communicate with doctors effectively, understand their
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39 385 own disease condition and make admission decisions accordingly, inappropriate
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42 386 admission tendency of elderly patients is significantly reduced. Secondly, the doctor's
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45 387 request for admission to the patient is not only based on the judgment of the patient's
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48 388 basic condition but also with the factors of medical accident risk aversion, departmental
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51 389 income, etc^[29,30]. Clinical decision-making of doctors under various factors meets the
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54 390 appropriate admission requirements of elderly patients becomes a key point affecting
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57 391 the rationality of patients' admission, which was proved by Aida bianco and Mytton.

392 **Conclusion**

393 In this study, the rate of inappropriate admissions of elderly patients in county-level
394 hospitals from rural China was high. We found that chronic diseases was the specific
395 factor and county, department and the response to the doctor's admission requirements
396 were the determinants of the inappropriate admission of elderly patients. We believe
397 that these factors are closely related to the management of chronic diseases to elderly,
398 regional health policies (especially the NRCMS), department management, and family
399 doctor service in rural China. Therefore, this study suggests that the government can
400 control the inappropriate admission of the elderly from the following points.1) the
401 NRCMS management department should adjust the reimbursement ratio of
402 hospitalisation and outpatient according to actual inspections and increase the ratio of
403 outpatient reimbursement to a certain extent, reducing unnecessary hospitalisation
404 needs. 2) hospital department needs to establish a performance appraisal system with
405 medical quality and patient satisfaction as the core, and admission criteria for the
406 severity of the disease and the intensity of required medical services should also be
407 established. 3) To improve elderly patients' cognition of the disease, China's rural areas
408 need to establish a family doctor service based on the concept of health management
409 ^[31], and provide medical consultation and guidance for elderly patients.

410 **Limitation**

411 This study has two limitations. Firstly, the cross-sectional study design could not
412 determine the causal relationship between unreasonable admission and related factors
413 in elderly patients. Secondly, no unified identification standard exists for the

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4 414 inappropriate admission of elderly patients in the current studies [32], making the
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6 415 identification of inappropriate admission dependent on the AEP. The AEP applicable
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9 416 to the entire population may not be the best tool for evaluating the inappropriate
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11 417 admission of elderly patients [17, 33-35].
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14 418 **Competing interests**

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17 419 The authors declare no competing interests.
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20 420 **Authors' contributions**

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22 421 X-M.H, H-X.G and Y.Z participated in the conception and design of the manuscript.
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25 422 X-M.H and H-X.G contributed equally to the development of this research study. Y.Z,
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28 423 H-M.L, D.S, J-J.C, S-H.L and D.J participated in the data collection and statistical
29
30 424 analysis. Y-C.C helped draft, review and revise the manuscript. All authors gave their
31
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33 425 approval to publish this version of the manuscript.
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39
40
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43 429 **Disclosure**

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46 430 This work has never been published or presented at any time in the past.
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48

49 431 **Provenance and peer review**

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52 432 This work is not commissioned and is externally peer reviewed.
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54 433 **Data sharing statement**

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57 434 The anonymised dataset can be requested by sending an email to the corresponding
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435 author.

Reference:

- 436
- 437 1. National Bureau of Statistics of China. Statistical Communiqué of the People's Republic of China
438 on the 2017 National Economic and Social Development [N]. China Information Daily, 2018-03-
439 01 (003).
- 440 2. Center for Health Statistics and Information. An Analysis Report of National Health Services
441 Survey in China, 2013 [M]. Peking Union Medical College Press, 2015.
- 442 3. Xiaona Gao, Yingchun Chen, Zhaoqun Chu, Lijing Zhang. Analysis of characteristic excessive
443 demand for elderly inpatient service and causes covered by NRCMS [J]. Chinese Journal of
444 Hospital Administration, 2015(4):279-282. 'doi': 10.3760/cma.j.issn.1000-6672.2015.04.011
- 445 4. Lavis, J.N.; Anderson, G.M. Appropriateness in health care delivery: Definitions, measurement and
446 policy implications. *CAN MED ASSOC J* **1996**, 154, 321-328.
- 447 5. Payne, S.M. Identifying and managing inappropriate hospital utilization: a policy synthesis.
448 *HEALTH SERV RES* **1987**, 22, 709-769.
- 449 6. Campbell, J. Inappropriate admissions: thoughts of patients and referring doctors. *J R Soc Med* **2001**,
450 94, 628-631. 'doi': 10.1177/014107680109401206
- 451 7. World Health Organization. China country assessment report on ageing and health [R].2016.
- 452 8. Jinghong Chen. Research on Demand an Utilization of Health Service among the Elderly in Rural
453 Areas under the Background of Ageing[D] Peking Union Medical College,2012.
- 454 9. XIE Chun-yan, HU Shan-lian, SUN Guo-zhen, et al. Exploration and Experience of Provider
455 Payment System Reform in China [J]. Chinese Health Economics, ,2010,29(05):27-29.
456 'doi':10.3969/j.issn.1003-0743.2010.05.008
- 457 10. Creditor M C. Hazards of hospitalization of the elderly[J]. Annals of Internal Medicine, 1993,
458 118(3):219-223. 'doi': 10.7326/0003-4819-118-3-199302010-00011
- 459 11. Fusco M, Buja A, Piergentili P, et al. Individual and hospital-related determinants of potentially
460 inappropriate admissions emerging from administrative records.[J]. Health Policy, 2016,
461 'doi':120(11):1304-1312. 10.1016/j.healthpol.2016.09.015
- 462 12. Gamper G, Wiedermann W, Barisonzo R, et al. Inappropriate hospital admission: interaction
463 between patient age and co-morbidity[J]. Internal & Emergency Medicine, 2011, 6(4):361-367.
464 'doi':10.1007/s11739-011-0629-0
- 465 13. Menand E, Lenain E, Lazarovici C, et al. French multicenter evaluation of the appropriateness of
466 admission to the emergency department of the over-80s[J]. Journal of Nutrition Health & Aging,
467 2015, 19(6):1-7. 'doi':10.1007/s12603-015-0489-9
- 468 14. Bianco A, Pileggi C, Rizza P, et al. An assessment of inappropriate hospital bed utilization by
469 elderly patients in southern Italy[J]. Aging Clinical & Experimental Research, 2006, 18(3):249-
470 256. 'doi':10.1007/BF03324656
- 471 15. Mytton O T, Oliver D, Mirza N, et al. Avoidable acute hospital admissions in older people[J].
472 British Journal of Health Care Management, 2013, 18(11):597-603.
473 'doi':10.12968/bjhc.2012.18.11.597
- 474 16. Gertman P M, Restuccia J D. The appropriateness evaluation protocol: a technique for assessing
475 unnecessary days of hospital care.[J]. Medical Care, 1981, 19(8):855-71. 'doi':10.1097/00005650-
476 198108000-00005

- 1
2
3
4 477 17. Yingchun Chen, Excessive demand for inpatient service in rural areas [M]. 科学出版社, 2014.
- 5
6 478 18. Leah V, Adams J. Assessment of older adults in the emergency department.[J]. Nursing Standard,
7 479 2010, 24(46):42. 'doi': 10.7748/ns2010.07.24.46.42.c7911
- 8
9 480 19. Ingold B B, Yersin B, Wietlisbach V, et al. Characteristics associated with inappropriate hospital
10 481 use in elderly patients admitted to a general internal medicine service[J]. Aging Clinical &
11 482 Experimental Research, 2000, 12(6):430-438. 'doi':10.1007/BF03339873
- 12
13 483 20. Zhang, Y., et al., Determinants of Inappropriate Admissions in County Hospitals in Rural China: A
14 484 Cross-Sectional Study. Int J Environ Res Public Health, 2018. 15(6). 'doi':10.3390/ijerph15061050
- 15
16 485 21. CHEN Fang-wu, YANG Xu-li, LIU Jie. Analysis on the situation of health service utilization and
17 486 its influencing factors among aged people[J].Modern Preventive Medicine,2007(16):3083-3085.
18 487 'doi':10.3969/j.issn.1003-8507.2007.16.037
- 19
20 488 22. HU HONG-Wei, LUAN Wen-jing, LI Jia-yi. Medical insurance, health Services Utilization and
21 489 Excessive Demands for Medical Services——The Impact of Medical Insurance on Utilization of
22 490 Health Service of the elderly [J]. Journal of Shanxi Finance and Economics University,
23 491 2015,37(05):14-24. 'doi':10.13781/j.cnki.1007-9556.2015.05.002
- 24
25 492 23. Yan Z, Chen Y, Xiang Z, et al. Current level and determinants of inappropriate admissions to
26 493 township hospitals under the new rural cooperative medical system in China: a cross-sectional
27 494 study[J]. BMC Health Services Research, 2014, 14(1):649. 'doi':10.1186/s12913-014-0649-3
- 28
29 495 24. TANG Yong-xia, LUO Wei-guo. Investigation on Family Status of Women in Poor Rural Areas—
30 496 —With Tongwei County in Dingxi of Gansu as an Example [J]. Journal of University of Science
31 497 and Technology Beijing (Social Sciences Edition), 2014, 30(4):46-55. 'doi':10.3969/j.issn.1008-
32 498 2689.2014.04.007
- 33
34 499 25. Tavakoli N, Hosseini Kasnavieh S M, Yasinzadeh M, et al. Evaluation of Appropriate and
35 500 Inappropriate Admission and Hospitalization Days According to Appropriateness Evaluation
36 501 Protocol (AEP).[J]. Archives of Iranian Medicine, 2015, 18(7):430-434.
- 37
38 502 26. Ferrero, B.O.; Sanchez, M.L.; Corredera, R.C.; Uriarte, A.E.; de Miguel, D.L.V.F. Inappropriate
39 503 admissions to the Department of Internal Medicine evaluated by the AEP (Appropriateness
40 504 Evaluation Protocol). An Med Interna 1998, 15, 674-675.
- 41
42 505 27. Mozes, B.; Schiff, E.; Modan, B. Factors affecting inappropriate hospital stay. Quality assurance in
43 506 health care : the official journal of the International Society for Quality Assurance in Health Care
44 507 1991, 3, 211-217. 'doi': 10.1093/intqhc/3.3.211
- 45
46 508 28. Gan C H, Zhou X, Zheng R G. Imperfect Information, Supplier-induced Demand and Quality of
47 509 Health Service[J]. Journal of Finance & Economics, 2007. 'doi':10.3969/j.issn.1001-
48 510 9952.2007.08.009
- 49
50 511 29. Yip, W.C.; Hsiao, W.; Meng, Q.; Chen, W.; Sun, X. Realignment of incentives for health-care
51 512 providers in China. LANCET 2010, 375, 1120-1130. 'doi':10.1016/S0140-6736(10)60063-3
- 52
53 513 30. Osinaike, B.B.; Olusanya, O. Inappropriate Intensive Care Unit admissions: Nigerian doctors'
54 514 perception and attitude. NIGER J CLIN PRACT 2016, 19, 721-724. 'doi':10.4103/1119-
55 515 3077.181354
- 56
57 516 31. Purdy S, Griffin T. Reducing hospital admissions[J]. Bmj, 2008, 336(7634):4-5.
58 517 'doi':10.1136/bmj.39394.402465.BE
- 59
60 518 32. Thwaites R, Glasby J, Le M N, et al. Room for one more? A review of the literature on
519 519 'inappropriate' admissions to hospital for older people in the English NHS.[J]. Health & Social Care

- 1
2
3 520 in the Community, 2017, 5(1):309-15. 'doi':10.1111/hsc.12281
4 521 33. Sánchez-García S, Juárez-Cedillo T, Mould-Quevedo J F, et al. The hospital appropriateness
5 522 evaluation protocol in elderly patients: a technique to evaluate admission and hospital stay[J].
6 523 Scandinavian Journal of Caring Sciences, 2010, 22(2):306-313. 'doi':10.1111/j.1471-
7 524 6712.2007.00528.x ·
8
9 525 34. Cardona-Morrell M, Jch K, Brabrand M, et al. What is inappropriate hospital use for elderly
10 526 people near the end of life? A systematic review[J]. European Journal of Internal Medicine, 2017.
11 527 'doi': 10.1016/j.ejim.2017.04.014
12
13 528 35. Liu W, Yuan S, Wei F, et al. Reliability and Validity of the Chinese Version Appropriateness
14 529 Evaluation Protocol[J]. Plos One, 2015, 10(8):e0136498. 'doi': 10.1371/journal.pone.0136498
15
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24
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For peer review only

Additional file 1 R-AEP criteria for county hospitalisation

A. Needed medical service

1. Need surgery or follow-up treatment within 24 hours: (1) local anesthesia or general anesthesia; and/or (2) instruments or other facilities that are only available for hospitalized patients (angiography, visceral biopsy)
2. Treatment with varying dosage or drug on a regular basis under direct medical supervision
3. Calculation of intake and output volume
4. Operation to be conducted on the following day in the operating room, detailed pre-operative consultation or evaluation on the day of admission
5. Main surgical incision and drainage nursing
6. Quarantined patients
7. Bedside electrocardiogram (ECG) monitoring or testing vital signs at least every 2 hours
8. Stopping (at least once every 8 hours) or continuing oxygen inhalation
9. Referral of post-operative recovery

B. Severity of illness

1. Continuous fever $>38.0^{\circ}\text{C}$ for more than 5 days
2. Acute confusion (coma or adipsoria)
3. Severe anomaly in electrolyte or blood and vigor, showing the following situations: (1) $\text{Na} < 123 \text{ mEq/L}$ or $> 156 \text{ mEq/L}$; (2) $\text{K} < 2.5 \text{ mEq/L}$ or $> 6.0 \text{ mEq/L}$; (3) $\text{HCO}_3 < 20 \text{ mEq/L}$ or $> 36 \text{ mEq/L}$; and (4) arterial blood $\text{pH} < 7.30$ or > 7.45
4. Loss of sight or hearing for 48 hours
5. Loss of activity in any part of the body for 48 hours
6. Excretion disorder or absence of intestinal peristalsis in the past 24 hours
7. Active bleeding
8. Needing blood transfusion because of bleeding
9. Mental disorders caused by non-alcohol dependence
10. Viscera removal or surgical wound dehiscence
11. Pulse less than 50 times or greater than 140 times per minute
12. Abnormal blood pressure: systolic blood pressure $< 90 \text{ mmHg}$ or $> 200 \text{ mmHg}$ and/or diastolic blood pressure $< 60 \text{ mmHg}$ or $> 120 \text{ mmHg}$
13. Ventricular fibrillation or acute myocardial ischemia shown by electrocardiogram (ECG) report or course log
14. Acute blood disorder, severe medium-sized leukopenia, thrombocytopenia, leukocytosis, erythrocytosis, thrombocytosis or hemolysis-resulted symptoms
15. Progressive acute neurological disorders
16. Soft tissue injuries affecting basic self-care
17. Acute myocardial infarction or cerebrovascular accident (stroke)
18. Spinal cord lesions
19. Lung infection above 40% or leafy lesions according to X-ray examination
20. Hyperemesis or acute pain at acute attack by chronic diseases
21. Burns occurred in specific areas

Additional file 2 NRCMS reimbursement policies in the survey areas in 2017

County	R _o		R _i						APL(RMB)
	township hospitals		township hospitals			county hospitals			
	RR	APL(RMB)	Deductible	RR	PL(RMB)	Deductible	RR	PL(RMB)	
Yilong	60%	120	100	90%	-	400	75%	-	180000
Huining	60%	300	150	90%	3000	500	85%	20000	80000
Dingyuan	45%	150	150	90%	-	620	85%	-	200000
Weiyuan	90%	110	150	80%	3000	500	70%	15000	80000

Note: R_o, Reimbursement of Outpatient; R_i, Reimbursement of Inpatient.

RR, Reimbursement ratio; APL, Annual payment limitation; PL, payment limitation of each time.

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2,3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6,7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	6,7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8,9,10
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	9
		(b) Describe any methods used to examine subgroups and interactions	9
		(c) Explain how missing data were addressed	
		(d) If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	11
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest	12
Outcome data	15*	Report numbers of outcome events or summary measures	11,12
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	14,15,16 12,13,14
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14
Discussion			
Key results	18	Summarise key results with reference to study objectives	17—21
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	22
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17—21
Generalisability	21	Discuss the generalisability (external validity) of the study results	
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.