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## **Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Cohort Study in China**

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4 **1 Determinants of Patient Choice for Hospital Readmission after**  
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7 **2 Township Hospitalisation: A Population-Based Retrospective Cohort**  
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9 **3 Study in China**  
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## Abstract

**Objective:** The lack of coordinated and appropriate healthcare across sectors has produced more patients for county hospitals. This research aimed to examine the differences in the choices between township and county hospitals for readmission after a township hospitalisation and the determinants that influence choice for hospital readmission.

**Design:** A retrospective cohort study drew out readmissions cross hospitals after first admission in township hospital, and the differences between township–township inpatients (TT group) and township-county inpatients (TC group) were compared. Moreover, a two-level logistic regression model was used to examine the determinants of choice for hospital readmission through MLwiN 2.30.

**Setting:** A population-based health utilisation database was used in Qianjiang District, China, from January 1, 2008 to December 31, 2013.

**Participants:** The study focused on readmitted individuals whose first admission was in township hospital. The readmission cases were identified with the same diagnosis in hospitalisation according to the ICD-10 within 30 days. In total, 6,764 readmissions had first admissions in township hospital.

**Primary outcome measures:** Patient choice for hospital readmission after township hospitalisation

**Results:** TT group accounted for 62.5% (4,225) and TC group accounted for 37.5% (2,539) in six years. These incidence rates varied in different towns ( $P < 0.001$ ). The notable differences between TC and TT group characteristics are as follows: length of

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4 45 stay (LOS) of first admission (6.96 versus 9.23), average interval (6.03 versus 14.95)  
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6 46 and disease category. Admitting year, age, arrival time to county hospital, inpatient  
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8 47 interval, LOS in first admission and disease category were the determinants of choice  
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11 48 for hospital readmission.

12  
13 49 **Conclusions:** Patients whose first admission was in a township hospital were more  
14  
15 50 likely to be readmitted to a county hospital year by year. Reducing the incidence and  
16  
17 51 decreasing patient dissatisfaction are the focused actions to rebuild the healthcare  
18  
19 52 delivery system in rural China.

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21 53 **Keywords:** readmission, choice, county hospital, patient flow, rural China  
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## 26 54 **Article summary**

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29 55 • This is the first study to introduce township-county readmission, the unique form of  
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31 56 hospitalisation in rural China.  
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34 57 • Population-level data on readmission is seldom reported across different level  
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36 58 hospitals. A two-level logistic regression model was used for the consideration of  
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38 59 aggregation at the town level.  
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41 60 • Findings in this research reveal the dissatisfied township-county readmission is a  
42  
43 61 probable cause of inappropriate level of hospitalisation for the first time.  
44  
45 62 • The combination of first LOS and interval may be an effective identification index  
46  
47 63 to identify the forms of township-county readmission.  
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49 64 • Hospitalisation information, geographical factor, referral status and disease were all  
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51 65 drawn into the logistic regression model, but some individual factors were deficient.  
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## 66 **Background**

67 Readmission is an episode where an inpatient is readmitted for once disease with  
68 30-day. <sup>[1, 2]</sup> In most studies, readmission findings reflect that inpatient care did not  
69 meet patient requirements, and readmission rate is used as an evaluation index of  
70 hospitalisation quality. <sup>[3]</sup> Readmission usually occurs in the same hospital,  
71 sometimes across hospitals because of the disease variability. <sup>[4]</sup> However, in rural  
72 China, multi-level institutional readmission is a popular and important healthcare  
73 utilisation, which reflects the defects of China's healthcare delivery system, instead of  
74 hospitalisation quality, especially township–county (TC) readmission. TC readmission  
75 is a health-seeking behaviour in which inpatients ask for healthcare services first in a  
76 township hospital and second in a county hospital, whether planned or unplanned,  
77 voluntarily or passively. TC readmission occurs constantly in rural China and  
78 accounts for approximately 4.0% of all inpatient services, currently. <sup>[5]</sup> It has become  
79 a common and inescapable healthcare utilisation. TC readmission usually occurs in  
80 two situations, namely, doctor suggestions and inappropriate individual choice.  
81 TC readmission as suggested by doctors occurs when a township doctor has an  
82 in-patient admission and finds that he/she cannot completely cure the patient or  
83 disease varied. <sup>[6]</sup> Consequently, the patient is referred directly to a county hospital or  
84 is advised to go to county hospitals for succeeding admission. This situation is caused  
85 by the fragmented healthcare delivery system in rural China, where residents seek  
86 care from a village–town–county three-tier healthcare delivery system, and all  
87 hospital services are supplied by township and county hospitals. <sup>[7]</sup> The higher the

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4 88 level of the institution, the stronger the service capability, the longer the distance and  
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6 89 the higher the medical cost. Town hospitals bear the responsibilities of transferring  
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8 90 patients, taking care of inpatients with general illnesses and advising patients with  
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10 91 severe diseases, which are beyond the capacity of township hospitals, to admit to  
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12 92 county hospitals. [8] In particular, township doctors sometimes receive patients whose  
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14 93 diseases are beyond their capacity because of their inaccurate judgment, or disease  
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16 94 varied, and it is hard to avoid.

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21 95 TC readmission caused by inappropriate individual choices happens when patients  
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23 96 who should be readmitted to township hospitals choose to be admitted to county  
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25 97 hospital for personal reasons. [9] Some readmissions are influenced by the quality  
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27 98 problem of township hospitals, poor compliance on medicine and after-cure from  
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29 99 patients themselves or a normal disease recurrence. Nonetheless, patients cannot  
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31 100 recognise the accurate readmission reason and easily transfer the responsibility of  
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33 101 readmission to the township doctor, thinking of it as failed treatment and consequently  
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35 102 deciding to be readmitted to a county hospital. This situation is an inappropriate  
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37 103 readmission. [10]

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43 104 In the view of patients, no order or limitation on patient choice exists, and no GPs or  
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45 105 consultants are available in rural China. Residents freely choose hospitals and service  
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47 106 types, depending mainly on their judgment on the disease and the cognition on  
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49 107 hospitals. If patients choose a higher institution than needed, they pay more; if they  
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51 108 choose a lower institution than needed; they would be referred or readmitted. Thus,  
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53 109 the cost of incorrect decision is borne by the patient himself. To guarantee patient

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4 110 interests on TC readmission, the three-tier healthcare delivery system required  
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6 111 different level hospitals to cooperate with one another in providing continuous  
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8 112 healthcare services. In reality however, communications among township and county  
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11 113 professional providers are limited, and no document sharing and interactions among  
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13 114 providers across the three tiers are virtually present.<sup>[11]</sup> County doctors do not deliver  
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15 115 continued care for readmitting patients on the account of income incentives and risk  
16  
17 116 aversion, and patients readmitted to a county hospital usually get a new treatment.<sup>[12]</sup>  
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19 117 Furthermore, compared with patients admitted directly to county hospitals,  
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21 118 readmitting patients pay more time and costs and even miss the best kind of treatment.  
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23 119 As a result, when diseases occur subsequently, and patients are unable to judge the  
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25 120 severity of the disease, they would tend to choose the county hospital directly for  
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27 121 admission, taking on excess economic risk to avoid delay. Some studies defined TC  
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29 122 readmission as failed treatment in the view of patients and prove that TC readmission  
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31 123 experience can influence the patient choice of hospitals afterwards.<sup>[13, 14]</sup> Gradually,  
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33 124 inpatients will be more likely to gather in county hospitals compared with township  
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35 125 hospitals; in fact, this kind of phenomenon is already happening. The annual growth  
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37 126 rate of inpatients in county hospital is 6.75% whereas that of township hospital  
38  
39 127 inpatients is 0.63% from 2010 to 2016.<sup>[15]</sup>  
40  
41 128 The first point of contact at primary medical institutions is the most efficient supply  
42  
43 129 model, as proven by medical practices around the world. While TC readmission can  
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45 130 easily result in inappropriate patient flow, patient admission to a higher-level hospital  
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47 131 than necessary leads to significant waste. TC readmission has become a determinant



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4 132 of increasing health expenditure. [13] Chinese government is seeking to solidify the  
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6 133 fragmented three-tier healthcare delivery system through the first point of care in  
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8 134 primary institutions and collaboration between township and county hospitals. Given  
9  
10 135 the current situation, guiding patients to choose the correct hospital for readmission  
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12 136 has rationally been a necessary consideration and a key content, and thus, the  
13  
14 137 identification of the choice for hospital readmission could be the first step. This  
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16 138 research focuses particularly on the choices for hospital readmissions, considering  
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18 139 that the first admission of an inpatient was in a township hospital, and makes clear  
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20 140 determinants of choice for hospital readmission.  
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## 26 141 **Methods**

### 27 28 29 142 **Study setting**

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32 143 We focused on individuals who had been discharged from participant hospitals. The  
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34 144 readmission cases were identified as the same diagnosis in hospitalisation between  
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36 145 county and township hospitals within 30 days. From a design of population-based  
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38 146 retrospective cohort, we compared the difference between township–township  
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40 147 readmitted inpatients (TT group) and TC readmitted inpatients (TC group).  
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### 46 148 **Data source**

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48 149 Qianjiang District was designated as the sample area through cluster sampling. It is a  
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50 150 typical rural area located in Chongqing and is the largest municipality in southwest  
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52 151 China. Qianjiang has a per capita GDP of 3984\$, which is below the average GDP in  
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54 152 China. The resident population is 550 thousand, and all residents are covered under  
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4 153 the New Rural Cooperative Medical System (NRCMS), where all residents could  
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6 154 receive reimbursement for inpatient care. Two county hospitals and 30 township  
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8 155 hospitals are in Qiangjiang District, and all township hospitals were divided into four  
9  
10 156 levels according to their scale and service quantity (Fig. 1). This study was based on  
11  
12 157 the NRCMS inpatient database in Qianjiang District, which contains all inpatient  
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14 158 utilisation of all population. In this database, a case means a single hospitalisation,  
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16 159 county or township hospitalisation.  
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## 21 160 **Data processing**

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24 161 This retrospective cohort study drew out all readmissions whose first inpatient  
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26 162 admission was in a township hospital. Samples were selected by MS Excel 2010  
27  
28 163 based on the NRCMS database from January 1, 2008 to December 31, 2013. First,  
29  
30 164 cases that shared the same patient identifier and the same disease codes were sorted  
31  
32 165 together in a chronological order. Second, we calculated the time interval in every  
33  
34 166 adjacent two cases of the same inpatient for the same disease; if the interval time was  
35  
36 167 less than 31 days, then the patient would be marked as a readmission patient. Then, if  
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38 168 the former inpatient of the readmission occurred in a township hospital, and the later  
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40 169 occurred in county hospital, the two cases would be merged as one case and is marked  
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42 170 as a TC readmission, and the patient would be marked as TC patient. TT and TT  
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44 171 patients were treated in the same way. Finally, all TC and TT cases were extracted  
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46 172 into a new database. Complementally, the diagnosis of the same disease may change  
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48 173 among different doctors, in different institutions or at different time; thus, we adjusted  
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50 174 the original ICD-10 disease code to a broader code (taking chronic obstructive  
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175 pulmonary disease for example, and its disease code was adjusted from J44.900 to  
 176 J44), which may improve accuracy of readmitting patients. After screening, the  
 177 number of readmitting patients in the sample county was 6,764 from 2008 to 2013.  
 178 Sociological characteristics, such as gender, age, arrival time to county hospital, first  
 179 inpatient information including length of stay (LOS), expenses, disease category,  
 180 capacity of the township hospital, interval information and readmitted hospital  
 181 choice,<sup>[16]</sup> were collected to build a final database. The distance and arrival time to  
 182 county hospital of all readmitting patients were captured by Google Map individually.  
 183 This study was registered in the Chinese Clinical Trial Registry  
 184 (ChiCTR-OOR-14005563), and patient information was anonymised and  
 185 de-identified prior to analysis.

### 186 **Statistical analysis**

187 Both treatment capacity of township hospital and arrival time to county hospital were  
 188 could be the influencing factors of choice for hospital readmission. The obtained data  
 189 indicated a hierarchical structure, and the 6,764 records may be aggregated by town  
 190 level. The determinants of choice for hospital readmission were examined using  
 191 multilevel binomial logistic regression analysis by MLwiN 2.30, which was  
 192 developed by the University of Bristol, UK. <sup>[17]</sup> The regression model is as follows.

$$193 \quad \text{logit}(\pi_{ij}) = \beta_0 \text{cons} + \beta_1 \text{Admitted Year}_{ij} + \beta_2 \text{Gender}_{ij} + \beta_3 \text{Age}_{ij} + \beta_4 \text{Distance}_{ij} + \beta_5 \text{Time}_{ij} \\ + \beta_6 \text{Capacity}_{ij} + \beta_7 \text{1}^{\text{st}} \text{LOS}_{ij} + \beta_8 \text{1}^{\text{st}} \text{Expends}_{ij} + \beta_9 \text{Interval}_{ij} + \text{More14}_{ij}$$

$$194 \quad \beta_{0j} = \beta_0 + u_{0j}$$

195  $\beta_i$  refers to the fixed effects parameter,  $u_{0j}$  refers to the random effects of level 2.

## 196 Results

### 197 Choices for hospital readmission after township hospitalisation

198 In 2008–2013, 6,764 first readmissions in township hospital occurred among 271,405  
 199 discharged admissions, where TT group accounted for 62.5% (4,225) and TC group  
 200 accounted for 37.5% (2,539), as shown in Table 1. The number of readmissions  
 201 increased sharply, whereas the proportion of readmissions in the total inpatients  
 202 changed a little, nearly 5.0%. TC group increased from 1.66% to 1.89% from 2008 to  
 203 2013.

204 **Table 1. Amounts of readmissions in each year, Qianjiang district, 2008–2013**

Year	All inpatients	Readmissions* n (%)**	Choice for hospital readmission**		P
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.8)	342 (3.13)	182 (1.66)	<0.001
2009	34,240	1,076 (6.29)	724 (4.03)	352 (2.05)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.14)	463 (1.82)	
2012	61,467	1,384 (4.5)	815 (2.56)	569 (1.85)	
2013	67,392	1,578 (4.68)	939 (2.78)	639 (1.89)	
<b>Total</b>	271,405	6,764 (4.98)	4225 (3.11)	2539 (1.87)	

205 \*Readmission here refers to readmission whose first admission was in a township hospital.

206 \*\*One readmission includes two admissions.

207 Readmission occurred variedly in different towns, as shown in Table 2. Chengnan  
 208 town had the lowest readmission ratio (2.95%) and the lowest TT readmission ratio  
 209 (1.52%) in 30 towns, Heixi town had the lowest TC readmission ratio (1.30%), Shijia  
 210 town had the highest TC readmission ratio (2.86%) and Jindong town had the highest  
 211 TT readmission ratio (5.49%) and readmission ratio (6.96%).

212 **Table 2. Amounts of readmissions in each town, Qianjiang district, 2008–2013**

Town	All inpatients	Readmissions* n (%)**	Choice for hospital readmission**		P
			TT group n (%)	TC group n (%)	

Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.46)	81 (1.58)	71 (1.62)	
~	~	~	~	~	<0.001
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
~	~	~	~	~	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.46)	
<b>Total</b>	<b>271,405</b>	<b>6,764 (4.98)</b>	<b>4225 (3.11)</b>	<b>2539 (1.87)</b>	

213 \* Readmission here refers to readmission whose first admission was in a township hospital.

214 \*\*One readmission includes two admissions.

### 215 **Characteristics of readmitting patients between TT and TC groups**

216 Table 3 shows the characteristics of the subject patients during 2008–2013. Male  
 217 patients accounted for 48.7% in TC group, higher than that in the TT group (41.9%,  $P$   
 218 < 0.001). The readmission choices varied in different age groups ( $P$  < 0.001), and  
 219 patients aged more than 40 years old in TC group reached than a half (57.9%). The  
 220 highest rate of TC group in inpatient interval was fewer than 3 days (61.1%) and that  
 221 of TT group was 16–30 days (50.6%,  $P$  < 0.001). The average interval in TC group is  
 222 much lower than that in TT group (6.03 versus 14.95), the same result was showed in  
 223 terms of average LOS in first inpatient admission (6.96 versus 9.23) and arrival time  
 224 to county hospital (59.73 versus 61.79); the opposite results were observed in terms of  
 225 expenses in first inpatient admission (¥831.35 versus ¥791.01). TC group mostly  
 226 had respiratory diseases (37.7%) and digestive diseases (20.3%). No significant  
 227 differences among the distance to county hospital, and township hospital capacity  
 228 were observed between TT and TC groups.

229 **Table 3. Distributions of characteristics of readmissions ( $n = 6,764$ )**

Variable	All n (%)	Choice for hospital readmission		$P$
		TT group n (%)	TC group n (%)	

All	6,764	4,225 (62.5)	2539(37.5)	
Gender				<0.001
Male	3,006 (44.4)	1769(41.9)	1237(48.7)	
Female	3,758(55.6)	2456(58.1)	1302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				
Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03
Capacity of TH		0.53		0.53
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001
Interval (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001
3–7	761 (11.3)	517(12.2)	244(9.6)	
7–15	1,328 (19.6)	987(23.4)	341(13.4)	
16–31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				
Cancer	178 (2.6)	109(2.6)	69(2.7)	<0.001
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	

Digestive disease	984 (14.5)	469(11.1)	515(20.3)
Urinary disease	269 (4.0)	89(2.1)	180(7.1)
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)

### 230 **Determinants of choice for hospital readmission after township hospitalisation**

231 The two-level logistic regression used and the patients were identified as level 1 and  
 232 town as level 2. The results are illustrated by the level 2 variance of the zero model,  
 233 which was statistically significant ( $\chi^2=61.493$ ,  $P<0.001$ ), with aggregation of  
 234 information at the town.

235 The specific results of the explanatory variables to fit two variance component models  
 236 are shown in Table 4. The major determinants of the choice for hospital readmission  
 237 after township hospitalisation were admitted year, age, arrival time to county hospital,  
 238 inpatient interval, first LOS and disease category. If other factors remain constant,  
 239 then patients were more likely to be readmitted to county hospital among aged more  
 240 than 40-year-old groups ( $OR=1.31$ ), with shorter time to county hospital, shorter LOS,  
 241 shorter interval, with urinary tract diseases ( $OR=2.67$ ) or in the closer year. The ratio  
 242 of patients with obstetrics or gynaecology diseases readmitted to county hospital is  
 243 much lower than that of patient with cancer ( $OR=0.39$ ).

244 **Table 4 Multilevel logistic regression model analysis of the choice for hospital readmission**

	Parameter estimate	Standard error	$\chi^2$	<i>P</i>	Adjusted OR
<b>Fixed Part:</b>					
Constant	-269.7	39.130	47.513	<0.001	—
Admitted Year	0.135	0.019	47.825	<0.001	1.14
Gender(baseline: female)					1.00
Male	-0.003	0.065	0.003	0.956	1.00

Age (baseline: less than 20)						1.00
20–39	−0.061	0.122	0.249	0.618		0.94
40–59	0.271	0.104	6.760	0.009		1.31
More than 59	0.034	0.101	0.115	0.735		1.03
Distance (km)	0.012	0.004	10.725	0.052		1.01
Time (min)	−0.021	0.006	11.841	<0.001		0.98
Capacity of TH	−0.016	0.035	0.197	0.657		0.98
1st LOS (day)	−0.036	0.005	53.167	<0.001		0.96
1st Expend (RMB)	0.001	0.001	1.304	0.254		1.00
2nd LOS (day)	−0.002	0.003	0.214	0.644		0.99
Interval (day)	−0.110	0.004	895.43	<0.001		0.90
Disease category (Baseline: cancer)						1.00
ENT	−0.405	0.261	2.401	0.121		0.67
Respiratory disease	−0.250	0.217	1.326	0.250		0.78
Circulatory disease	0.515	0.240	4.619	0.032		1.67
Digestive disease	0.556	0.226	6.077	0.014		1.74
Urinary disease	0.981	0.263	13.938	<0.001		2.67
Haematological disorders	2.305	0.847	7.408	0.006		10.02
Bones and muscles	0.245	0.239	1.055	0.304		1.28
Obstetrics and gynaecology	−0.946	0.238	15.847	<0.001		0.39
Else	−0.132	0.264	0.250	0.617		0.88
<b>Random Part:</b>						
TH variance	0.152	0.036	17.811	<0.001		—
Patient scale parameter	1	0.00	—	—		—

245 Note: Capacity of township hospital is included in the analysis by order of ranked data.

## 246 Discussion

### 247 Choice for hospital readmission and aggregation

248 Readmission is common and inescapable, and can be attributed to technology and  
 249 management problems. <sup>[18]</sup> TC readmission accounts for 1.87% of all hospitalisation  
 250 cases in Qianjiang, and one third of the readmission cases had first inpatient  
 251 admission was in a township hospital, which is indeed a popular utilisation in rural



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4 252 China. However, as mentioned TC readmission, either through doctor suggestions or  
5  
6 253 patient choice, is an inefficient utilisation, TC patients suffer from disease delays or  
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8 254 cost waste, easily causing patient dissatisfaction on township hospital. One point that  
9  
10  
11 255 needs to be explained here is the uncertainty as to whether TT patients has also been  
12  
13 256 readmitted to a county hospital thrice or more, which does exists in a real scenario.  
14  
15  
16 257 The two-level logistic regression showed an evident hierarchy among the inpatient  
17  
18 258 data (town–patients). Patients’ choice for hospital readmission in the town level were  
19  
20  
21 259 clustered. In other words, 6,764 readmitting patients were non-independent, and the  
22  
23 260 choices for hospital readmission in same town tend to be approximated. The incidence  
24  
25  
26 261 differed from 2.95% (Chengnan) to 6.96% (Jindong) in different towns, the 30 towns  
27  
28 262 differed in township hospital, social customs and geographic location, and different  
29  
30  
31 263 township hospitals carried out different service concepts and medical capabilities,  
32  
33 264 which affected patient’s choice for hospital readmission.

### 265 **Determinants of the choice for hospital readmission**

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39 266 Logistic regression analysis showed that neither patient gender, capacity of township  
40  
41 267 hospital nor first expenses had any significant effects on the choice for hospital  
42  
43  
44 268 readmission, which was affected by age, arrival time to county hospital, inpatient  
45  
46 269 interval, LOS in first inpatient and disease category. Although the towns that patients  
47  
48  
49 270 lived in affected their choice for hospital readmission, capacity of township hospital  
50  
51 271 had no significant effects, so the town effects could be speculatively attributed from  
52  
53 272 social customs and geographic location, same results with Calvillo King.<sup>[19]</sup> In other  
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56 273 words, regardless of capacity of township hospital, readmission is inescapable under

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4 274 the same OR, and prevalence was produced from the doctors' assessment on treatment  
5  
6 275 ability, or disease varied not the general capacity in theory.<sup>[20]</sup>  
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8  
9 276 In general, patients were more likely to be readmitted to a county hospital among  
10  
11 277 groups of older age, more convenient, lower expense, shorter interval or diseases  
12  
13  
14 278 those were harder to assess, easier to vary. With the increase of age, the ratio of  
15  
16 279 choosing to be readmitted to a county hospital also increased, which may be caused  
17  
18  
19 280 by the increased attention on the cure rate among those with more advanced ages. The  
20  
21 281 OR in terms of arrival time to county hospital is 0.98, which is easy to understand that  
22  
23 282 patients pursue a convenience choice.<sup>[16-19]</sup> The most obvious influencing factors are  
24  
25  
26 283 first LOS and the interval, and we need to combine them to discuss the difference in  
27  
28 284 choice. The average first LOS of TT groups is 9.23 days, which is very close to 9.7  
29  
30  
31 285 days, the standard LOS in township hospitals in China, moreover, the average interval  
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34 286 was 14.95 days, and the same ratios in TC groups were 6.96 and 6.03 days. The  
35  
36 287 shorter the first LOS ( $OR=0.96$ ), with shorter interval ( $OR=0.90$ ), the higher the ratio  
37  
38 288 of choosing county hospital. This disparity would be associated with the degree of  
39  
40  
41 289 emergency of disease. For types of diseases, patients with diseases related to the  
42  
43 290 urinary systems ( $OR=2.67$ ) and haematological disorders ( $OR=10.02$ ) were more  
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45  
46 291 likely to choose county hospital compared with those with cancer, respiratory diseases  
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48 292 and other disease types. This finding can be related to township doctor assessment on  
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51 293 treatment ability. Diseases in the urinary system, cardiovascular system and  
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53 294 haematological disorders cannot be controlled well in township hospitals, and thus, a  
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56 295 higher rate of inaccurate assessments, higher probability of readmission to county

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4 296 hospital. [21] Respiratory and digestive diseases, such as influenza, paediatric  
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6 297 bronchial pneumonia and COPD, [22] have a high incidence and recurrence rate and  
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8 298 can be controlled in township hospital. Meanwhile, these diseases usually have failed  
9  
10  
11 299 treatment outcomes because of poor patient compliance on medicine and  
12  
13 300 after-cure. [23] Consequently, these patients more choose township hospitals for their  
14  
15 301 readmission. Moreover, the readmissions tend to county hospitals as time draws near  
16  
17 302 ( $OR=1.14$ ), which implies an endogenous factor affects the increase of inpatients in  
18  
19 303 county hospitals in recent years.  
20  
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23

#### 24 304 **Amendments of TC readmission**

25  
26 305 According to the results, we could identify the forms of TC readmission by the first  
27  
28 306 LOS and interval in preliminary. Intervals in TC patient admission show a 'U'-shaped  
29  
30 307 distribution; 61.1% was readmitted to a county hospital within 3 days, and a small  
31  
32 308 prevalence peak appeared in the group after more than 15 days. Correspondently, 50.1%  
33  
34 309 of the patients in TT patients were in the group more than 15 days. Thus, the shorter  
35  
36 310 the first LOS and the shorter the interval, the higher the probability of TC readmission  
37  
38 311 as suggested by doctors. Longer first LOS and longer interval are more likely to  
39  
40 312 conversely cause an inappropriate level of care of readmission. Therefore, the  
41  
42 313 combination of first LOS and interval may be an effective identification index, and we  
43  
44 314 took one week as the cut-off value as illustrated from Table 3. TC readmissions  
45  
46 315 caused by doctor incorrect assessment was approximately 70.7%, and those caused by  
47  
48 316 patients probably accounted for 29.3%. So, we can develop different interventions  
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50 317 based on the different types of TC readmission.  
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4 318 Dealing with the bad influence of TC readmission become a key content of China's  
5  
6 319 new healthcare reform, which involves rebuilding the tiered healthcare delivery  
7  
8 320 system. The negative effects of TC readmission can be decreased in two steps. First,  
9  
10 321 the incidence of TC readmission was reduced, which is inescapable but abasable. [24]  
11  
12  
13 322 The key is to improve the diagnosis of township doctors and antidiastole level, for  
14  
15 323 example, by establishing a clear diagnosis protocol to common diseases for township  
16  
17 324 hospitals, or risk prediction models for hospital readmission.[25] Second, decreasing  
18  
19 325 TC patient dissatisfaction is necessary, such as approval and the use of treatments  
20  
21 326 from township hospital, county doctors deliver continued care for admitting patients.  
22  
23 327 Chinese government should explore a new mechanism to stimulate doctors to supply  
24  
25 328 continued care between township and county hospitals, such as global budget of  
26  
27 329 multi-level institutions on certain diseases. Continued care could save examinations  
28  
29 330 and decrease inpatient cost, then increase patient satisfaction. When a patient gets sick  
30  
31 331 and needs hospitalisation, he or she would be willing to choose township hospital  
32  
33 332 again.

## 333 **Conclusions**

334 Inpatients were more likely to choose county hospital for readmission year by year.  
335 Moreover, TC readmission remains a popular utilisation in rural China and easily  
336 produces inappropriate patient flows. Differences in readmission choices were  
337 associated with age, arrival time to county hospital, first LOS, interval and diseases,  
338 which are all easy to be identified. Reducing the incidence of TC readmission and  
339 decreasing patient dissatisfaction are the focused actions to restore the network

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4 340 function of three-tier healthcare delivery system in rural China.  
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6  
7 341 However, our study has several limitations. Hospitalisation information, geographical  
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9 342 factor, referral status and disease were all drawn into the logistic regression model in  
10  
11 343 this study, but possible individual factors, such as economic capability, education and  
12  
13 344 preference, were deficient. Moreover, the influence on choice of hospitals may be an  
14  
15 345 accumulated process, which means the more patients experience TC, the more  
16  
17 346 significant the influence would become. However, we only studied the influence of  
18  
19 347 the first TC in a year. All these limitations may bring instability to our study and need  
20  
21 348 to be solved in further studies.  
22  
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## 25 26 349 **Competing interests**

27  
28  
29 350 The authors have declared that no competing interests exist.  
30

## 31 351 **Authors' contributions**

32  
33  
34 352 Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the  
35  
36 353 manuscript. Y-D.N. participated in data collection and performed the statistical  
37  
38 354 analysis. L.Z. helped to draft the manuscript, reviewed the manuscript and made final  
39  
40 355 changes. All authors have given their final approval of the version to be published.  
41  
42  
43

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47  
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49

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52  
53  
54 360 No past publication history, no past presentation history  
55  
56  
57

## 361 Provenance and peer review

362 Not commissioned; externally peer reviewed.

## 363 Data sharing statement

364 The anonymized dataset is available through the email of the corresponding author.

365

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433

## 434 **Figure Legend**

435 **Figure 1.** Map of Qianjiang district: geographic distribution

436



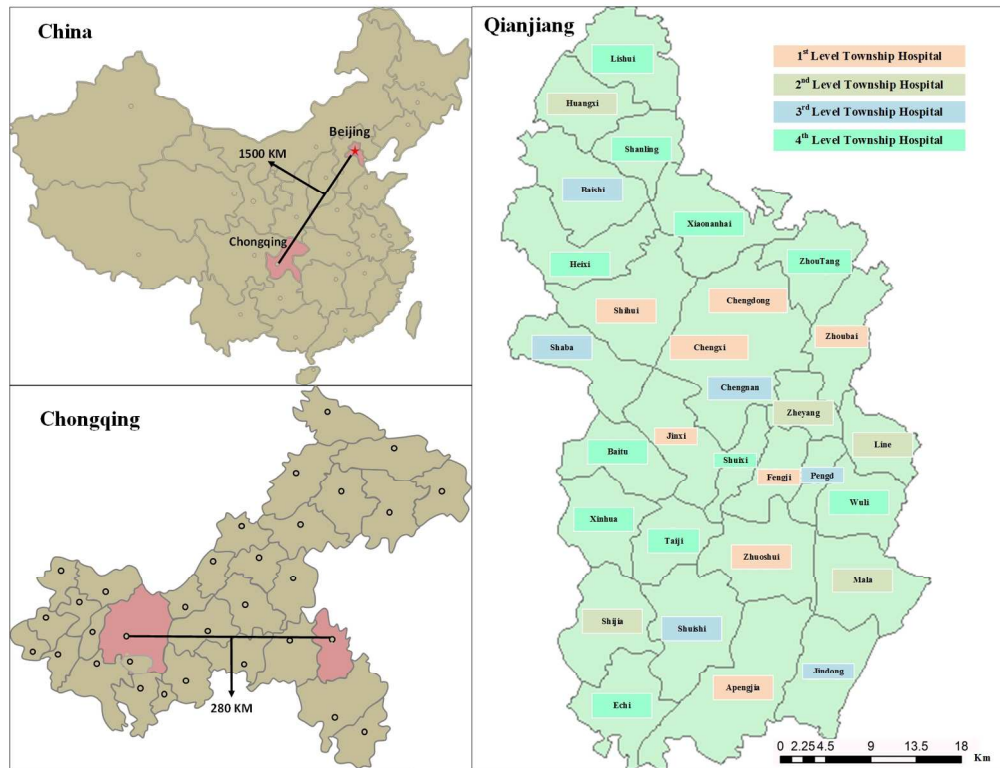


Figure 1. Map of Qianjiang district: geographic distribution

399x308mm (120 x 120 DPI)

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

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>9</b>
		(b) Give reasons for non-participation at each stage	<b>N</b>
		(c) Consider use of a flow diagram	<b>N</b>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	<b>10</b>
		(b) Indicate number of participants with missing data for each variable of interest	<b>N</b>
Outcome data	15*	Report numbers of outcome events or summary measures	<b>9</b>
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>13-15</b>
		(b) Report category boundaries when continuous variables were categorized	<b>13-15</b>
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	<b>13-15</b>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	<b>10-13</b>
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	<b>13-17</b>
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	<b>19</b>
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	<b>17-19</b>
Generalisability	21	Discuss the generalisability (external validity) of the study results	<b>19</b>
<b>Other information</b>			
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	<b>21</b>

\*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](http://www.strobe-statement.org).

# BMJ Open

## Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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<b>Primary Subject Heading</b>:	Health services research
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Keywords:	readmission, choice, county hospital, patient flow, rural China

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4 **1 Determinants of Patient Choice for Hospital Readmission after Township**  
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7 **2 Hospitalisation: A Population-Based Retrospective Study in China**  
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49 **19 Word Count: 3259**  
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## 21 **Abstract**

22 **Objective:** The lack of coordinated and appropriate healthcare across sectors has produced  
23 more patients for county hospitals in China. This study examined differences in patient  
24 choice between township and county hospitals for readmission after a first township  
25 hospitalisation, and the determinants that influenced this choice.

26 **Design:** A retrospective study of readmissions across hospitals after a first admission in  
27 township hospital. A township–township inpatient (TT) group and a township–county  
28 inpatient (TC) group were compared. A two-level logistic regression model was used to  
29 examine the determinants of choice for hospital readmission.

30 **Setting:** Data were drawn from a population-based health utilisation database for  
31 Qianjiang District, China, from 1 January 2008 to 31 December 2013.

32 **Participants:** This study focused on readmitted patients whose first admission was in a  
33 township hospital. Readmission cases were identified as the same diagnosis (International  
34 Classification of Diseases, tenth revision) in a subsequent hospitalisation within 30 days. In  
35 total, 6,764 readmissions had first admissions in township hospitals.

36 **Primary outcome measures:** Patient choice for hospital readmission after a first township  
37 hospitalisation

38 **Results:** The TT group accounted for 62.5% (4,225) and the TC group for 37.5% (2,539)  
39 of readmissions in 6 years. Readmission rates varied among towns ( $P < 0.001$ ). Differences  
40 between the TC and TT groups included: length of stay (LOS) of first admission (6.96 days  
41 vs. 9.23 days), average interval between admissions (6.03 days vs. 14.95 days) and disease  
42 category. Admission year, age, travel time to county hospital, interval between admissions,

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4 43 first admission LOS and disease category were determinants of choice for hospital  
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6 44 readmission.

7  
8 45 **Conclusions:** Patients whose first admission was in a township hospital were more likely  
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10 46 to be readmitted to a county hospital. A combination of first LOS and interval between  
11  
12 47 admissions may be an effective identification index for township–county readmission.

13  
14  
15 48 **Keywords:** readmission, choice, county hospital, patient flow, rural China

## 19 49 **Strengths and limitations**

- 20  
21  
22 50 • This is the first study to introduce township-county readmission, a feature of  
23  
24 51 hospitalisation in rural China.
- 25  
26 52 • Population-level data on readmission is seldom reported across hospitals of different  
27  
28 53 levels.
- 29  
30 54 • Programming techniques, including Microsoft Excel formulas and case processing  
31  
32 55 technologies, were used in the data processing.
- 33  
34 56 • A two-level logistic regression model was used to consider aggregation at the town level.
- 35  
36 57 • Hospitalisation information, geographical factors, interval status and disease were all  
37  
38 58 entered into the logistic regression model, but some individual factors were missing.

## 44 45 59 **Background**

46  
47  
48 60 Readmission refers to an episode where an inpatient is readmitted for the same disease  
49  
50 61 with 30 days.<sup>[1, 2]</sup> In most studies, readmission findings reflect that inpatient care did not  
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52 62 meet patient requirements, with readmission rates used as an evaluation index for  
53  
54 63 hospitalisation quality.<sup>[3]</sup> Readmission usually occurs in the same hospital, but sometimes

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4 64 occurs across hospitals because of deterioration of a patient's disease.<sup>[4]</sup> However, in rural  
5  
6 65 China, multilevel institutional readmission is a common and important healthcare  
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8 66 utilisation. This reflects defects of China's healthcare delivery system, rather than  
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11 67 hospitalisation quality, especially in township–county (TC) readmissions. TC readmission  
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13 68 is a health-seeking behaviour in which inpatients seek healthcare services in a township  
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15 69 hospital first, and then in a county hospital, whether planned or unplanned, voluntarily or  
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17 70 passively. TC readmission is frequent in rural China, and currently accounts for  
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20 71 approximately 2.0% of all inpatient services.<sup>[5]</sup> TC readmission usually occurs following  
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22 72 doctor recommendation/referral or by individual patient choice.  
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24  
25 73 TC readmission recommended by doctors occurs when a township doctor has an inpatient  
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27 74 admission that they cannot fully treat or completely cure,<sup>[6]</sup> consequently, that patient is  
28  
29 75 referred directly to a county hospital or advised to go to a county hospital for subsequent  
30  
31 76 admission.<sup>[6]</sup> This situation results from the three-tier healthcare delivery system in rural  
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33 77 China, where care is provided in a village–town–county healthcare delivery system, and all  
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35 78 hospital services are supplied by township and county hospitals.<sup>[7]</sup> In general, the higher  
36  
37 79 the level of the institution, the stronger the service capability, the greater the distance a  
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39 80 patient must travel and the higher the medical cost. Township hospitals bear the  
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41 81 responsibilities of transferring patients, taking care of inpatients with general illnesses and  
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43 82 advising patients with severe diseases (that are beyond their capacity) to seek admission at  
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45 83 county hospitals.<sup>[8]</sup> Township hospital doctors sometimes receive patients whose diseases  
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47 84 are beyond their capacity to manage (e.g. because of their inaccurate judgment, or  
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49 85 deterioration of the disease), meaning TC readmission may be unavoidable.  
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4 86 TC readmission from individual choice occurs when patients who should be readmitted to  
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6 87 township hospitals choose to be admitted to county hospitals for personal reasons.<sup>[9]</sup> Some  
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8 88 readmissions are influenced by quality concerns with township hospitals, poor patient  
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10 89 compliance on medicine and after-care or from a normal disease recurrence. However,  
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12 90 patients often do not acknowledge the real readmission reason and transfer responsibility  
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14 91 for readmission to the township hospital doctor (e.g. considering readmission as a result of  
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16 92 failed treatment) and consequently decide to be readmitted to a county hospital. This  
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18 93 situation often represents inappropriate readmission.<sup>[10]</sup>  
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23 94 From the patients' perspective, no order or limitation on patient choice exists. In addition,  
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25 95 no general practitioners or consultants are available in rural China. Therefore, residents  
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27 96 freely choose hospitals and service types, mainly depending on their judgment regarding  
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29 97 their disease and understanding of hospitals. If a patient chooses a higher-level institution  
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31 98 than necessary, they pay more; if they choose a lower-level institution than necessary they  
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33 99 would be referred or readmitted. Therefore, the cost of an incorrect decision is borne by the  
34  
35 100 patient. To guarantee patient interests regarding TC readmission, the three-tier healthcare  
36  
37 101 delivery system requires different-level hospitals to cooperate in providing continuous  
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39 102 healthcare services. However, in reality, communication among township and county  
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41 103 professional providers are limited, and there is virtually no document sharing and  
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43 104 interactions among providers across the three tiers.<sup>[11]</sup> County hospital doctors do not  
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45 105 deliver continued care for readmitted patients because of income incentives and risk  
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47 106 aversion, and patients readmitted to a county hospital usually receive new treatment.<sup>[12]</sup>  
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55 107 Furthermore, compared with patients admitted directly to county hospitals, readmitted



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4 108 patients spend more time, pay more costs and may even miss proper treatments. As a result,  
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6 109 when subsequent illnesses occur and patients are unable to judge the severity of their  
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8 110 illness, they tend to choose admission in a county hospital, taking excess economic risk to  
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10 111 avoid delay. Some studies have defined TC readmission as failed treatment from the  
11  
12 112 patients' perspective, and shown that the TC readmission experience can influence a  
13  
14 113 patient's later choice of hospital.<sup>[13, 14]</sup> Inpatients may be more likely to seek care in  
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16 114 county hospitals compared with township hospitals; a phenomenon that is already  
17  
18 115 happening. The annual growth rate of inpatients in county hospitals from 2010 to 2016 was  
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20 116 6.75%, whereas that of township hospital inpatients was 0.63%.<sup>[15]</sup>  
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23 117 As noted, TC readmission from individual choice belongs to the inappropriate level  
24  
25 118 admission, and TC readmission recommended by doctors can also result in inappropriate  
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27 119 level admission for subsequent hospitalisation. Inappropriate level admission means  
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29 120 patients seek healthcare in a higher-level hospital than necessary. This may result from  
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31 121 patients' intentional institution selection and distrust of the capability of township hospitals;  
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33 122 such patients prefer to spend more money on healthcare to avoid the risk of needing  
34  
35 123 referral. Inappropriate level admission is a major form of excess service demand,<sup>[12]</sup> and  
36  
37 124 an important determinant of increasing health expenditure that leads to significant waste.  
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39 125 In this context, identifying the forms and determinants of TC readmission will help to  
40  
41 126 improve the New Rural Cooperative Medical System (NRCMS). This study focused on  
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43 127 choices for hospital readmission after a first admission as an inpatient in a township  
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45 128 hospital, and identified the determinants of choice for hospital readmission.  
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## 129 **Methods**

### 130 **Study setting**

131 Qianjiang District was designated as the sample area through cluster sampling. This is a  
132 typical rural area located in Chongqing, which is the largest municipality in southwest  
133 China. Qianjiang has a per capita GDP of \$7,515 in 2016, which is below the average GDP  
134 in China. The resident population is 550,000 people; all residents are covered under the  
135 NRCMS, and are eligible to receive reimbursement for inpatient care. Qianjiang District  
136 has two county hospitals and 30 township hospitals. The township hospitals are divided  
137 into four levels according to their scale and service quantity by Qianjiang Health Bureau  
138 (Fig. 1). First-level township hospitals are allocated more than 30 beds and may perform  
139 abdomen operations; these hospitals had more than 1,200 discharged patients in 2013.  
140 Second-level township hospitals cannot perform abdomen operations of the same scale.  
141 Third-level township hospitals have fewer than 30 beds and around 600~1,200 discharged  
142 patients. All other township hospitals belong to the fourth level.

### 143 **Data source**

144 This study was based on the NRCMS inpatient database in Qianjiang District, which  
145 contains all inpatient data for the population. In this database, a case refers to a single  
146 hospitalisation in a county or township hospital.

### 147 **Data processing**

148 We focused on individuals who had been discharged from participating hospitals.

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4 149 Readmission cases were identified as the same diagnosis in subsequent hospitalisations  
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6 150 between county and township hospitals or township hospitals and township hospitals  
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8 151 within 30 days. Given our population-based retrospective design, we compared the  
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10 152 differences between township–township readmitted inpatients (TT group) and TC  
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12 153 readmitted inpatients (TC group). Samples were entered into MS Excel 2010, based on the  
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14 154 NRCMS database from 1 January 2008 to 31 December 2013. First, cases that shared the  
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16 155 same patient identifier and the same disease codes were sorted in chronological order.  
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20 156 Second, we calculated the interval between admissions in two adjacent cases for the same  
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22 157 inpatient for the same disease; if the interval between admissions was less than 31 days, the  
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24 158 patient was marked as a readmission patient. For example, if the first admission occurred  
25  
26 159 in a township hospital and the second occurred in county hospital, the two cases would be  
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28 160 merged as one case and marked as a TC readmission, and the patient marked as TC patient.  
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32 161 TT patients were identified in a similar manner. Finally, all TC and TT cases were  
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34 162 extracted into a new database. As diagnosis of a disease may change among different  
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36 163 doctors, in different institutions or at different times, we adjusted the original International  
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38 164 Classification of Diseases, tenth revision disease code into a broader code (e.g. chronic  
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40 165 obstructive pulmonary disease was adjusted from J44.900 to J44), which may improve  
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42 166 accuracy in identifying readmitted patients. After screening, there were 6,764 readmitted  
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44 167 patients from 2008–2013 in the sample. The main programming techniques included  
45  
46 168 Microsoft Excel formulas (e.g. COUNTIF, SUMPRODUCT, LOOKUP and IF) and case  
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48 169 processing technologies (e.g. split columns and removal of duplicates).  
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52 170 Sociological characteristics were collected to build a final database, including: gender; age;

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4 171 travel time to county hospital; first inpatient information including length of stay (LOS),  
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6 172 expenses, disease category, capacity of the township hospital, interval between admissions  
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8 173 and readmitted hospital choice.<sup>[16]</sup> The distance and travel time to the county hospital for  
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10 174 all readmitted patients were captured individually by Google Maps. Because traffic  
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12 175 conditions are different in different towns (e.g. national roads, provincial roads or county  
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14 176 roads), both the distance and travel time were captured.

### 177 **Statistical analysis**

178 The characteristics of patients' choices for hospital readmission were compared using  
179 t-tests and chi-square tests in IBM SPSS Statistics 22.0. The treatment capacity of  
180 township hospitals and the travel time to a county hospital from different towns have  
181 differential impacts on the observed predictors. Therefore, we assumed that the obtained  
182 data indicated a hierarchical structure, and the 6,764 records could be aggregated by town  
183 level. The determinants of choice for hospital readmission were examined using multilevel  
184 binomial logistic regression analysis using MLwiN 2.30, which was developed by the  
185 University of Bristol, UK.<sup>[17]</sup> Patients were identified as level 1 and town as level 2. The  
186 regression model was as follows.

$$187 \quad \log \text{it}(\pi_{ij}) = \beta_0 \text{cons} + \beta_1 \text{Admitted Year}_{ij} + \beta_2 \text{Gender}_{ij} + \beta_3 \text{Age}_{ij} + \beta_4 \text{Distance}_{ij} + \beta_5 \text{Time}_{ij} \\ + \beta_6 \text{Capacity}_{ij} + \beta_7 \text{1st LOS}_{ij} + \beta_8 \text{1st Expends}_{ij} + \beta_9 \text{Interval}_{ij} + \text{More14}_{ij}$$

$$188 \quad \beta_{0j} = \beta_0 + u_{0j}$$

189  $\beta_i$  refers to the fixed effects parameter, and  $u_{0j}$  refers to the random effects of level 2.

### 190 **Patient and Public Involvement**

191 No patients or public were involved in this research.

## 192 Ethical approval

193 The study protocol conformed to the guidelines of the Ethics Committee of the Tongji  
 194 Medical College of Huazhong University of Science and Technology. The protocol was  
 195 registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563). Patient  
 196 information was anonymised and de-identified before analysis.

## 197 Results

### 198 Choices for hospital readmission after a first township hospitalisation

199 Among 271,405 discharged admissions in 2008–2013, there were 6,764 readmissions after  
 200 a first hospitalisation in a township hospital. The TT group accounted for 62.5% (4,225) of  
 201 all readmissions and the TC group for 37.5% (2,539) (Table 1). The number of  
 202 readmissions increased sharply, whereas the proportion of readmissions in the total  
 203 inpatients only changed slightly (5.0%). The TC group increased from 1.66% in 2008 to  
 204 1.89% in 2013, with the annual growth rate of the TC group being 28.55%, which was  
 205 higher than that of the TT group (22.38%).

206 **Table 1. Number of readmissions each year in Qianjiang district (2008–2013)**

Year	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		P***
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.80)	342 (3.14)	182 (1.66)	<0.001
2009	34,240	1,076 (6.27)	724 (4.23)	352 (2.04)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.16)	463 (1.82)	
2012	61,467	1,384 (4.50)	815 (2.64)	569 (1.86)	
2013	67,392	1,578 (4.67)	939 (2.78)	639 (1.89)	
<b>Total</b>	271,405	6,764 (4.98)	4,225 (3.11)	2,539 (1.87)	

207 \* Readmission refers to readmissions whose first admission was in a township hospital.

208 \*\* One readmission includes two admissions.

209 \*\*\* Pearson's chi-square test.

210 Readmission varied among towns (Table 2). Chengnan town had the lowest overall  
 211 readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) of the 30 towns.  
 212 Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC  
 213 readmission ratio (2.86%) and Jindong town had the highest TT readmission (5.49%) and  
 214 overall readmission (6.96%) ratios.

215 **Table 2. Number of readmissions Qianjiang district (2008–2013), by town**

Town	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		P***
			TT group n (%)	TC group n (%)	
Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.20)	81 (1.58)	71 (1.62)	
~	~	~	~	~	<0.001
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
~	~	~	~	~	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.47)	
<b>Total</b>	<b>271,405</b>	<b>6,764 (4.98)</b>	<b>4225 (3.11)</b>	<b>2539 (1.87)</b>	

216 \* Readmission refers to readmissions whose first admission was in a township hospital.

217 \*\* One readmission includes two admissions.

218 \*\*\* Pearson's chi-square test.

### 219 **Characteristics of readmitted patients between TT and TC groups**

220 Table 3 shows the characteristics of readmitted patients from 2008–2013. Male patients  
 221 accounted for 48.7% of the TC group, which was a higher rate than in the TT group (41.9%,  
 222  $P < 0.001$ ). Readmission choices varied in different age groups ( $P < 0.001$ ), with over half  
 223 (57.9%) of patients in the TC group aged 40–59 years. The most common interval between  
 224 admissions in the TC group was shorter than 3 days (61.1%), whereas that in the TT group  
 225 was 16–30 days (50.6%,  $P < 0.001$ ). The average interval between admissions in the TC  
 226 group was lower than that in TT group (6.03 days vs. 14.95 days). Similar patterns were  
 227 observed in the average LOS of first inpatient admissions (6.96 days vs. 9.23 days) and

228 travel time to county hospital (59.73 minutes vs. 61.79 minutes). However, an opposite  
 229 trend was observed in terms of expenses of first inpatient admission (¥831.35 vs. ¥791.01).  
 230 The TC group mostly had respiratory (37.7%) and digestive diseases (20.3%). There were  
 231 no significant differences in the distance to a county hospital and the township hospital  
 232 capacity between the TT and TC groups.

233 **Table 3. Distribution of characteristics of readmitted patients (n = 6,764)**

Variable	All n (%)	Choice for hospital readmission		P
		TT group n (%)	TC group n (%)	
All	6,764	4,225 (62.5)	2539(37.5)	
Gender				<0.001*
Male	3,006 (44.4)	1769(41.9)	1237(48.7)	
Female	3,758(55.6)	2456(58.1)	1302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001**
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001*
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				
Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15**
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03**
Capacity of TH				0.53*
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001**
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01**
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04**
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001**

Interval between admissions (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001**
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001*
3–7	761 (11.3)	517(12.2)	244(9.6)	
7–15	1,328 (19.6)	987(23.4)	341(13.4)	
16–31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				<0.001*
Cancer	178 (2.6)	109(2.6)	69(2.7)	
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	
Digestive disease	984 (14.5)	469(11.1)	515(20.3)	
Urinary disease	269 (4.0)	89(2.1)	180(7.1)	
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)	
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)	
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)	

234 \* Pearson's chi-square test.

235 \*\* ANOVA.

### 236 **Determinants of choice for hospital readmission after township hospitalisation**

237 The two-level logistic regression is illustrated by the level 2 variance of the zero model.

238 This was statistically significant ( $\chi^2 = 63.524$ ,  $P < 0.001$ ), with aggregation of information

239 at the town level. The specific results of the explanatory variables to fit the two variance

240 component model are shown in Table 4. The major determinants of the choice for hospital

241 readmission after a first township hospitalisation were admission year, age, travel time to a

242 county hospital, interval between admissions, first LOS and disease category. If other

243 factors remained constant, patients in the group aged 40–59 years were more likely to be

244 readmitted to a county hospital (odds ratio [ $OR$ ] = 1.32). Other factors associated with TC

245 readmission were a shorter travel time to county hospital, shorter LOS, shorter interval

246 between admissions, urinary tract diseases ( $OR = 2.68$ ) or first admission/readmission in a



247 more recent year. The ratio of patients with obstetric or gynaecological diseases readmitted  
 248 to a county hospital was much lower than that of patients with cancer ( $OR = 0.40$ ).

249 **Table 4. Multilevel logistic regression model for hospital readmission choice**

	Parameter estimate	Standard error	$\chi^2$	<i>P</i>	Adjusted OR
<b>Fixed Part:</b>					
Constant	-271.3	41.231	49.524	<0.001	
Admitted year*	0.136	0.027	47.934	<0.001	1.14
Gender(reference: female)					
Male	-0.003	0.066	0.003	0.955	1.00
Age (reference: less than 20)					
20–39	-0.062	0.123	0.250	0.617	0.94
40–59	0.294	0.111	6.870	0.008	1.32
More than 59	0.034	0.102	0.116	0.735	1.03
Travel time (min)	-0.023	0.013	17.468	<0.001	0.97
Capacity of TH**	-0.017	0.035	0.204	0.658	0.98
1st LOS (day)	-0.036	0.006	53.177	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.323	0.255	1.00
2nd LOS (day)	-0.002	0.003	0.213	0.644	0.99
Interval between admissions (day)	-0.110	0.004	895.49	<0.001	0.90
Disease category (reference: cancer)					
ENT	-0.406	0.263	2.462	0.131	0.67
Respiratory disease	-0.256	0.217	1.327	0.251	0.78
Circulatory disease	0.512	0.256	4.627	0.028	1.64
Digestive disease	0.553	0.227	6.217	0.013	1.74
Urinary disease	0.982	0.264	13.950	<0.001	2.68
Haematological disorders	2.310	0.853	7.641	0.004	10.03
Bones and muscles	0.245	0.242	1.066	0.301	1.28
Obstetrics and gynaecology	-0.947	0.238	15.874	<0.001	0.40
Else	-0.132	0.265	0.251	0.617	0.88
<b>Random Part:</b>					
Town variance	0.153	0.036	17.921	<0.001	—
Patient scale parameter	1	0.00	—	—	—

250 \* TC shows a stable increase in recent years, so admitted year was included in the analysis by order of ranked data.

251 \*\* Capacity of township hospital included in the analysis by order of ranked data.

## 252 Discussion

### 253 Choice for hospital readmission and aggregation

254 Readmission is common and unavoidable, and can often be attributed to technology and  
255 management problems.<sup>[18]</sup> TC readmission accounted for 1.89% of all hospitalisation  
256 cases in Qianjiang in 2013, showing steady growth from 2008 (1.67%). TC Readmission  
257 accounts for one-third of readmission cases had a first inpatient admission in a township  
258 hospital, which is common in rural China. However, as mentioned, TC readmission (either  
259 through doctor referral/recommendation or the patient's choice) often reflects an inefficient  
260 use of health services for patients; TC readmission patients may experience disease delays  
261 or cost waste, which may result in patient dissatisfaction regarding the township hospital.  
262 A point that needs to be noted here is the uncertainty about whether TT patients had been  
263 readmitted to a county hospital three or more times, which has been reported as a real  
264 scenario.

265 The two-level logistic regression analysis showed a hierarchy in the inpatient data (town-  
266 patients). Patients' choice of hospital readmission at the town level was clustered. In other  
267 words, 6,764 readmitted patients were non-independent, and the choices for hospital  
268 readmission in same town tended to be approximated. The incidence differed in different  
269 towns, from 2.95% (Chengnan) to 6.96% (Jindong). The 30 towns in the study area also  
270 differed in terms of township hospital, social customs and geographic location. Different  
271 township hospitals also have different service concepts and medical capabilities, which  
272 might have affected patients' hospital readmission choice.

### 273 **Determinants of choice for hospital readmission**

274 Logistic regression analysis showed that patient gender, capacity of township hospital and  
275 first admission expenses did not have significant effects on the choice of hospital for  
276 readmission. Readmission choice was affected by age, travel time to a county hospital,  
277 interval between admissions, LOS in the first admission and disease category. Although the  
278 towns in which patients lived affected their choice of hospital for readmission, the capacity  
279 of township hospitals had no significant effects; therefore, the town-based effects could be  
280 speculatively attributed to social customs and geographic location, which is consistent with  
281 a previous study.<sup>[19]</sup> In other words, regardless of capacity of the township hospital,  
282 readmission is unavoidable and prevalence under the same rate; in theory, TC readmission  
283 resulted from the doctors' assessment of their treatment ability, or deterioration of disease  
284 rather than the general hospital capacity.<sup>[20]</sup>

285 In general, patients were more likely to be readmitted to a county hospital if they were in  
286 an older age group, found travel to a county hospital more convenient, had lower expenses,  
287 had a shorter interval between admissions or diseases that were harder to assess. The ratio  
288 of patients choosing to be readmitted to a county hospital increased with age, which may  
289 be a result of the increased attention to the cure rate among those of more advanced age.

290 The OR for travel time to a county hospital was 0.97, indicating that patients made their  
291 choice based on convenience.<sup>[16, 19]</sup> The most obvious influencing factors were first LOS  
292 and the interval between admissions. These factors need to be combined to discuss the  
293 difference in choice. The average first LOS in the TT group was 9.23 days, which is close  
294 to 9.7 days, the standard LOS in township hospitals in China.<sup>[15]</sup> Moreover, the average

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4 295 interval between admissions was 14.95 days. In the TC group, the average first LOS was  
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6 296 6.96 days and the interval between admissions was 6.03 days. A shorter the first LOS (*OR*  
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8 297 = 0.96) and a shorter the interval between admissions (*OR* = 0.90) was associated with a  
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10 298 greater likelihood of choosing a county hospital. This disparity may be associated with the  
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13 299 degree of urgency of the disease. Patients with diseases related to the urinary system (*OR* =  
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15 300 2.68) and haematological disorders (*OR* = 10.03) were more likely to choose a county  
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17 301 hospital compared with patients with cancer, respiratory diseases and other disease types.  
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20 302 This finding may be related to township doctor assessment regarding treatment ability.  
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23 303 Diseases in the urinary system, cardiovascular system and haematological disorders cannot  
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25 304 be controlled well in township hospitals, leading to a higher rate of inaccurate assessments  
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27 305 and a higher probability of readmission to a county hospital.<sup>[21]</sup> Respiratory and digestive  
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29 306 diseases (e.g. influenza, paediatric bronchial pneumonia and chronic obstructive  
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31 307 pulmonary disease<sup>[22]</sup>) have a high incidence and recurrence rate and can be controlled in  
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33 308 township hospitals. However, these diseases usually have failed treatment outcomes  
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35 309 because of poor patient compliance on medicine and after-care.<sup>[23]</sup> Consequently, these  
36  
37 310 patients may be more likely to choose township hospitals for readmission. Moreover,  
38  
39 311 readmissions tended to move toward county hospitals as urgency increased (*OR* = 1.14),  
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41 312 which implies an endogenous factor as affected the increase of inpatients in county  
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43 313 hospitals in recent years.  
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#### 51 314 **Identifying forms of TC readmission**

52  
53 315 We could differentiate TC admission from TT admission by first LOS and interval between  
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55 316 admissions. Intervals in TC patient admission showed a U-shaped distribution; 61.1% were

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4 317 readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the  
5  
6 318 group after more than 15 days. Correspondently, 50.1% of patients in the TT group had an  
7  
8 319 interval between admissions of more than 15 days. Therefore, a considerable proportion of  
9  
10 320 early readmissions might be referrals; patients readmitted after a short first LOS with a  
11  
12 321 short interval may be assumed to have been referred by doctors. A long first LOS and long  
13  
14 322 interval were more likely to indicate a TC caused by individual choice, means an  
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16 323 inappropriate TC readmission. Longer first LOS means a complete treatment in township  
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18 324 hospital, and longer interval indicates readmission maybe been caused by poor compliance  
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20 325 on medicine and after-cure from patients themselves or a normal disease  
21  
22 326 recurrence. Therefore, a combination of first LOS and interval may be an effective  
23  
24 327 identification index; we used 1 week as the cut-off value (Table 3). TC readmissions based  
25  
26 328 on a doctor's incorrect assessment accounted for approximately 70.7% of admissions  
27  
28 329 (interval between admissions <7 days), and those caused by patients accounted for 29.3%  
29  
30 330 (interval between admissions >7 days).

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37  
38 331 The sample county is a typical rural area, and this research is a population based study, so  
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40 332 the results could present the TC phenomenon in all rural China, and data process technical  
41  
42 333 can also be used to different counties.

## 334 **Conclusions**

335 Patients were more likely to choose a county hospital for readmission in each study year.  
336 TC readmission remains a common health service use in rural China, and may result in  
337 inappropriate patient flows. Differences in readmission choices were associated with age,

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4 338 travel time to county hospital, first LOS, interval between admissions and diseases; all of  
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6 339 these factors are easy to identify. Combination of first LOS and interval between  
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8 340 admissions could be an effective identification index for the forms of TC readmission.  
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## 11 341 **Limitations**

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14 342 Our study has several limitations. Hospitalisation information, geographical factors,  
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16  
17 343 interval status and disease were all entered into the logistic regression model. However,  
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19  
20 344 some individual factors (e.g. economic status, education and preference) were not available.  
21  
22 345 Moreover, influence on choice of hospitals may reflect an accumulated process, meaning  
23  
24 346 that the more patients experience TC readmission, the more significant the influence would  
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26  
27 347 become. However, we only studied the influence of the first TC readmission in a single  
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29  
30 348 year. These limitations may bring instability to our study and need to be resolved in future  
31  
32 349 studies.  
33

## 34 350 **Competing interests**

35  
36  
37 351 The authors have declared that no competing interests exist.  
38

## 39 352 **Authors' contributions**

40  
41  
42 353 Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the  
43  
44  
45 354 manuscript. Y-D.N. participated in data collection and performed the statistical analysis.  
46  
47 355 L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All  
48  
49  
50 356 authors have given their final approval of the version to be published.  
51

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53  
54  
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56  
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4 359 grant number (71603088).

5  
6 360 **Disclosure**

7  
8  
9 361 No past publication history, no past presentation history

10  
11 362 **Provenance and peer review**

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14 363 Not commissioned; externally peer reviewed.

15  
16 364 **Data sharing statement**

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19 365 The anonymized dataset is available through the email of the corresponding author.

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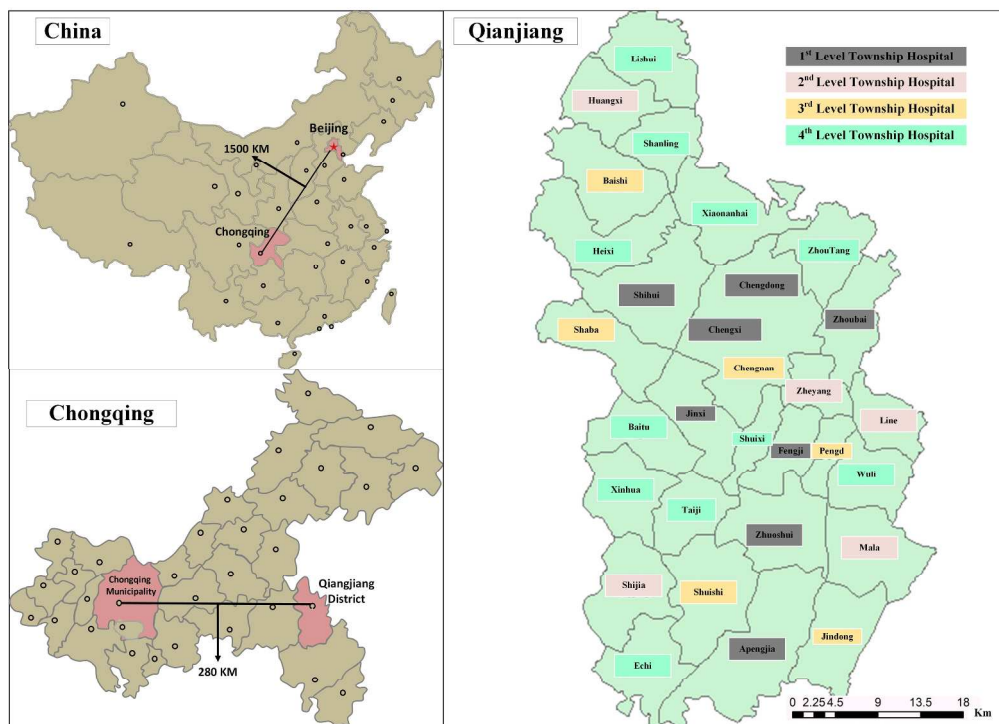
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## 425 Figure Legend

426 **Figure 1.** Map of Qianjiang distract: geographic distribution





Map of Qianjiang district: geographic distribution

136x113mm (600 x 600 DPI)

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

Section/Topic	Item #	Recommendation	Reported on Line #
<b>Title and abstract</b>	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	<b>Lines:1-2</b>
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	<b>Lines:22-58</b>
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	<b>Lines:60-126</b>
Objectives	3	State specific objectives, including any prespecified hypotheses	<b>Lines:126-129</b>
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	<b>Lines:152-154</b>
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	<b>Lines:131-143</b>
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	<b>Lines:145-147</b>
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	<b>Lines:148-152</b>
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	<b>Lines:152-166</b>
Bias	9	Describe any efforts to address potential sources of bias	<b>No</b>
Study size	10	Explain how the study size was arrived at	<b>Lines:167-168</b>
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	<b>Lines:169-177</b>
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	<b>Lines:178-180</b>
		(b) Describe any methods used to examine subgroups and interactions	<b>Lines:180-190</b>
		(c) Explain how missing data were addressed	<b>No</b>
		(d) If applicable, describe analytical methods taking account of sampling strategy	<b>No</b>
		(e) Describe any sensitivity analyses	<b>No</b>
<b>Results</b>			

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>Lines:197-204</b>
		(b) Give reasons for non-participation at each stage	<b>No</b>
		(c) Consider use of a flow diagram	<b>No</b>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	<b>Lines:218-234</b>
		(b) Indicate number of participants with missing data for each variable of interest	<b>No</b>
Outcome data	15*	Report numbers of outcome events or summary measures	<b>Lines:198-201</b>
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>Lines:235-250</b>
		(b) Report category boundaries when continuous variables were categorized	<b>Lines:235-250</b>
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	<b>No</b>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	<b>Lines:209-217</b>
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	<b>Lines:252-271; 332-338</b>
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	<b>Lines:339-347</b>
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	<b>Lines:272-328</b>
Generalisability	21	Discuss the generalisability (external validity) of the study results	<b>Lines:329-331</b>
<b>Other information</b>			
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	<b>Lines:356-357</b>

\*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](http://www.strobe-statement.org).

# BMJ Open

## Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

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<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Health services research, Health policy, Medical management
Keywords:	readmission, choice, county hospital, patient flow, rural China

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4 **1 Determinants of Patient Choice for Hospital Readmission after Township**  
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6 **2 Hospitalisation: A Population-Based Retrospective Study in China**  
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12 4 Yan Zhang<sup>1,2</sup>, Yadong Niu<sup>1,2</sup>, Liang Zhang<sup>1,2</sup> §  
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## 21 **Abstract**

22 **Objective:** The lack of coordinated and appropriate healthcare across sectors has produced  
23 more patients for county hospitals in China. This study examined differences in patient  
24 choice between township and county hospitals for readmission after a first township  
25 hospitalisation, and the determinants that influenced this choice.

26 **Design:** A retrospective study of readmissions across hospitals after a first admission in  
27 township hospital. A township–township inpatient (TT) group and a township–county  
28 inpatient (TC) group were compared. A two-level logistic regression model was used to  
29 examine the determinants of choice for hospital readmission.

30 **Setting:** Data were drawn from a population-based health utilisation database for  
31 Qianjiang District, China, from 1 January 2008 to 31 December 2013.

32 **Participants:** This study focused on readmitted patients whose first admission was in a  
33 township hospital. Readmission cases were identified as the same diagnosis (International  
34 Classification of Diseases, tenth revision) in a subsequent hospitalisation within 30 days. In  
35 total, 6,764 readmissions had first admissions in township hospitals.

36 **Primary outcome measures:** Patient choice for hospital readmission after a first township  
37 hospitalisation.

38 **Results:** The TT group accounted for 62.5% (4,225) and the TC group for 37.5% (2,539)  
39 of readmissions in 6 years. Readmission rates varied among towns ( $P < 0.001$ ). Differences  
40 between the TC and TT groups included: length of stay (LOS) of first admission (6.96 days  
41 vs. 9.23 days), average interval between admissions (6.03 days vs. 14.95 days) and disease  
42 category. Admission year, age, travel time to county hospital, interval between admissions,

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4 43 first admission LOS and disease category were determinants of choice for hospital  
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6 44 readmission.

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8 45 **Conclusions:** Patients whose first admission was in a township hospital were more likely  
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10 46 to be readmitted to a county hospital. A combination of first LOS and interval between  
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12 47 admissions may be an effective identification index for township–county readmission.

13  
14  
15 48 **Keywords:** readmission, choice, county hospital, patient flow, rural China

## 19 49 **Strengths and limitations**

- 20  
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22 50 • This is the first study to focus on township–county readmission, a feature of  
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24 51 hospitalisation in rural China.
- 25  
26 52 • Population-level data on readmission is seldom reported across hospitals of different  
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28 53 levels.
- 29  
30 54 • Programming techniques, including Microsoft Excel formulas and case processing  
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32 55 technologies, were used in the data processing.
- 33  
34 56 • A two-level logistic regression model was used to consider aggregation at the town level.
- 35  
36 57 • Hospitalisation information, geographical factors, interval status and disease were all  
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38 58 entered into the logistic regression model, but some individual factors were missing.

## 44 45 59 **Background**

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48 60 Readmission refers to an episode where an inpatient is readmitted for the same disease  
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50 61 with 30 days.<sup>[1, 2]</sup> In most studies, readmission findings reflect that inpatient care did not  
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52 62 meet patient requirements, with readmission rates used as an evaluation index for  
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54 63 hospitalisation quality.<sup>[3]</sup> Readmission usually occurs in the same hospital, but sometimes

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4 64 occurs across hospitals because of deterioration of a patient's disease.<sup>[4]</sup> However, in rural  
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6 65 China, multilevel institutional readmission is a common and important healthcare  
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8 66 utilisation. This reflects defects of China's healthcare delivery system, rather than  
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11 67 hospitalisation quality, especially in township–county (TC) readmissions. TC readmission  
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13 68 is a health-seeking behaviour in which inpatients seek healthcare services in a township  
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15 69 hospital first, and then in a county hospital, whether planned or unplanned, voluntarily or  
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17 70 passively. TC readmission is frequent in rural China, and currently accounts for  
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20 71 approximately 2.0% of all inpatient services.<sup>[5]</sup> TC readmission usually occurs following  
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22 72 doctor recommendation/referral or by individual patient choice.  
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25 73 TC readmission recommended by doctors occurs when a township doctor has an inpatient  
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27 74 admission that they cannot fully treat or completely cure,<sup>[6]</sup> consequently, that patient is  
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29 75 referred directly to a county hospital or advised to go to a county hospital for subsequent  
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31 76 admission.<sup>[6]</sup> This situation results from the three-tier healthcare delivery system in rural  
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33 77 China, where care is provided in a village–town–county healthcare delivery system, and all  
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35 78 hospital services are supplied by township and county hospitals.<sup>[7]</sup> In general, the higher  
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37 79 the level of the institution, the stronger the service capability, the greater the distance a  
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39 80 patient must travel and the higher the medical cost. Township hospitals bear the  
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41 81 responsibilities of transferring patients, taking care of inpatients with general illnesses and  
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43 82 advising patients with severe diseases (that are beyond their capacity) to seek admission at  
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45 83 county hospitals.<sup>[8]</sup> Township hospital doctors sometimes receive patients whose diseases  
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47 84 are beyond their capacity to manage (e.g. because of their inaccurate judgment, or  
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49 85 deterioration of the disease), meaning TC readmission may be unavoidable.  
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4 86 TC readmission from individual choice may occur when patients who should be readmitted  
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6 87 to township hospitals choose to be admitted to county hospitals for personal reasons.<sup>[9]</sup>  
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8 88 Some readmissions are influenced by quality concerns with township hospitals, poor  
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10 89 patient compliance on medicine and after-care or from a normal disease recurrence.  
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13 90 However, patients often do not acknowledge the real readmission reason and transfer  
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15 91 responsibility for readmission to the township hospital doctor (e.g. considering readmission  
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17 92 as a result of failed treatment) and consequently decide to be readmitted to a county  
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19 93 hospital. This situation often represents inappropriate readmission.<sup>[10]</sup>  
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23 94 From the patients' perspective, no order or limitation on patient choice exists. In addition,  
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25 95 no general practitioners or consultants are available in rural China. Therefore, residents  
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27 96 freely choose hospitals and service types, mainly depending on their judgment regarding  
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29 97 their disease and understanding of hospitals. If a patient chooses a higher-level institution  
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31 98 than necessary, they pay more; if they choose a lower-level institution than necessary they  
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33 99 would be referred or readmitted. Therefore, the cost of an incorrect decision is borne by the  
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35 100 patient. To guarantee patient interests regarding TC readmission, the three-tier healthcare  
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37 101 delivery system requires different-level hospitals to cooperate in providing continuous  
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39 102 healthcare services. However, in reality, communication among township and county  
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41 103 professional providers is limited, and there is virtually no document sharing or interaction  
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43 104 among providers across the three tiers.<sup>[11]</sup> County hospital doctors do not deliver  
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45 105 continued care for readmitted patients because of income incentives and risk aversion, and  
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47 106 patients readmitted to a county hospital usually receive new treatment.<sup>[12]</sup> Furthermore,  
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49 107 compared with patients admitted directly to county hospitals, readmitted patients spend

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4 108 more time, pay more costs and may even miss proper treatments. As a result, when  
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6 109 subsequent illnesses occur and patients are unable to judge the severity of their illness, they  
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8 110 tend to choose admission in a county hospital, taking excess economic risk to avoid delay.  
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10 111 Some studies have defined TC readmission as failed treatment from the patients'  
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12 perspective, and shown that the TC readmission experience can influence a patient's later  
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14 112 choice of hospital.<sup>[13, 14]</sup> Inpatients may be more likely to seek care in county hospitals  
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16 113 compared with township hospitals; a phenomenon that is already happening. The annual  
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18 114 growth rate of inpatients in county hospitals from 2010 to 2016 was 6.75%, whereas that of  
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20 115 township hospital inpatients was 0.63% in rural China.<sup>[15]</sup>  
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23 116 As noted, TC readmission from individual choice may be an inappropriate level of  
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25 117 admission, and TC readmission recommended by doctors can also result in inappropriate  
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27 118 level admission for subsequent hospitalisation. Inappropriate level admission means  
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29 119 patients seek healthcare in a higher-level hospital than necessary. This may result from  
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31 120 patients' intentional institution selection and distrust of the capability of township hospitals;  
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33 121 such patients prefer to spend more money on healthcare to avoid the risk of needing  
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35 122 referral. Inappropriate level admission is a major form of excess service demand,<sup>[12]</sup> and  
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37 123 an important determinant of increasing health expenditure that leads to significant waste.  
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39 124 In this context, identifying the forms and determinants of TC readmission will help to  
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41 125 improve the New Rural Cooperative Medical System (NRCMS). This study focused on  
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43 126 choices for hospital readmission after a first admission as an inpatient in a township  
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45 127 hospital, and identified the determinants of choice for hospital readmission.  
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## 129 **Methods**

### 130 **Study setting**

131 Qianjiang District was designated as the sample area through cluster sampling. This is a  
132 typical rural area located in Chongqing, which is the largest municipality in southwest  
133 China. Qianjiang has a per capita GDP of \$7,515 in 2016, which is below the average GDP  
134 in China. The resident population is 550,000 people; all residents are covered under the  
135 NRCMS, and are eligible to receive reimbursement for inpatient care. Qianjiang District  
136 has two county hospitals and 30 township hospitals. The township hospitals are divided  
137 into four levels according to their scale and service quantity by Qianjiang Health Bureau  
138 (Fig. 1). First-level township hospitals are allocated more than 30 beds and may perform  
139 abdominal operations; these hospitals had more than 1,200 discharged patients in 2013.  
140 Second-level township hospitals cannot perform abdominal operations of the same scale as  
141 first-level township hospitals. Third-level township hospitals have fewer than 30 beds and  
142 around 600~1,200 discharged patients. All other township hospitals belong to the fourth  
143 level.

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4 144 **Data source**  
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7 145 This study was based on the NRCMS inpatient database in Qianjiang District, which  
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9 146 contains all inpatient data for the population. In this database, a case refers to a single  
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12 147 hospitalisation in a county or township hospitals.  
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15 148 **Data processing**  
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18 149 We focused on individuals who had been discharged from participating hospitals.  
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20 150 Readmission cases were identified as having the same diagnosis in subsequent  
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22 151 hospitalisations between county and township hospitals or township hospitals and township  
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24 152 hospitals within 30 days. Given our population-based retrospective design, we compared  
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27 153 the differences between township–township readmitted inpatients (TT group) and TC  
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29 154 readmitted inpatients (TC group). Samples were entered into MS Excel 2010, based on the  
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31 155 NRCMS database from 1 January 2008 to 31 December 2013. First, cases that shared the  
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33 156 same patient identifier and the same disease codes were sorted in chronological order.  
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36 157 Second, we calculated the interval between admissions in two adjacent cases for the same  
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38 158 inpatient for the same disease; if the interval between admissions was less than 31 days, the  
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40 159 patient was marked as a readmission patient. For example, if the first admission occurred  
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42 160 in a township hospital and the second occurred in county hospital, the two cases would be  
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44 161 merged as one case and marked as a TC readmission, and the patient marked as TC patient.  
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47 162 TT patients were identified in a similar manner. Finally, all TC and TT cases were  
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49 163 extracted into a new database. As diagnosis of a disease may change among different  
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52 164 doctors, in different institutions or at different times, we adjusted the original International  
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4 165 Classification of Diseases, tenth revision disease code into a broader code (e.g. chronic  
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6 166 obstructive pulmonary disease was adjusted from J44.900 to J44), which may improve  
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8 167 accuracy in identifying readmitted patients. After screening, there were 6,764 readmitted  
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11 168 patients from 2008–2013 in the sample.

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13 169 The main programming techniques included Microsoft Excel formulas (e.g. COUNTIF,  
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16 170 SUMPRODUCT, LOOKUP and IF) and case processing technologies (e.g. split columns  
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18 171 and removal of duplicates).

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20 172 Sociological characteristics were collected to build a final database, including: gender; age;  
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23 173 travel time from home to county hospital; first inpatient information including length of  
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25 174 stay (LOS), expenses, disease category, capacity of the township hospital, interval between  
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28 175 admissions and readmitted hospital choice.<sup>[16]</sup> The distance and travel time to the county  
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30 176 hospital for all readmitted patients were captured individually by Google Maps. Because  
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33 177 traffic conditions are different in different towns (e.g. national roads, provincial roads or  
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35 178 county roads), both the distance and travel time were captured.

### 36 37 38 179 **Data obtained and Statistical analysis**

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41 180 The characteristics of patients' choices for hospital readmission were compared using  
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44 181 t-tests and chi-square tests in IBM SPSS Statistics 22.0. The treatment capacity of  
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46 182 township hospitals and the travel time to a county hospital from different towns have  
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49 183 differential impacts on the observed predictors. Therefore, we assumed that the obtained  
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51 184 data indicated a hierarchical structure, and the 6,764 records could be aggregated by town  
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54 185 level. The determinants of choice for hospital readmission were examined using multilevel  
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56 186 binomial logistic regression analysis using MLwiN 2.30, which was developed by the

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4 187 University of Bristol, UK.<sup>[17]</sup> Patients were identified as level 1 and town as level 2. The  
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6 188 regression model was as follows.

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$$\log it(\pi_{ij}) = \beta_0 \text{cons} + \beta_1 \text{Admitted Year}_{ij} + \beta_2 \text{Gender}_{ij} + \beta_3 \text{Age}_{ij} + \beta_4 \text{Distance}_{ij} + \beta_5 \text{Time}_{ij} \\ + \beta_6 \text{Capacity}_{ij} + \beta_7 \text{1st LOS}_{ij} + \beta_8 \text{1st Expend}_{ij} + \beta_9 \text{Interval}_{ij} + \text{More14}_{ij}$$

$$\beta_{0j} = \beta_0 + u_{0j}$$

191  $\beta_i$  refers to the fixed effects parameter, and  $u_{0j}$  refers to the random effects of level 2.

## 192 **Patient and Public Involvement**

193 No patients or public were involved in this research.

## 194 **Ethical approval**

195 The study protocol conformed to the guidelines of the Ethics Committee of the Tongji  
196 Medical College of Huazhong University of Science and Technology. The protocol was  
197 registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563). Patient  
198 information was anonymised and de-identified before analysis.

## 199 **Results**

### 200 **Choices for hospital readmission after a first township hospitalisation**

201 Among 271,405 discharged admissions in 2008–2013, there were 6,764 readmissions after  
202 a first hospitalisation in a township hospital. The TT group accounted for 62.5% (4,225) of  
203 all readmissions and the TC group for 37.5% (2,539) (Table 1). The number of  
204 readmissions increased sharply, whereas the proportion of readmissions in the total  
205 inpatients averaging around 5%. The TC group increased from 1.66% in 2008 to 1.89% in  
206 2013, with the annual growth rate of the TC group being 28.55%, which was higher than

207 that of the TT group (22.38%).

208 **Table 1. Number of readmissions each year in Qianjiang district (2008–2013)**

Year	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		P***
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.80)	342 (3.14)	182 (1.66)	<0.001
2009	34,240	1,076 (6.27)	724 (4.23)	352 (2.04)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.16)	463 (1.82)	
2012	61,467	1,384 (4.50)	815 (2.64)	569 (1.86)	
2013	67,392	1,578 (4.67)	939 (2.78)	639 (1.89)	
<b>Total</b>	<b>271,405</b>	<b>6,764 (4.98)</b>	<b>4,225 (3.11)</b>	<b>2,539 (1.87)</b>	

209 \* Readmission refers to readmissions whose first admission was in a township hospital.

210 \*\* One readmission includes two admissions.

211 \*\*\* Pearson's chi-square test.

212 Readmission varied among towns (Table 2). Chengnan town had the lowest overall

213 readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) of the 30 towns.

214 Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC

215 readmission ratio (2.86%) and Jindong town had the highest TT readmission (5.49%) and

216 overall readmission (6.96%) ratios.

217 **Table 2. Number of readmissions Qianjiang district (2008–2013), by town**

Town	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		P***
			TT group n (%)	TC group n (%)	
Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	<0.001
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.20)	81 (1.58)	71 (1.62)	
~	~	~	~	~	
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.47)	
<b>Total</b>	<b>271,405</b>	<b>6,764 (4.98)</b>	<b>4225 (3.11)</b>	<b>2539 (1.87)</b>	

218 \* Readmission refers to readmissions whose first admission was in a township hospital.

219 \*\* One readmission includes two admissions.

220 \*\*\* Pearson's chi-square test.

### 221 **Characteristics of readmitted patients between TT and TC groups**

222 Table 3 shows the characteristics of readmitted patients from 2008–2013. Male patients  
 223 accounted for 48.7% of the TC group, which was a higher rate than in the TT group (41.9%,  
 224  $P < 0.001$ ). Readmission choices varied in different age groups ( $P < 0.001$ ), with over half  
 225 (57.9%) of patients in the TC group aged 40–59 years. The most common interval between  
 226 admissions in the TC group was shorter than 3 days (61.1%), whereas that in the TT group  
 227 was 16–30 days (50.6%,  $P < 0.001$ ). The average interval between admissions in the TC  
 228 group was lower than that in TT group (6.03 days vs. 14.95 days). Similar patterns were  
 229 observed in the average LOS of first inpatient admissions (6.96 days vs. 9.23 days) and  
 230 travel time to county hospital (59.73 minutes vs. 61.79 minutes). However, an opposite  
 231 trend was observed in terms of expenses of first inpatient admission (¥831.35 vs. ¥791.01).  
 232 The TC group mostly had respiratory (37.7%) and digestive diseases (20.3%). There were  
 233 no significant differences in the distance to a county hospital and the township hospital  
 234 capacity between the TT and TC groups.

235 **Table 3. Distribution of characteristics of readmitted patients ( $n = 6,764$ )**

Variable	All n (%)	Choice for hospital readmission		<i>P</i>
		TT group n (%)	TC group n (%)	
All	6,764	4,225 (62.5)	2,539(37.5)	
Gender				<0.001*
Male	3,006 (44.4)	1,769(41.9)	1,237(48.7)	
Female	3,758(55.6)	2,456(58.1)	1,302(51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94(0.35)	50.25(0.43)	<0.001**
Less than 20	950 (22.0)	629(22.9)	321(20.5)	<0.001*
20–39	1,215 (28.2)	877(31.9)	338(21.6)	
40–59	2,045 (47.4)	1,192(43.4)	853(54.4)	
More than 59	103 (2.4)	48(1.7)	55(3.5)	
Distance to CH (km)				



Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15**
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03**
Capacity of TH				
				0.53*
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001**
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01**
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04**
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001**
Interval between admissions (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001**
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001*
3-7	761 (11.3)	517(12.2)	244(9.6)	
7-15	1,328 (19.6)	987(23.4)	341(13.4)	
16-31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				
				<0.001*
Cancer	178 (2.6)	109(2.6)	69(2.7)	
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	
Digestive disease	984 (14.5)	469(11.1)	515(20.3)	
Urinary disease	269 (4.0)	89(2.1)	180(7.1)	
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)	
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)	
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)	

236 \* Pearson's chi-square test.

237 \*\* ANOVA.

## 238 **Determinants of choice for hospital readmission after township hospitalisation**

239 The two-level logistic regression is illustrated by the level 2 variance of the zero model.

240 This was statistically significant ( $\chi^2 = 63.524$ ,  $P < 0.001$ ), with aggregation of information  
 241 at the town level. The specific results of the explanatory variables to fit the two variance  
 242 component model are shown in Table 4. The major determinants of the choice for hospital  
 243 readmission after a first township hospitalisation were admission year, age, travel time to a  
 244 county hospital, interval between admissions, first LOS and disease category. If other  
 245 factors remained constant, patients in the group aged 40–59 years were more likely to be  
 246 readmitted to a county hospital (odds ratio [OR] = 1.32). Other factors associated with TC  
 247 readmission were a shorter travel time to county hospital, shorter LOS, shorter interval  
 248 between admissions, urinary tract diseases (OR = 2.68) or first admission/readmission in a  
 249 more recent year. The ratio of patients with obstetric or gynaecological diseases readmitted  
 250 to a county hospital was much lower than that of patients with cancer (OR = 0.40).

251 **Table 4. Multilevel logistic regression model for hospital readmission choice**

	Parameter estimate	Standard error	$\chi^2$	P	Adjusted OR
<b>Fixed Part:</b>					
Constant	-271.3	41.231	49.524	<0.001	
Admitted year*	0.136	0.027	47.934	<0.001	1.14
Gender(reference: female)					
Male	-0.003	0.066	0.003	0.955	1.00
Age (reference: less than 20)					
20–39	-0.062	0.123	0.250	0.617	0.94
40–59	0.294	0.111	6.870	0.008	1.32
More than 59	0.034	0.102	0.116	0.735	1.03
Travel time (min)	-0.023	0.013	17.468	<0.001	0.97
Capacity of TH**	-0.017	0.035	0.204	0.658	0.98
1st LOS (day)	-0.036	0.006	53.177	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.323	0.255	1.00
2nd LOS (day)	-0.002	0.003	0.213	0.644	0.99
Interval between admissions (day)	-0.110	0.004	895.49	<0.001	0.90
Disease category (reference: cancer)					

ENT	-0.406	0.263	2.462	0.131	0.67
Respiratory disease	-0.256	0.217	1.327	0.251	0.78
Circulatory disease	0.512	0.256	4.627	0.028	1.64
Digestive disease	0.553	0.227	6.217	0.013	1.74
Urinary disease	0.982	0.264	13.950	<0.001	2.68
Haematological disorders	2.310	0.853	7.641	0.004	10.03
Bones and muscles	0.245	0.242	1.066	0.301	1.28
Obstetrics and gynaecology	-0.947	0.238	15.874	<0.001	0.40
Else	-0.132	0.265	0.251	0.617	0.88
<b>Random Part:</b>					
Town variance	0.153	0.036	17.921	<0.001	—
Patient scale parameter	1	0.00	—	—	—

252 \* TC shows a stable increase in recent years, so admitted year was included in the analysis by order of ranked data.

253 \*\* Capacity of township hospital included in the analysis by order of ranked data.

## 254 Discussion

### 255 Choice for hospital readmission and aggregation

256 Readmission is common and unavoidable, and can often be attributed to technology and  
 257 management problems.<sup>[18]</sup> TC readmission accounted for 1.89% of all hospitalisation  
 258 cases in Qianjiang in 2013, showing steady growth from 2008 (1.66%). In the study period,  
 259 TC readmission accounted for more than one-third of readmission cases that had a first  
 260 inpatient admission in a township hospital, which is common in rural China. However, as  
 261 mentioned, TC readmission (either through doctor referral/recommendation or the patient's  
 262 choice) often reflects an inefficient use of health services for patients; TC readmission  
 263 patients may experience disease delays or cost waste, which may result in patient  
 264 dissatisfaction regarding the township hospital. A point that needs to be noted here is the  
 265 uncertainty about whether TT patients had been readmitted to a county hospital three or  
 266 more times, which has been reported as a real scenario.

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4 267 The two-level logistic regression analysis showed a hierarchy in the inpatient data (town–  
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6 268 patients). Patients' choice of hospital readmission was clustered at the town level. In other  
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8 269 words, 6,764 readmitted patients were non-independent, and the choices for hospital  
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10 270 readmission in same town tended to be approximated. The incidence differed in different  
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12 271 towns, from 2.95% (Chengnan) to 6.96% (Jindong). The 30 towns in the study area also  
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14 272 differed in terms of township hospital, social customs and geographic location. Different  
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16 273 township hospitals also have different service concepts and medical capabilities, which  
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18 274 might have affected patients' hospital readmission choice.  
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#### 24 **Determinants of choice for hospital readmission**

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26 276 Logistic regression analysis showed that patient gender, capacity of township hospital and  
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28 277 first admission expenses did not have significant effects on the choice of hospital for  
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30 278 readmission. Readmission choice was affected by age, travel time to a county hospital,  
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32 279 interval between admissions, LOS in the first admission and disease category. Although the  
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34 280 towns in which patients lived affected their choice of hospital for readmission, the capacity  
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36 281 of township hospitals had no significant effects; therefore, the town-based effects could be  
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38 282 speculatively attributed to social customs and geographic location, which is consistent with  
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40 283 a previous study.<sup>[19]</sup> In other words, regardless of capacity of the township hospital,  
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42 284 readmission is unavoidable and occurs under the same rate; in theory, TC readmission  
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44 285 resulted from the doctors' assessment of their treatment ability, or deterioration of disease  
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46 286 rather than the general hospital capacity.<sup>[20]</sup>  
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54 287 In general, patients were more likely to be readmitted to a county hospital if they were in  
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4 288 an older age group, found travel to a county hospital more convenient, had lower expenses,  
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6 289 had a shorter interval between admissions or diseases that were harder to assess. The ratio  
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8 290 of patients choosing to be readmitted to a county hospital increased with age, which may  
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10 291 be a result of the increased attention to the cure rate among those of more advanced age.  
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13 292 The OR for travel time to a county hospital was 0.97, indicating that patients made their  
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15 293 choice based on convenience.<sup>[16-19]</sup> The most obvious influencing factors were first LOS  
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17 294 and the interval between admissions. These factors can be combined to discuss the  
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19 295 difference in choice. The average first LOS in the TT group was 9.23 days, which is close  
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21 296 to 9.7 days, the standard LOS in township hospitals in China.<sup>[15]</sup> Moreover, the average  
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23 297 interval between admissions was 14.95 days. In the TC group, the average first LOS was  
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25 298 6.96 days and the interval between admissions was 6.03 days. A shorter first LOS ( $OR =$   
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27 299 0.96) and a shorter the interval between admissions ( $OR = 0.90$ ) was associated with a  
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29 300 greater likelihood of choosing a county hospital. This disparity may be associated with the  
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31 301 degree of urgency of the disease. Patients with diseases related to the urinary system ( $OR =$   
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33 302 2.68) and haematological disorders ( $OR = 10.03$ ) were more likely to choose a county  
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35 303 hospital compared with patients with cancer, respiratory diseases and other disease types.  
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37 304 This finding may be related to township doctor assessment regarding treatment ability.  
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39 305 Diseases in the urinary system, cardiovascular system and haematological disorders cannot  
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41 306 be controlled well in township hospitals, leading to a higher rate of inaccurate assessments  
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43 307 and a higher probability of readmission to a county hospital.<sup>[21]</sup> Respiratory and digestive  
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45 308 diseases (e.g. influenza, paediatric bronchial pneumonia and chronic obstructive  
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47 309 pulmonary disease<sup>[22]</sup>) have a high incidence and recurrence rate and can be controlled in  
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4 310 township hospitals. However, these diseases often have failed treatment outcomes because  
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6 311 of poor patient compliance on medicine and after-care.<sup>[23]</sup> Consequently, these patients  
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8 312 may be more likely to choose county hospitals for readmission. Moreover, readmissions  
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11 313 tended to move toward county hospitals as year increased ( $OR = 1.14$ ), which implies an  
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13 314 endogenous factor as affected the increase of inpatients in county hospitals in recent years.

### 16 315 **Identifying forms of TC readmission**

19 316 We could differentiate TC admission from TT admission by first LOS and interval between  
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21 317 admissions. Intervals in TC patient admission showed a U-shaped distribution; 61.1% were  
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23 318 readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the  
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25 319 group after more than 15 days. Correspondently, 50.1% of patients in the TT group had an  
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27 320 interval between admissions of more than 15 days. Therefore, a considerable proportion of  
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29 321 early readmissions might be referrals; patients readmitted after a short first LOS with a  
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31 322 short interval may be assumed to have been referred by doctors. A long first LOS and long  
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33 323 interval were more likely to indicate a TC caused by individual choice, meaning an  
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35 324 inappropriate TC readmission. Longer first LOS means a complete treatment in township  
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37 325 hospital, and longer interval indicates readmission may have been caused by poor  
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39 326 compliance on medicine and after-care from patients themselves or a normal disease  
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41 327 recurrence. Therefore, a combination of first LOS and interval may be an effective  
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43 328 identification index; we used 1 week as the cut-off value (Table 3). TC readmissions based  
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45 329 on a doctor's incorrect assessment accounted for approximately 70.7% of admissions  
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47 330 (interval between admissions <7 days), and those caused by patients accounted for 29.3%  
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49 331 (interval between admissions >7 days).

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4 332 The sample county is a typical rural area, and this research is a population based study, so  
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6 333 the results could present the TC phenomenon in all rural China.  
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## 9 334 **Conclusions**

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12 335 Patients were more likely to choose a county hospital for readmission over time. TC  
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14 336 readmission remains a common health service use in rural China, and may result in  
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17 337 inappropriate patient flows. Differences in readmission choices were associated with age,  
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19 338 travel time to county hospital, first LOS, interval between admissions and diseases; all of  
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21 339 these factors are easy to identify. Combination of first LOS and interval between  
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24 340 admissions could be an effective identification index for the forms of TC readmission.  
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## 28 341 **Limitations**

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31 342 Our study has several limitations. Hospitalisation information, geographical factors,  
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33 343 interval status and disease were all entered into the logistic regression model. However,  
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35 344 some individual factors (e.g. economic status, education and preference) were not available.  
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38 345 Moreover, influence on choice of hospitals may reflect an accumulated process, meaning  
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40 346 that the more patients experience TC readmission, the more significant the influence would  
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42 347 become. However, we only studied the influence of the first TC readmission in a single  
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44 348 year. These limitations may bring instability to our study and need to be resolved in future  
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47 349 studies.  
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## 50 350 **Competing interests**

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52  
53 351 The authors have declared that no competing interests exist.  
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## 352 **Authors' contributions**

353 Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the  
354 manuscript. Y-D.N. participated in data collection and performed the statistical analysis.  
355 L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All  
356 authors have given their final approval of the version to be published.

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361 No past publication history, no past presentation history

## 362 **Provenance and peer review**

363 Not commissioned; externally peer reviewed.

## 364 **Data sharing statement**

365 The anonymized dataset is available through the email of the corresponding author.

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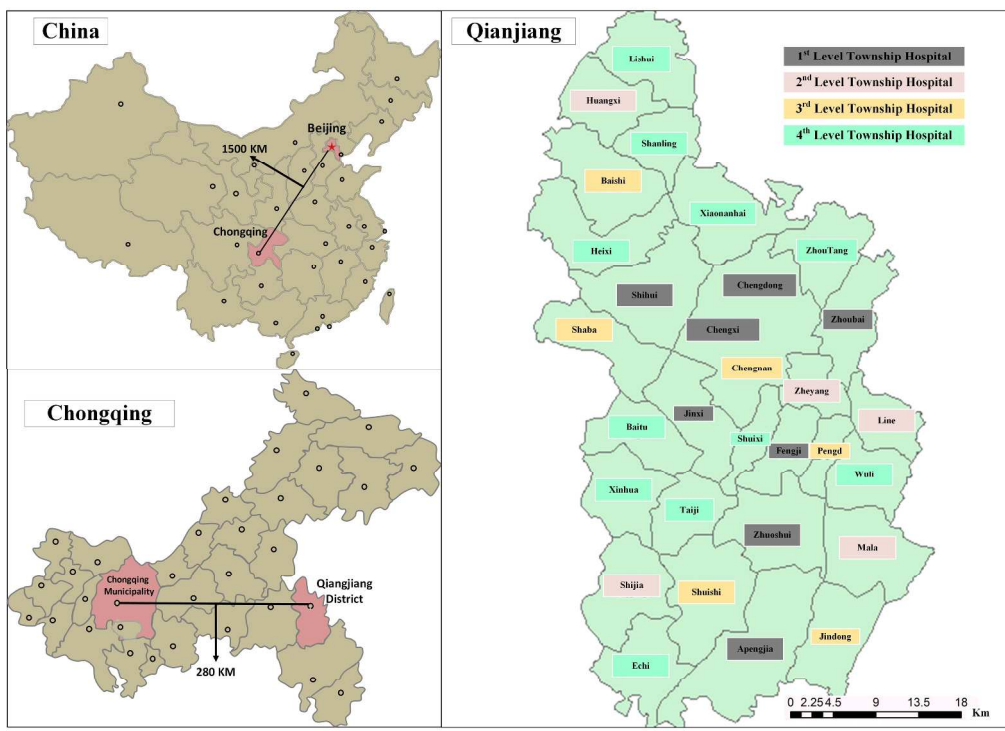
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6 425 **Figure Legend**  
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8 426 **Figure 1.** Map of Qianjiang district: geographic distribution  
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Map of Qianjiang distract: geographic distribution

136x113mm (600 x 600 DPI)

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

Section/Topic	Item #	Recommendation	Reported on Line #
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	<b>Lines:1-2</b>
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	<b>Lines:22-58</b>
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	<b>Lines:60-126</b>
Objectives	3	State specific objectives, including any prespecified hypotheses	<b>Lines:126-129</b>
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	<b>Lines:152-154</b>
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	<b>Lines:131-143</b>
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	<b>Lines:145-147</b>
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	<b>Lines:148-152</b>
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	<b>Lines:152-166</b>
Bias	9	Describe any efforts to address potential sources of bias	<b>No</b>
Study size	10	Explain how the study size was arrived at	<b>Lines:167-168</b>
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	<b>Lines:169-177</b>
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	<b>Lines:178-180</b>
		(b) Describe any methods used to examine subgroups and interactions	<b>Lines:180-190</b>
		(c) Explain how missing data were addressed	<b>No</b>
		(d) If applicable, describe analytical methods taking account of sampling strategy	<b>No</b>
		(e) Describe any sensitivity analyses	<b>No</b>
<b>Results</b>			

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>Lines:197-204</b>
		(b) Give reasons for non-participation at each stage	<b>No</b>
		(c) Consider use of a flow diagram	<b>No</b>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	<b>Lines:218-234</b>
		(b) Indicate number of participants with missing data for each variable of interest	<b>No</b>
Outcome data	15*	Report numbers of outcome events or summary measures	<b>Lines:198-201</b>
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>Lines:235-250</b>
		(b) Report category boundaries when continuous variables were categorized	<b>Lines:235-250</b>
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	<b>No</b>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	<b>Lines:209-217</b>
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	<b>Lines:252-271; 332-338</b>
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	<b>Lines:339-347</b>
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	<b>Lines:272-328</b>
Generalisability	21	Discuss the generalisability (external validity) of the study results	<b>Lines:329-331</b>
<b>Other information</b>			
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	<b>Lines:356-357</b>

\*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](http://www.strobe-statement.org).

# BMJ Open

## Determinants of Patient Choice for Hospital Readmission after Township Hospitalisation: A Population-Based Retrospective Study in China

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2018-021516.R3
Article Type:	Research
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Complete List of Authors:	Zhang, Yan; Huazhong University of Science and Technology Tongji Medical College, School of Medicine and Health Management Yadong, Niu; Huazhong University of Science and Technology ZHANG, LIANG; Huazhong University of Science and Technology Tongji Medical College
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Health services research, Health policy, Medical management
Keywords:	readmission, choice, county hospital, patient flow, rural China

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4 **1 Determinants of Patient Choice for Hospital Readmission after Township**  
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12 4 Yan Zhang<sup>1,2</sup>, Yadong Niu<sup>1,2</sup>, Liang Zhang<sup>1,2</sup> §  
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## 21 Abstract

22 **Objective:** The lack of coordinated and appropriate healthcare across sectors has produced  
23 more patients for county hospitals in China. This study examined differences in patient  
24 choice between township and county hospitals for readmission after a first township  
25 hospitalisation, and the determinants that influenced this choice.

26 **Design:** A retrospective study of readmissions across hospitals after a first admission in  
27 township hospital. A township–township inpatient (TT) group and a township–county  
28 inpatient (TC) group were compared. A two-level logistic regression model was used to  
29 examine the determinants of choice for hospital readmission.

30 **Setting:** Data were drawn from a population-based health utilisation database for  
31 Qianjiang District, China, from 1 January 2008 to 31 December 2013.

32 **Participants:** This study focused on readmitted patients whose first admission was in a  
33 township hospital. Readmission cases were identified as the same diagnosis (International  
34 Classification of Diseases, tenth revision) in a subsequent hospitalisation within 30 days. In  
35 total, 6,764 readmissions had first admissions in township hospitals.

36 **Primary outcome measures:** Patient choice for hospital readmission after a first township  
37 hospitalisation.

38 **Results:** The TT group accounted for 62.5% (4,225) and the TC group for 37.5% (2,539)  
39 of readmissions in 6 years, and the proportion of TC readmissions in total inpatients  
40 increased from 1.66% to 1.89%. Readmission rates varied among towns ( $P < 0.001$ ).  
41 Differences between the TC and TT groups included: length of stay (LOS) of first  
42 admission (6.96 days vs. 9.23 days), average interval between admissions (6.03 days vs.



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4 43 14.95 days) and disease category. Admission year, age, travel time to county hospital,  
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6 44 interval between admissions, first admission LOS and disease category were determinants  
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8 45 of choice for hospital readmission.  
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11 46 **Conclusions:** Patients whose first admission was in a township hospital were more likely  
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13 47 to be readmitted to a county hospital. A combination of first LOS and interval between  
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15 48 admissions may be an effective identification index for township–county readmission.  
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18 49 **Keywords:** readmission, choice, county hospital, patient flow, rural China  
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## 21 50 **Strengths and limitations**

- 22 51 • This is the first study to focus on township–county readmission, a feature of  
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24 52 hospitalisation in rural China.
- 25  
26 53 • Population-level data on readmission is seldom reported across hospitals of different  
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28 54 levels.
- 29  
30 55 • Programming techniques, including Microsoft Excel formulas and case processing  
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32 56 technologies, were used in the data processing.
- 33  
34 57 • A two-level logistic regression model was used to consider aggregation at the town level.
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36 58 • Hospitalisation information, geographical factors, interval status and disease were all  
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38 59 entered into the logistic regression model, but some individual factors were missing.

## 39 60 **Background**

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41 61 Readmission refers to an episode where an inpatient is readmitted for the same disease  
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43 62 with 30 days.<sup>[1, 2]</sup> In most studies, readmission findings reflect that inpatient care did not  
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45 63 meet patient requirements, with readmission rates used as an evaluation index for  
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4 64 hospitalisation quality.<sup>[3]</sup> Readmission usually occurs in the same hospital, but sometimes  
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6 65 occurs across hospitals because of deterioration of a patient's disease.<sup>[4]</sup> However, in rural  
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8 66 China, multilevel institutional readmission is a common and important healthcare  
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11 67 utilisation. This reflects defects of China's healthcare delivery system, rather than  
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13 68 hospitalisation quality, especially in township–county (TC) readmissions. TC readmission  
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16 69 is a health-seeking behaviour in which inpatients seek healthcare services in a township  
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18 70 hospital first, and then in a county hospital, whether planned or unplanned, voluntarily or  
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21 71 passively. TC readmission is frequent in rural China, and currently accounts for  
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23 72 approximately 2.0% of all inpatient services.<sup>[5]</sup> TC readmission usually occurs following  
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26 73 doctor recommendation/referral or by individual patient choice.  
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28 74 TC readmission recommended by doctors occurs when a township doctor has an inpatient  
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31 75 admission that they cannot fully treat or completely cure,<sup>[6]</sup> consequently, that patient is  
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33 76 referred directly to a county hospital or advised to go to a county hospital for subsequent  
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36 77 admission.<sup>[6]</sup> This situation results from the three-tier healthcare delivery system in rural  
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38 78 China, where care is provided in a village–town–county healthcare delivery system, and all  
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41 79 hospital services are supplied by township and county hospitals.<sup>[7]</sup> In general, the higher  
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43 80 the level of the institution, the stronger the service capability, the greater the distance a  
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46 81 patient must travel and the higher the medical cost. Township hospitals bear the  
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48 82 responsibilities of transferring patients, taking care of inpatients with general illnesses and  
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51 83 advising patients with severe diseases (that are beyond their capacity) to seek admission at  
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53 84 county hospitals.<sup>[8]</sup> Township hospital doctors sometimes receive patients whose diseases  
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56 85 are beyond their capacity to manage (e.g. because of their inaccurate judgment, or

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4 86 deterioration of the disease), meaning TC readmission may be unavoidable.  
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7 87 TC readmission from individual choice may occur when patients who should be readmitted  
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9 88 to township hospitals choose to be admitted to county hospitals for personal reasons.<sup>[9]</sup>  
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11 89 Some readmissions are influenced by quality concerns with township hospitals, poor  
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14 90 patient compliance on medicine and after-care or from a normal disease recurrence.  
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16 91 However, patients often do not acknowledge the real readmission reason and transfer  
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19 92 responsibility for readmission to the township hospital doctor (e.g. considering readmission  
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21 93 as a result of failed treatment) and consequently decide to be readmitted to a county  
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24 94 hospital. This situation often represents inappropriate readmission.<sup>[10]</sup>  
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27 95 From the patients' perspective, no order or limitation on patient choice exists. In addition,  
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29 96 no general practitioners or consultants are available in rural China. Therefore, residents  
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31 97 freely choose hospitals and service types, mainly depending on their judgment regarding  
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34 98 their disease and understanding of hospitals. If a patient chooses a higher-level institution  
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37 99 than necessary, they pay more; if they choose a lower-level institution than necessary they  
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39 100 would be referred or readmitted. Therefore, the cost of an incorrect decision is borne by the  
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41 101 patient. To guarantee patient interests regarding TC readmission, the three-tier healthcare  
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44 102 delivery system requires different-level hospitals to cooperate in providing continuous  
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46 103 healthcare services. However, in reality, communication among township and county  
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49 104 professional providers is limited, and there is virtually no document sharing or interaction  
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51 105 among providers across the three tiers.<sup>[11]</sup> County hospital doctors do not deliver  
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54 106 continued care for readmitted patients because of income incentives and risk aversion, and  
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56 107 patients readmitted to a county hospital usually receive new treatment.<sup>[12]</sup> Furthermore,

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4 108 compared with patients admitted directly to county hospitals, readmitted patients spend  
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6 109 more time, pay more costs and may even miss proper treatments. As a result, when  
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8 110 subsequent illnesses occur and patients are unable to judge the severity of their illness, they  
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10 111 tend to choose admission in a county hospital, taking excess economic risk to avoid delay.  
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13 112 Some studies have defined TC readmission as failed treatment from the patients'  
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15 113 perspective, and shown that the TC readmission experience can influence a patient's later  
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17 114 choice of hospital.<sup>[13, 14]</sup> Inpatients may be more likely to seek care in county hospitals  
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19 115 compared with township hospitals; a phenomenon that is already happening. The annual  
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21 116 growth rate of inpatients in county hospitals from 2010 to 2016 was 6.75%, whereas that of  
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23 117 township hospital inpatients was 0.63% in rural China.<sup>[15]</sup>  
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28 118 As noted, TC readmission from individual choice may be an inappropriate level of  
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30 119 admission, and TC readmission recommended by doctors can also result in inappropriate  
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32 120 level admission for subsequent hospitalisation. Inappropriate level admission means  
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34 121 patients seek healthcare in a higher-level hospital than necessary. This may result from  
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36 122 patients' intentional institution selection and distrust of the capability of township hospitals;  
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38 123 such patients prefer to spend more money on healthcare to avoid the risk of needing  
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40 124 referral. Inappropriate level admission is a major form of excess service demand,<sup>[12]</sup> and  
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42 125 an important determinant of increasing health expenditure that leads to significant waste.  
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47 126 In this context, identifying the forms and determinants of TC readmission will help to  
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49 127 improve the New Rural Cooperative Medical System (NRCMS). This study focused on  
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51 128 choices for hospital readmission after a first admission as an inpatient in a township  
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53 129 hospital, and identified the determinants of choice for hospital readmission.  
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## 130 **Methods**

### 131 **Study setting**

132 Qianjiang District was designated as the sample area through cluster sampling. This is a  
133 typical rural area located in Chongqing, which is the largest municipality in southwest  
134 China. Qianjiang has a per capita GDP of \$7,515 in 2016, which is below the average GDP  
135 in China. The resident population is 550,000 people; all residents are covered under the  
136 NRCMS, and are eligible to receive reimbursement for inpatient care. Qianjiang District  
137 has two county hospitals and 30 township hospitals. The township hospitals are divided  
138 into four levels according to their scale and service quantity by Qianjiang Health Bureau  
139 (Fig. 1). First-level township hospitals are allocated more than 30 beds and may perform  
140 abdominal operations; these hospitals had more than 1,200 discharged patients in 2013.  
141 Second-level township hospitals cannot perform abdominal operations of the same scale as  
142 first-level township hospitals. Third-level township hospitals have fewer than 30 beds and  
143 around 600~1,200 discharged patients. All other township hospitals belong to the fourth  
144 level.

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4 145 **Data source**  
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7 146 This study was based on the NRCMS inpatient database in Qianjiang District, which  
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9 147 contains all inpatient data for the population. In this database, a case refers to a single  
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12 148 hospitalisation in a county or township hospitals.  
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15 149 **Data processing**  
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18 150 We focused on individuals who had been discharged from participating hospitals.  
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20 151 Readmission cases were identified as having the same diagnosis in subsequent  
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22 152 hospitalisations between county and township hospitals or township hospitals and township  
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24 153 hospitals within 30 days. Given our population-based retrospective design, we compared  
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27 154 the differences between township–township readmitted inpatients (TT group) and TC  
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29 155 readmitted inpatients (TC group). Samples were entered into MS Excel 2010, based on the  
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32 156 NRCMS database from 1 January 2008 to 31 December 2013. First, cases that shared the  
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34 157 same patient identifier and the same disease codes were sorted in chronological order.  
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37 158 Second, we calculated the interval between admissions in two adjacent cases for the same  
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39 159 inpatient for the same disease; if the interval between admissions was less than 31 days, the  
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42 160 patient was marked as a readmission patient. For example, if the first admission occurred  
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44 161 in a township hospital and the second occurred in county hospital, the two cases would be  
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47 162 merged as one case and marked as a TC readmission, and the patient marked as TC patient.  
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49 163 TT patients were identified in a similar manner. Finally, all TC and TT cases were  
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52 164 extracted into a new database. As diagnosis of a disease may change among different  
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55 165 doctors, in different institutions or at different times, we adjusted the original International  
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4 166 Classification of Diseases, tenth revision disease code into a broader code (e.g. chronic  
5  
6 167 obstructive pulmonary disease was adjusted from J44.900 to J44), which may improve  
7  
8 168 accuracy in identifying readmitted patients. After screening, there were 6,764 readmitted  
9  
10  
11 169 patients from 2008–2013 in the sample.

12  
13 170 The main programming techniques included Microsoft Excel formulas (e.g. COUNTIF,  
14  
15 171 SUMPRODUCT, LOOKUP and IF) and case processing technologies (e.g. split columns  
16  
17  
18 172 and removal of duplicates).

19  
20 173 Sociological characteristics were collected to build a final database, including: gender; age;  
21  
22  
23 174 travel time from home to county hospital; first inpatient information including length of  
24  
25 175 stay (LOS), expenses, disease category, capacity of the township hospital, interval between  
26  
27  
28 176 admissions and readmitted hospital choice.<sup>[16]</sup> The distance and travel time to the county  
29  
30 177 hospital for all readmitted patients were captured individually by Google Maps. Because  
31  
32  
33 178 traffic conditions are different in different towns (e.g. national roads, provincial roads or  
34  
35 179 county roads), both the distance and travel time were captured.

### 36 37 38 180 **Data obtained and Statistical analysis**

39  
40  
41 181 The characteristics of patients' choices for hospital readmission were compared using  
42  
43  
44 182 t-tests and chi-square tests in IBM SPSS Statistics 22.0. The treatment capacity of  
45  
46 183 township hospitals and the travel time to a county hospital from different towns have  
47  
48  
49 184 differential impacts on the observed predictors. Therefore, we assumed that the obtained  
50  
51 185 data indicated a hierarchical structure, and the 6,764 records could be aggregated by town  
52  
53  
54 186 level. The determinants of choice for hospital readmission were examined using multilevel  
55  
56 187 binomial logistic regression analysis using MLwiN 2.30, which was developed by the

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4 188 University of Bristol, UK.<sup>[17]</sup> Patients were identified as level 1 and town as level 2. The  
5  
6 189 regression model was as follows.

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10 190 
$$\log it(\pi_{ij}) = \beta_0 \text{cons} + \beta_1 \text{Admitted Year}_{ij} + \beta_2 \text{Gender}_{ij} + \beta_3 \text{Age}_{ij} + \beta_4 \text{Distance}_{ij} + \beta_5 \text{Time}_{ij}$$
  
11 
$$+ \beta_6 \text{Capacity}_{ij} + \beta_7 \text{1st LOS}_{ij} + \beta_8 \text{1st Expend}_{ij} + \beta_9 \text{Interval}_{ij} + \text{More14}_{ij}$$

12 191 
$$\beta_{0j} = \beta_0 + u_{0j}$$

13  
14 192  $\beta_i$  refers to the fixed effects parameter, and  $u_{0j}$  refers to the random effects of level 2.

### 15 16 17 18 193 **Patient and Public Involvement**

19  
20 194 No patients or public were involved in this research.

### 21 22 23 24 195 **Ethical approval**

25  
26 196 The study protocol conformed to the guidelines of the Ethics Committee of the Tongji  
27  
28 197 Medical College of Huazhong University of Science and Technology. The protocol was  
29  
30 198 registered in the Chinese Clinical Trial Registry (ChiCTR-OOR-14005563). Patient  
31  
32 199 information was anonymised and de-identified before analysis.

## 33 34 35 36 37 200 **Results**

### 38 39 40 41 201 **Choices for hospital readmission after a first township hospitalisation**

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43 202 Among 271,405 discharged admissions in 2008–2013, there were 6,764 readmissions after  
44  
45 203 a first hospitalisation in a township hospital. The TT group accounted for 62.5% (4,225) of  
46  
47 204 all readmissions and the TC group for 37.5% (2,539) (Table 1). The number of  
48  
49 205 readmissions increased sharply, whereas the proportion of readmissions in the total  
50  
51 206 inpatients averaging around 5%. The TC group increased from 1.66% in 2008 to 1.89% in  
52  
53  
54  
55 207 2013, with the annual growth rate of the TC group being 28.55%, which was higher than



208 that of the TT group (22.38%).

209 **Table 1. Number of readmissions each year in Qianjiang district (2008–2013)**

Year	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		P***
			TT group n (%)	TC group n (%)	
2008	21,823	524 (4.80)	342 (3.14)	182 (1.66)	<0.001
2009	34,240	1,076 (6.27)	724 (4.23)	352 (2.04)	
2010	35,866	942 (5.25)	608 (3.39)	334 (1.86)	
2011	50,616	1,260 (4.98)	797 (3.16)	463 (1.82)	
2012	61,467	1,384 (4.50)	815 (2.64)	569 (1.86)	
2013	67,392	1,578 (4.67)	939 (2.78)	639 (1.89)	
<b>Total</b>	<b>271,405</b>	<b>6,764 (4.98)</b>	<b>4,225 (3.11)</b>	<b>2,539 (1.87)</b>	

210 \* Readmission refers to readmissions whose first admission was in a township hospital.

211 \*\* One readmission includes two admissions.

212 \*\*\* Pearson's chi-square test.

213 Readmission varied among towns (Table 2). Chengnan town had the lowest overall

214 readmission ratio (2.95%) and the lowest TT readmission ratio (1.52%) of the 30 towns.

215 Heixi town had the lowest TC readmission ratio (1.30%), Shijia town had the highest TC

216 readmission ratio (2.86%) and Jindong town had the highest TT readmission (5.49%) and

217 overall readmission (6.96%) ratios.

218 **Table 2. Number of readmissions Qianjiang district (2008–2013), by town**

Town	All inpatients	Readmissions* n (%)	Choice for hospital readmission**		P***
			TT group n (%)	TC group n (%)	
Chengnan	11,716	173 (2.95)	89 (1.52)	84 (1.43)	<0.001
Heixi	9,073	137 (3.02)	78 (1.72)	53 (1.30)	
Shaba	8,778	152 (3.20)	81 (1.58)	71 (1.62)	
~	~	~	~	~	
Shijia	8,605	223 (5.18)	100 (2.32)	123 (2.86)	
Jindong	6,007	209 (6.96)	165 (5.49)	44 (1.47)	
<b>Total</b>	<b>271,405</b>	<b>6,764 (4.98)</b>	<b>4225 (3.11)</b>	<b>2539 (1.87)</b>	

219 \* Readmission refers to readmissions whose first admission was in a township hospital.

220 \*\* One readmission includes two admissions.

221 \*\*\* Pearson's chi-square test.

## 222 Characteristics of readmitted patients between TT and TC groups

223 Table 3 shows the characteristics of readmitted patients from 2008–2013. Male patients  
 224 accounted for 48.7% of the TC group, which was a higher rate than in the TT group (41.9%,  
 225  $P < 0.001$ ). Readmission choices varied in different age groups ( $P < 0.001$ ), with over half  
 226 (57.9%) of patients in the TC group aged 40–59 years. The most common interval between  
 227 admissions in the TC group was shorter than 3 days (61.1%), whereas that in the TT group  
 228 was 16–30 days (50.6%,  $P < 0.001$ ). The average interval between admissions in the TC  
 229 group was lower than that in TT group (6.03 days vs. 14.95 days). Similar patterns were  
 230 observed in the average LOS of first inpatient admissions (6.96 days vs. 9.23 days) and  
 231 travel time to county hospital (59.73 minutes vs. 61.79 minutes). However, an opposite  
 232 trend was observed in terms of expenses of first inpatient admission (¥831.35 vs. ¥791.01).  
 233 The TC group mostly had respiratory (37.7%) and digestive diseases (20.3%). There were  
 234 no significant differences in the distance to a county hospital and the township hospital  
 235 capacity between the TT and TC groups.

236 **Table 3. Distribution of characteristics of readmitted patients ( $n = 6,764$ )**

Variable	All n (%)	Choice for hospital readmission		<i>P</i>
		TT group n (%)	TC group n (%)	
All	6,764	4,225 (62.5)	2,539 (37.5)	
Gender				<0.001*
Male	3,006 (44.4)	1,769 (41.9)	1,237 (48.7)	
Female	3,758 (55.6)	2,456 (58.1)	1,302 (51.3)	
Age, years				
Mean (SD)	48.18 (0.27)	46.94 (0.35)	50.25 (0.43)	<0.001**
Less than 20	950 (22.0)	629 (22.9)	321 (20.5)	<0.001*
20–39	1,215 (28.2)	877 (31.9)	338 (21.6)	
40–59	2,045 (47.4)	1,192 (43.4)	853 (54.4)	
More than 59	103 (2.4)	48 (1.7)	55 (3.5)	
Distance to CH (km)				

Mean (SD)	36.29 (0.27)	35.99(0.34)	36.78(0.42)	0.15**
Time to CH (min)				
Mean (SD)	60.51 (0.45)	59.73(0.57)	61.79(0.72)	0.03**
Capacity of TH				
				0.53*
1st level (Strong)	3,076 (45.5)	1918(45.4)	1158(45.6)	
2nd level (Better)	1,315 (19.4)	802(19)	513(20.2)	
3rd level (General)	9,35 (13.8)	591(14)	344(13.5)	
4th level (Weak)	1,438 (21.3)	914(21.6)	524(20.6)	
1st LOS (day)				
Mean (SD))	8.38 (0.12)	9.23(0.16)	6.96(0.16)	<0.001**
1st Expense (RMB)				
Mean (SD)	816.21 (7.94)	831.35(9.95)	791.01(13.14)	0.01**
2nd LOS (day)				
Mean (SD)	10.24 (0.13)	10.03(0.16)	10.58(0.22)	0.04**
2nd Expense (RMB)				
Mean (SD)	2215.49 (45.46)	862.99(12.77)	4466.09(104.99)	<0.001**
Interval between admissions (day)				
Mean (SD)	11.6 (0.12)	14.95(0.14)	6.03(0.17)	<0.001**
~3	2,133(31.5)	582(13.8)	1551(61.1)	<0.001*
3-7	761 (11.3)	517(12.2)	244(9.6)	
7-15	1,328 (19.6)	987(23.4)	341(13.4)	
16-31	2,542 (37.6)	2139(50.6)	403(15.9)	
Disease category				
				<0.001*
Cancer	178 (2.6)	109(2.6)	69(2.7)	
ENT disease	338 (5.0)	243(5.8)	95(3.7)	
Respiratory disease	2,673 (39.5)	1715(40.6)	958(37.7)	
Circulatory disease	450 (6.7)	224(5.3)	226(8.9)	
Digestive disease	984 (14.5)	469(11.1)	515(20.3)	
Urinary disease	269 (4.0)	89(2.1)	180(7.1)	
Haematological disorders	19 (0.2)	2(0.1)	17(0.7)	
Bones and muscles	425 (6.3)	218(5.2)	207(8.2)	
Obstetrics and gynaecology	1,213 (17.9)	1037(24.5)	176(6.9)	

237 \* Pearson's chi-square test.

238 \*\* ANOVA.

## 239 **Determinants of choice for hospital readmission after township hospitalisation**

240 The two-level logistic regression is illustrated by the level 2 variance of the zero model.

241 This was statistically significant ( $\chi^2 = 63.524$ ,  $P < 0.001$ ), with aggregation of information  
 242 at the town level. The specific results of the explanatory variables to fit the two variance  
 243 component model are shown in Table 4. The major determinants of the choice for hospital  
 244 readmission after a first township hospitalisation were admission year, age, travel time to a  
 245 county hospital, interval between admissions, first LOS and disease category. If other  
 246 factors remained constant, patients in the group aged 40–59 years were more likely to be  
 247 readmitted to a county hospital (odds ratio [OR] = 1.32). Other factors associated with TC  
 248 readmission were a shorter travel time to county hospital, shorter LOS, shorter interval  
 249 between admissions, urinary tract diseases (OR = 2.68) or first admission/readmission in a  
 250 more recent year. The ratio of patients with obstetric or gynaecological diseases readmitted  
 251 to a county hospital was much lower than that of patients with cancer (OR = 0.40).

252 **Table 4. Multilevel logistic regression model for hospital readmission choice**

	Parameter estimate	Standard error	$\chi^2$	P	Adjusted OR
<b>Fixed Part:</b>					
Constant	-271.3	41.231	49.524	<0.001	
Admitted year*	0.136	0.027	47.934	<0.001	1.14
Gender(reference: female)					
Male	-0.003	0.066	0.003	0.955	1.00
Age (reference: less than 20)					
20–39	-0.062	0.123	0.250	0.617	0.94
40–59	0.294	0.111	6.870	0.008	1.32
More than 59	0.034	0.102	0.116	0.735	1.03
Travel time (min)	-0.023	0.013	17.468	<0.001	0.97
Capacity of TH**	-0.017	0.035	0.204	0.658	0.98
1st LOS (day)	-0.036	0.006	53.177	<0.001	0.96
1st Expends (RMB)	0.001	0.001	1.323	0.255	1.00
2nd LOS (day)	-0.002	0.003	0.213	0.644	0.99
Interval between admissions (day)	-0.110	0.004	895.49	<0.001	0.90
Disease category (reference: cancer)					

ENT	-0.406	0.263	2.462	0.131	0.67
Respiratory disease	-0.256	0.217	1.327	0.251	0.78
Circulatory disease	0.512	0.256	4.627	0.028	1.64
Digestive disease	0.553	0.227	6.217	0.013	1.74
Urinary disease	0.982	0.264	13.950	<0.001	2.68
Haematological disorders	2.310	0.853	7.641	0.004	10.03
Bones and muscles	0.245	0.242	1.066	0.301	1.28
Obstetrics and gynaecology	-0.947	0.238	15.874	<0.001	0.40
Else	-0.132	0.265	0.251	0.617	0.88
<b>Random Part:</b>					
Town variance	0.153	0.036	17.921	<0.001	—
Patient scale parameter	1	0.00	—	—	—

253 \* TC shows a stable increase in recent years, so admitted year was included in the analysis by order of ranked data.

254 \*\* Capacity of township hospital included in the analysis by order of ranked data.

## 255 Discussion

### 256 Choice for hospital readmission and aggregation

257 Readmission is common and unavoidable, and can often be attributed to technology and  
 258 management problems.<sup>[18]</sup> TC readmission accounted for 1.89% of all hospitalisation  
 259 cases in Qianjiang in 2013, showing steady growth from 2008 (1.66%). In the study period,  
 260 TC readmission accounted for more than one-third of readmission cases that had a first  
 261 inpatient admission in a township hospital, which is common in rural China. However, as  
 262 mentioned, TC readmission (either through doctor referral/recommendation or the patient's  
 263 choice) often reflects an inefficient use of health services for patients; TC readmission  
 264 patients may experience disease delays or cost waste, which may result in patient  
 265 dissatisfaction regarding the township hospital. A point that needs to be noted here is the  
 266 uncertainty about whether TT patients had been readmitted to a county hospital three or  
 267 more times, which has been reported as a real scenario.

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4 268 The two-level logistic regression analysis showed a hierarchy in the inpatient data (town–  
5  
6 269 patients). Patients' choice of hospital readmission was clustered at the town level. In other  
7  
8 270 words, 6,764 readmitted patients were non-independent, and the choices for hospital  
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10 271 readmission in same town tended to be approximated. The incidence differed in different  
11  
12 272 towns, from 2.95% (Chengnan) to 6.96% (Jindong). The 30 towns in the study area also  
13  
14 273 differed in terms of township hospital, social customs and geographic location. Different  
15  
16 274 township hospitals also have different service concepts and medical capabilities, which  
17  
18 275 might have affected patients' hospital readmission choice.  
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#### 24 **Determinants of choice for hospital readmission**

25  
26 277 Logistic regression analysis showed that patient gender, capacity of township hospital and  
27  
28 278 first admission expenses did not have significant effects on the choice of hospital for  
29  
30 279 readmission. Readmission choice was affected by age, travel time to a county hospital,  
31  
32 280 interval between admissions, LOS in the first admission and disease category. Although the  
33  
34 281 towns in which patients lived affected their choice of hospital for readmission, the capacity  
35  
36 282 of township hospitals had no significant effects; therefore, the town-based effects could be  
37  
38 283 speculatively attributed to social customs and geographic location, which is consistent with  
39  
40 284 a previous study.<sup>[19]</sup> In other words, regardless of capacity of the township hospital,  
41  
42 285 readmission is unavoidable and occurs under the same rate; in theory, TC readmission  
43  
44 286 resulted from the doctors' assessment of their treatment ability, or deterioration of disease  
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46 287 rather than the general hospital capacity.<sup>[20]</sup>  
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54 288 In general, patients were more likely to be readmitted to a county hospital if they were in  
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4 289 an older age group, found travel to a county hospital more convenient, had lower expenses,  
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6 290 had a shorter interval between admissions or diseases that were harder to assess. The ratio  
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8 291 of patients choosing to be readmitted to a county hospital increased with age, which may  
9  
10 292 be a result of the increased attention to the cure rate among those of more advanced age.  
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13 293 The OR for travel time to a county hospital was 0.97, indicating that patients made their  
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15 294 choice based on convenience.<sup>[16-19]</sup> The most obvious influencing factors were first LOS  
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17 295 and the interval between admissions. These factors can be combined to discuss the  
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20 296 difference in choice. The average first LOS in the TT group was 9.23 days, which is close  
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22 297 to 9.7 days, the standard LOS in township hospitals in China.<sup>[15]</sup> Moreover, the average  
23  
24 298 interval between admissions was 14.95 days. In the TC group, the average first LOS was  
25  
26 299 6.96 days and the interval between admissions was 6.03 days. A shorter first LOS ( $OR =$   
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28 300 0.96) and a shorter the interval between admissions ( $OR = 0.90$ ) was associated with a  
29  
30 301 greater likelihood of choosing a county hospital. This disparity may be associated with the  
31  
32 302 degree of urgency of the disease. Patients with diseases related to the urinary system ( $OR =$   
33  
34 303 2.68) and haematological disorders ( $OR = 10.03$ ) were more likely to choose a county  
35  
36 304 hospital compared with patients with cancer, respiratory diseases and other disease types.  
37  
38 305 This finding may be related to township doctor assessment regarding treatment ability.  
39  
40 306 Diseases in the urinary system, cardiovascular system and haematological disorders cannot  
41  
42 307 be controlled well in township hospitals, leading to a higher rate of inaccurate assessments  
43  
44 308 and a higher probability of readmission to a county hospital.<sup>[21]</sup> Respiratory and digestive  
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46 309 diseases (e.g. influenza, paediatric bronchial pneumonia and chronic obstructive  
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48 310 pulmonary disease<sup>[22]</sup>) have a high incidence and recurrence rate and can be controlled in  
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4 311 township hospitals. However, these diseases often have failed treatment outcomes because  
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6 312 of poor patient compliance on medicine and after-care.<sup>[23]</sup> Consequently, these patients  
7  
8 313 may be more likely to choose county hospitals for readmission. Moreover, readmissions  
9  
10 314 tended to move toward county hospitals as year increased ( $OR = 1.14$ ), which implies an  
11  
12 315 endogenous factor as affected the increase of inpatients in county hospitals in recent years.

### 16 316 **Identifying forms of TC readmission**

19 317 We could differentiate TC admission from TT admission by first LOS and interval between  
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21 318 admissions. Intervals in TC patient admission showed a U-shaped distribution; 61.1% were  
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23 319 readmitted to a county hospital within 3 days, and a small prevalence peak appeared in the  
24  
25 320 group after more than 15 days. Correspondently, 50.1% of patients in the TT group had an  
26  
27 321 interval between admissions of more than 15 days. Therefore, a considerable proportion of  
28  
29 322 early readmissions might be referrals; patients readmitted after a short first LOS with a  
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31 323 short interval may be assumed to have been referred by doctors. A long first LOS and long  
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33 324 interval were more likely to indicate a TC caused by individual choice, meaning an  
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35 325 inappropriate TC readmission. Longer first LOS means a complete treatment in township  
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37 326 hospital, and longer interval indicates readmission may have been caused by poor  
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39 327 compliance on medicine and after-care from patients themselves or a normal disease  
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41 328 recurrence. Therefore, a combination of first LOS and interval may be an effective  
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43 329 identification index; we used 1 week as the cut-off value (Table 3). TC readmissions based  
44  
45 330 on a doctor's incorrect assessment accounted for approximately 70.7% of admissions  
46  
47 331 (interval between admissions <7 days), and those caused by patients accounted for 29.3%  
48  
49 332 (interval between admissions >7 days).



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4 333 The sample county is a typical rural area, and this research is a population based study, so  
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6 334 the results could present the TC phenomenon in all rural China.  
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## 9 335 **Conclusions**

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12 336 Patients were more likely to choose a county hospital for readmission over time. TC  
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14 337 readmission remains a common health service use in rural China, and may result in  
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17 338 inappropriate patient flows. Differences in readmission choices were associated with age,  
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19 339 travel time to county hospital, first LOS, interval between admissions and diseases; all of  
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21  
22 340 these factors are easy to identify. Combination of first LOS and interval between  
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25 341 admissions could be an effective identification index for the forms of TC readmission.  
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## 28 342 **Limitations**

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31 343 Our study has several limitations. Hospitalisation information, geographical factors,  
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33 344 interval status and disease were all entered into the logistic regression model. However,  
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35 345 some individual factors (e.g. economic status, education and preference) were not available.  
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38 346 Moreover, influence on choice of hospitals may reflect an accumulated process, meaning  
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41 347 that the more patients experience TC readmission, the more significant the influence would  
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43 348 become. However, we only studied the influence of the first TC readmission in a single  
44  
45  
46 349 year. These limitations may bring instability to our study and need to be resolved in future  
47  
48 350 studies.  
49

## 50 351 **Competing interests**

51  
52  
53 352 The authors have declared that no competing interests exist.  
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## 353 **Authors' contributions**

354 Y.Z. and L.Z. participated in conception and design, and the analyses, and wrote the  
355 manuscript. Y-D.N. participated in data collection and performed the statistical analysis.  
356 L.Z. helped to draft the manuscript, reviewed the manuscript and made final changes. All  
357 authors have given their final approval of the version to be published.

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## 361 **Disclosure**

362 No past publication history, no past presentation history

## 363 **Provenance and peer review**

364 Not commissioned; externally peer reviewed.

## 365 **Data sharing statement**

366 The anonymized dataset is available through the email of the corresponding author.

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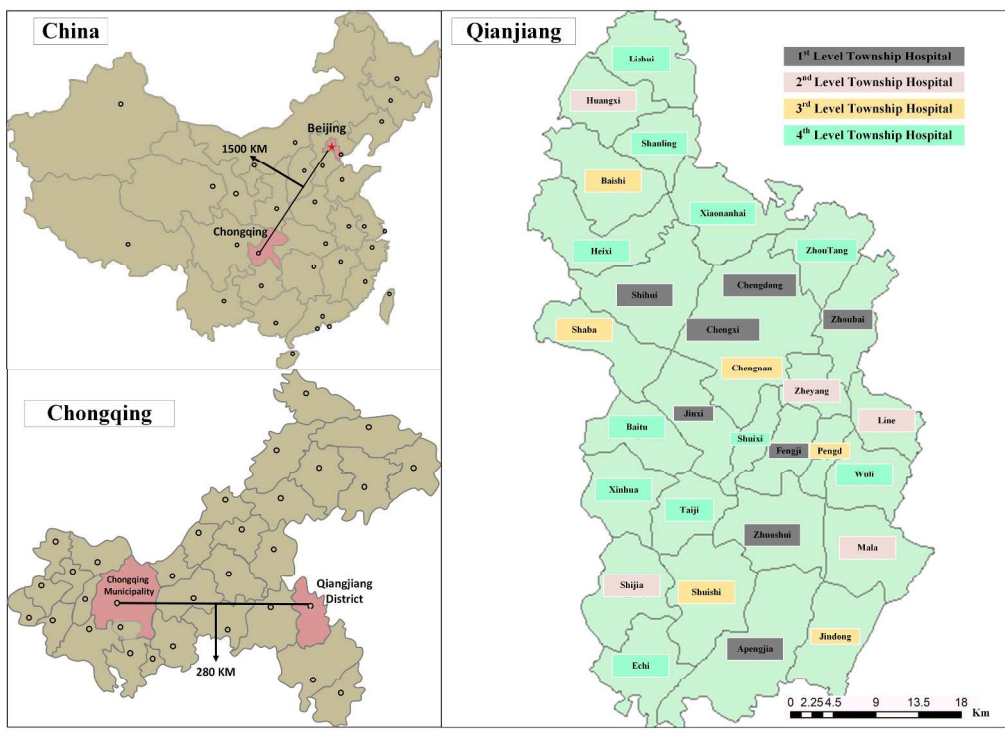
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6 426 **Figure Legend**  
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8 427 **Figure 1.** Map of Qianjiang district: geographic distribution  
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Map of Qianjiang distract: geographic distribution

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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 Line #
<b>Title and abstract</b>	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	<b>Lines:1-2</b>
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	<b>Lines:22-58</b>
<b>Introduction</b>			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	<b>Lines:60-126</b>
Objectives	3	State specific objectives, including any prespecified hypotheses	<b>Lines:126-129</b>
<b>Methods</b>			
Study design	4	Present key elements of study design early in the paper	<b>Lines:152-154</b>
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	<b>Lines:131-143</b>
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	<b>Lines:145-147</b>
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	<b>Lines:148-152</b>
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	<b>Lines:152-166</b>
Bias	9	Describe any efforts to address potential sources of bias	<b>No</b>
Study size	10	Explain how the study size was arrived at	<b>Lines:167-168</b>
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	<b>Lines:169-177</b>
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	<b>Lines:178-180</b>
		(b) Describe any methods used to examine subgroups and interactions	<b>Lines:180-190</b>
		(c) Explain how missing data were addressed	<b>No</b>
		(d) If applicable, describe analytical methods taking account of sampling strategy	<b>No</b>
		(e) Describe any sensitivity analyses	<b>No</b>
<b>Results</b>			

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>Lines:197-204</b>
		(b) Give reasons for non-participation at each stage	<b>No</b>
		(c) Consider use of a flow diagram	<b>No</b>
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	<b>Lines:218-234</b>
		(b) Indicate number of participants with missing data for each variable of interest	<b>No</b>
Outcome data	15*	Report numbers of outcome events or summary measures	<b>Lines:198-201</b>
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>Lines:235-250</b>
		(b) Report category boundaries when continuous variables were categorized	<b>Lines:235-250</b>
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	<b>No</b>
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	<b>Lines:209-217</b>
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	<b>Lines:252-271; 332-338</b>
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	<b>Lines:339-347</b>
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	<b>Lines:272-328</b>
Generalisability	21	Discuss the generalisability (external validity) of the study results	<b>Lines:329-331</b>
<b>Other information</b>			
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	<b>Lines:356-357</b>

\*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](http://www.strobe-statement.org).