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# Differences in medical costs among urban lung cancer patients with different health insurance schemes: a retrospective study

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## Abstract

**Background:** Health insurance plays a significant role in reducing the financial burden for lung cancer patients. However, limited research exists regarding the differences in medical costs for lung cancer patients with different insurance schemes across different cities. We aimed to assess disparities in lung cancer patients' costs by insurance type and city-specific insurance type.

**Methods:** Claim data of China Urban Employees' Basic Medical Insurance (UEBMI) and Urban Residents' Basic Medical Insurance (URBMI) between 2010 and 2016 were employed to investigate differences in medical costs. This study primarily applied descriptive analysis and a generalized linear model with a gamma distribution and a log link.

**Results:** In total, 92,856 lung cancer patients with inpatient records were identified, with Renminbi (RMB) 11,276 [6322–20,850] (median [interquartile range]) medical costs for the UEBMI group and RMB 8303 [4492–14,823] for the URBMI group. Out-of-pocket (OOP) expenses for the UEBMI group was RMB 2143 [1108–4506] and RMB 2975 [1367–6275] for the URBMI group. The UEBMI group also had significantly higher drug costs, medical service costs, and medical consumable costs, compared to the URBMI group. Regarding city-specific insurances, medical costs for the UEBMI and the URBMI lung cancer patients in Shanghai were RMB 9771 [5183–16,623] and RMB 9741 [5924–16,067], respectively. In Xianyang, the medical costs for UEBMI and URBMI patients were RMB 11,398 [6880–20,648] and RMB 9853 [5370–24,674], respectively. The regression results showed that the UEBMI group had 27.31% fewer OOP expenses than the URBMI group did, while patients in Xiangyang and Xianyang had 39.53 and 35.53% fewer OOP expenses, respectively, compared to patients in Shanghai.

**Conclusions:** Compared with the URBMI patients, the UEBMI lung cancer patients obtained more or even better health services and had reduced financial burden. The differences in insurances among cities were greater, compared to those among insurances within cities, and the differences in OOP expenses between cities were greater compared to those between UEBMI and URBMI. Our results called for further reform of China's fragmented insurance schemes.

**Keywords:** Lung cancer, Health insurance, Health policy, Medical costs

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## Introduction

Lung cancer has been the second most commonly diagnosed cancer and the major cause of death from cancer worldwide, imposing a heavy disease burden on global health [1]. In 2018, the global number of new lung cancer cases was approximately 2.09 million, ranking first among all cancer types. Other than causing 19.4%



of total cancer deaths, lung cancer is also considered one of the main causes of cancer-caused disability-adjusted life years (DALYs) [2, 3].

Lung cancer imposed a heavy burden on patients, their families, and the health system in China, with approximately 787,000 new cases in 2015. The age-standardized mortality rate in China reached 28.16 per 100,000 people, and approximately 30% of cancer deaths were due to lung cancer in 2015, both higher than most countries [4]. For each lung cancer patient in 2015, the average expenses in the first year following diagnosis accounted for 171% of the household annual income, and the all-direct expenses within 5 years after diagnosis was \$42,540 [5]. For the whole country in the same year, about 0.6% of total health expenditure (RMB 24.31 billion) was on lung cancer treatment [6]. The incidence of catastrophic expenditure on lung cancer was estimated at 42.78%, higher than that for gastric, liver, esophageal, and breast cancer in China [7]. Under such circumstances, health insurance drew increasing public attention in that it could significantly get this burden down for families with lung cancer survivors.

China's health insurance schemes for urban workers and urban residents bifurcate into the Urban Employee Basic Medical Insurance (UEBMI) and the Urban Resident Basic Medical Insurance (URBMI). UEBMI is compulsory and designed exclusively for urban employees. Contrarily, URBMI is a voluntary insurance program covering urban residents without formal employment, including young children, students, seniors, disabled, and other unemployed urban residents. The two health insurance schemes vary considerably in funding source, service coverage, and benefits packages [8]. Based on the annual salary of employees, employers and employees contribute 6 and 2% to UEBMI, respectively. URBMI is co-financed by both individuals and the government, the government has higher subsidies compared to individual premium contributions. In 2016, the per capita fund for UEBMI and URBMI was RMB 3478 and RMB 626, respectively [9]. UEBMI covers both outpatient and inpatient services whereas URBMI covers only inpatient services in most situations. Compared with URBMI, UEBMI provides a higher reimbursement rate, higher reimbursement ceiling, and more comprehensive service coverage, which means UEBMI has a better financial protection capacity for those enrolled. Importantly, a prior study stated that both UEBMI and URBMI schemes are pooled at the municipal level in China (approximately 333 UEBMI and 333 URBMI health insurance schemes under China's fragmented health insurance system) [8], leading to uneven benefit packages in different insurance types and cities.

The financial protection ability of health insurance schemes is either an incentive or a disincentive for patients to utilize health services [10, 11]. Existing studies have compared patients' medical costs for stroke [12], schizophrenia [13], and tuberculosis [14], supported by different insurance schemes. However, research investigating disparities in medical costs for lung cancer patients supported by different insurance schemes is scarce. Further, considering the differences in health insurance schemes among cities could be significant. Therefore, we used 7-year claims data for lung cancer from UEBMI and URBMI schemes in China to elucidate how these two health insurance schemes and their municipal differences shaped healthcare access and medical costs for lung cancer inpatients.

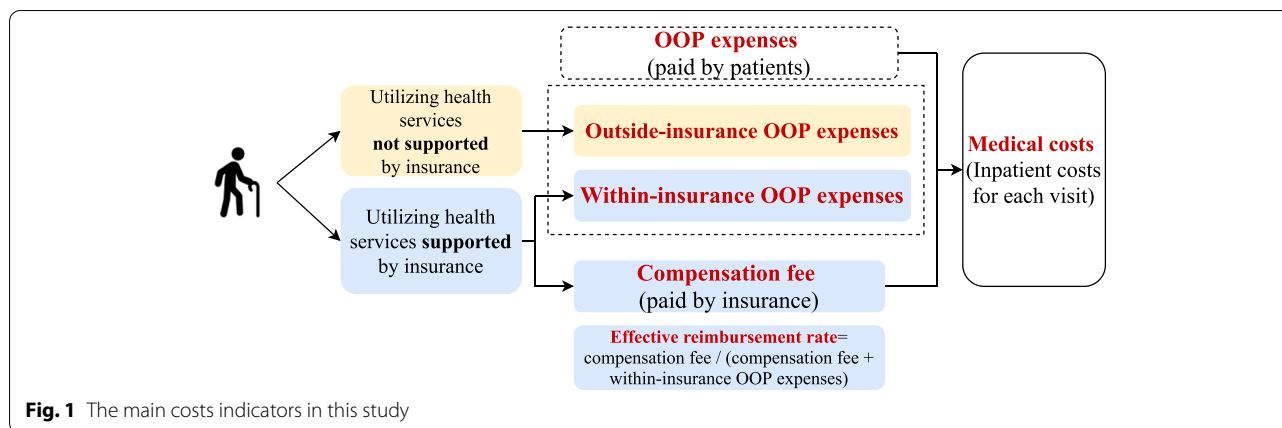
## Methods

### Data source

The data extracted claims from a 5% random sample comprising UEBMI and URBMI beneficiaries in 31 provinces in mainland China (covering more than 93% of the urban residents), who were supported by the China Health Insurance Research Association (CHIRA). A previous study describes the sampling process in detail [15]. The database includes 65 cities, all the records of urban beneficiaries' demographic information, and primary diagnoses of hospital admissions. Thus, we believe that the data is accurate and reflecting the situations of all lung cancer patients in China. First, inpatient data for lung cancer between 2010 and 2016 from all included cities was used to analyze the overall differences in medical costs between these two health insurance groups. Second, data from three cities, Shanghai, Xiangyang, and Xianyang (referring to city A, B, and C, respectively), was used to compare medical costs by different economic levels (usually divided into eastern, central and western regions in China) through city-specific insurance schemes. All three cities had well-established health insurance systems, with a health insurance coverage that was higher than 95% before 2016. In 2019, the per capita GDP in China was RMB 72447, and the per capita GDP in Shanghai, Xiangyang, and Xianyang was RMB 157,300, RMB 84,700, and RMB 50,200, respectively. It is plausible that the differences in the lung cancer patients' medical costs among all 333 cities could be inferred by assessing the differences in these three cities. According to the 10th revision of the International Statistical Classification of Disease (ICD-10), the principal diagnosis codes for all patients were identified as C34.

### Measures and variables

Medical costs in the database comprised drug costs, medical service costs, and medical consumable costs.



**Fig. 1** The main costs indicators in this study

Other cost variables such as surgery and radiation therapy were also included in the medical costs, but not in detail. Drug costs could be further categorized as western medicine costs, Chinese patent medicine (CPM) costs, and Chinese herbal medicine (CHM) costs (The CPM and CHM belong to traditional Chinese medicine (TCM)). We used out-of-pocket (OOP) expenses per visit and outside-insurance OOP expenses per visit to reflect the financial burden of lung cancer patients. As the service package of UEBMI is more comprehensive, URBMI patients may face higher outside-insurance OOP expenses for the same health services, compared to the UEBMI patients. The effective reimbursement rate was among the important indicators of the financial protection ability and generosity of health insurance schemes. Figure 1 shows these four indicators and their relationships in detail. The control variables included gender, age group (younger than 45, 45–59, 60–75, and older than 75), hospital-level (primary, secondary, and tertiary), area (eastern, central, and western region), comorbidity (with or without comorbid conditions, which was identified using patients’ second diagnosis at discharge). Various types of comorbidities including cardiovascular disease, chronic obstructive pulmonary disease, diabetes mellitus, and hypertension were included), and year (from the year 2010 to 2016). Control variables were only used when analyzing medical costs, OOP expenses, and outside-insurance OOP expenses. Our methods followed the guidelines for reporting economic evaluations (Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement) [16].

**Statistical analysis**

This study mainly employed descriptive analysis and a generalized linear model (GLM) with a gamma distribution and a log link. First, median and interquartile range (IQR) were calculated to display medical costs, OOP

expenses, outside-insurance OOP expenses by health insurance schemes, and control variables. Thereafter we evaluated the overall differences between the UEBMI and URBMI group regarding the four above-mentioned medical costs and the effective reimbursement rates. Second, we compared costs by health insurance schemes and cities. For the non-normal distribution of all cost variables, we used the Mann-Whitney test or Kruskal-Wallis test to inspect the differences in medical costs. Finally, GLM regression was employed to analyze the influence of the two insurance types and the cities with variance on medical costs. The STATA version 16.0 (Stata Corp, College Station, TX, USA) was mainly used to analyze the data and a *P*-value less than 0.05 was considered statistically significant.

**Results**

**Sample characteristics**

As shown in Table 1, this study involved 92,856 lung cancer patients with inpatient medical records (70,661 from UEBMI and 22,195 from URBMI) from 2010 to 2016. In both the UEBMI (47.88%) and the URBMI (49.07%) groups, the largest proportion was aged 60–75 years. Of the patients in the UEBMI groups, 75.43 and 50.61% chose tertiary hospitals for treatment, respectively. Nearly half the patients in both the UEBMI and the URBMI groups (49.84% vs. 46.03%) were from eastern China. The UEBMI group had more patients with comorbidity (27.04%) compared to the URBMI group (20.84%). By year, 22,767 patients (24.52%) were from 2016, 18,868 patients (20.32%) from 2015, 17,680 patients (19.04%) from 2014 and 17,022 (18.33%) patients from 2013. The patients between 2010 and 2012 totaled 16,519 (17.79%).

**Medical costs for lung cancer patients by insurance type**

Table 2 presents lung cancer patients’ medical costs, outside-insurance OOP expenses, and total OOP expenses,

**Table 1** Sample characteristics ( $n = 92,856$ )

	UEBMI	URBMI	Overall
<b>Gender</b>			
Male	48,496 (68.63)	13,004 (58.59)	61,500 (66.23)
Female	22,165 (31.37)	9191 (41.41)	31,356 (33.77)
<b>age</b>			
< 45	3104 (4.39)	1084 (4.88)	4188 (4.51)
45–59	20,977 (29.69)	6913 (31.15)	27,890 (30.04)
60–75	33,836 (47.88)	10,892 (49.07)	44,728 (48.17)
> 75	12,744 (18.04)	3306 (14.9)	16,050 (17.28)
<b>Hospital level</b>			
Primary	2668 (3.78)	2177 (9.81)	4845 (5.22)
Secondary	14,694 (20.8)	8785 (39.58)	23,479 (25.29)
Tertiary	53,299 (75.43)	11,233 (50.61)	64,532 (69.5)
<b>Region</b>			
East	35,220 (49.84)	10,216 (46.03)	45,436 (48.93)
Central	19,535 (27.65)	7113 (32.05)	26,648 (28.7)
West	15,906 (22.51)	4866 (21.92)	20,772 (22.37)
<b>Comorbidity</b>			
Yes	19,105 (27.04)	4625 (20.84)	23,730 (25.56)
No	51,556 (72.96)	17,570 (79.16)	69,126 (74.44)
<b>Year</b>			
2010	3675 (5.2)	590 (2.66)	4265 (4.59)
2011	5110 (7.23)	917 (4.13)	6027 (6.49)
2012	5247 (7.43)	980 (4.42)	6227 (6.71)
2013	13,725 (19.42)	3297 (14.85)	17,022 (18.33)
2014	13,480 (19.08)	4200 (18.92)	17,680 (19.04)
2015	13,319 (18.85)	5549 (25.00)	18,868 (20.32)
2016	16,105 (22.79)	6662 (30.02)	22,767 (24.52)
<b>Overall</b>	<b>70,661 (76.10)</b>	<b>22,195 (23.9)</b>	<b>92,856</b>

n (%) for all variables; UEBMI Urban Employees' Basic Medical insurance; URBMI Urban Residents' Basic Medical Insurance

by different insurances. Overall, the UEBMI group had higher median medical costs than the URBMI group did (RMB 11,276 [6322–20,850] vs. RMB 8303 [4492–14,823]). Similar results were found (all  $p < 0.001$ ) within the subgroups, especially hospital level and region (Supplementary Table 1). The overall median outside-insurance OOP expenses for the UEBMI group was lower than that for the URBMI group (RMB 302 [40–1430] vs. RMB 358 [60–1272]), and there were similar differences in most subgroups. However, regarding the mean value, the situation was reversed (RMB 2335 for the UEBMI and RMB 1782 for the URBMI, Supplementary Tables 2–3).

Additionally, the URBMI group had significantly higher overall median OOP expenses than the UEBMI group did (RMB 2975 [1367–6275] vs. RMB 2143 [1108–4506]), and most subgroups showed similar results. However, in the subgroup including primary hospitals and the western region, the UEBMI patients had higher median OOP expenses, compared to the URBMI patients

(Supplementary Table 4). Additionally, patients covered by UEBMI visited hospitals more frequently and stayed longer for treatment in hospitals, compared to those covered by URBMI.

#### Differences in the composition of medical costs

Table 3 and Fig. 2 present the differences between UEBMI and URBMI regarding the composition of medical costs for lung cancer patients. The UEBMI group had significantly higher median values of drug costs, TCM costs, medical service costs, and medical consumable costs than the URBMI group did ( $p < 0.001$ ). For example, the UEBMI patients incurred higher median drug costs (RMB 6419 [3008–12,121]), compared to the URBMI patients (RMB 4477 [1943–8519]). Further, the UEBMI patients incurred higher median TCM costs than the URBMI patients did (RMB 945 [47–2497] vs. RMB 556 [22–1665]). Importantly, UEBMI had a higher effective reimbursement rate compared with URBMI.

Regarding the proportion of different types of costs, the URBMI patients had higher medical service costs, but lower medical consumable and TCM costs, compared with the URBMI patients.

#### Medical costs for lung cancer patients in three cities

Table 4 presents the differences in medical costs for lung cancer patients by city-specific health insurance schemes. City A had 4029 UEBMI and 375 URBMI patients, city B had 9829 UEBMI patients and 4334 URBMI patients, and city C had 640 UEBMI and 60 URBMI patients. The results revealed that the UEBMI patients had higher median medical costs and median outside-insurance OOP expenses, but lower median OOP expenses compared to the URBMI beneficiaries in all three cities. In Cities B and C, the UEBMI group had higher median drug costs compared with the URBMI group, and the median medical service costs for the UEBMI patients in cities A and B were higher than for the URBMI counterparts. Gaps of median medical costs between health insurance schemes among the cities were greater than the gaps within each city. For example, the median medical costs of either URBMI or URBMI in city A were higher than the corresponding median values in city B, but lower than those in city C. Similar gaps also existed in outside-insurance OOP cost, drug costs, medical service costs, medical consumable costs, and length of stay (LOS) indicators.

Table 5 shows the influence of health insurance schemes and cities on the expenditure of lung cancer patients. The UEBMI group had 26.24% ( $=\exp^{0.233}-1$ ) higher medical costs than the URBMI group did, and patients in city C had 18.06% ( $=\exp^{0.166}-1$ ) higher medical costs compared with patients in city A. For

**Table 2** Medical costs for lung cancer patients (RMB)

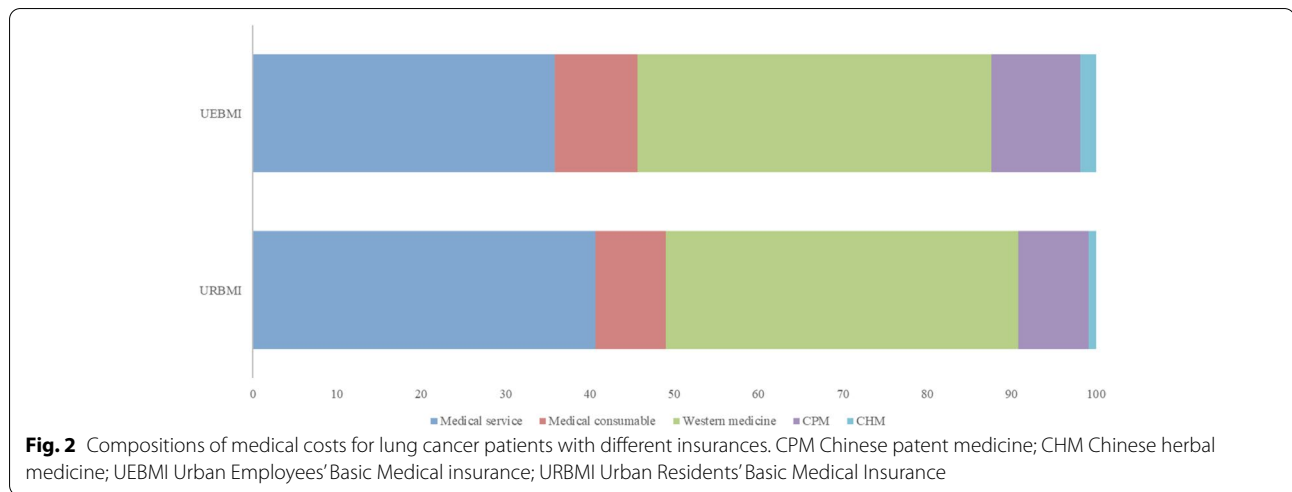
Indicators	UEBMI	URBMI	P-value
<b>Medical costs (RMB)</b>			
<b>Hospital level</b>			
Primary	5109 [2108–13,164]	2537 [1472–4693]	<0.001
Secondary	8697 [5035–15,709]	7148 [4217–12,641]	<0.001
Tertiary	12,433 [7115–22,732]	10,706 [6369–18,382]	<0.001
<b>Region</b>			
East	11,345 [6209–20,620]	9433 [5237–16,299]	<0.001
Central	10,236 [5860–19,363]	7711 [4373–13,867]	<0.001
West	12,444 [72,44–23,230]	6834 [3250–13,025]	<0.001
<b>Overall</b>	11,276 [6322–20,850]	8303 [4492–14,823]	<0.001
<b>Outside-insurance OOP expenses (RMB)</b>			
<b>Hospital level</b>			
Primary	45 [0.00–379]	51 [6–167]	0.275
Secondary	160 [30–651]	320 [62–994]	<0.001
Tertiary	404 [53–1817]	565 [108–1927]	<0.001
<b>Region</b>			
East	479 [30–2083]	833 [226–2152]	<0.001
Central	176 [40–763]	110 [24–441]	<0.001
West	300 [60–1083]	255 [57–764]	<0.001
<b>Overall</b>	302 [40–1430]	358 [60–1272]	<0.001
<b>OOP expenses for lung cancer patients (RMB)</b>			
<b>Hospital level</b>			
Primary	713 [169–2017]	317 [117–779]	<0.001
Secondary	1512 [874–2846]	2292 [1219–4408]	<0.001
Tertiary	2451 [12,889–5214]	4389 [2365–8543]	<0.001
<b>Region</b>			
East	2209 [1063–4914]	3987 [2102–7859]	<0.001
Central	2003 [1139–4049]	2774 [1577–5377]	<0.001
West	2189 [1143–4290]	1146 [332–3451]	<0.001
<b>Overall</b>	2143 [1108–4506]	2975 [1367–6275]	<0.001
<b>Average number of hospitalization M (SD)</b>	1.92 (2.06)	1.88 (1.83)	<0.001
<b>Median length of stay</b>	11 [6–17]	10 [6–15]	<0.001

All costs results are displayed using Median [Interquartile Range]; M (SD) mean (standard deviation); UEBMI Urban Employees' Basic Medical insurance; URBMI Urban Residents' Basic Medical Insurance

**Table 3** Composition of medical costs for lung cancer patients

	UEBMI	URBMI	Overall	P-value
Median drug cost (RMB)	6419	4477	5897	<0.001
IQR	[3008–12,122]	[1943–8519]	[2679–11,270]	
Median TCM cost (RMB)	945	556	834	<0.001
IQR	[47–2497]	[227–1665]	[36–2286]	
Median medical service cost (RMB)	3172	2603	3015	<0.001
IQR	[1673–6821]	[1446–5286]	[1608–6407]	
Median medical consumable cost (RMB)	263	207	247	<0.001
IQR	[90–765]	[70–560]	[84–709]	
Effective reimbursement rate	83.33%	65.61%	79.09%	<0.001

IQR Interquartile range, TCM Traditional Chinese medicine (including Chinese patent medicine and Chinese herbal medicine), UEBMI Urban Employees' Basic Medical insurance, URBMI Urban Residents' Basic Medical Insurance



**Table 4** Disparities in medical cost for patients in different cities

	City A		City B		City C		P-value
	UEBMI	URBMI	UEBMI	URBMI	UEBMI	URBMI	
N (%)	4029 (91.49)	375 (8.51)	9829 (69.4)	4334 (30.6)	640 (91.43)	60 (8.57)	
Median medical cost (RMB)	9–771	9–741	9091	7135	11,398	9853	<0.001
IQR	[5183–16,623]	[5924–16,067]	[5570–16,864]	[4137–12,383]	[6880–20,648]	[5370–24,674]	
Median outside-insurance OOP cost (RMB)	210	166	70	54	186	130	<0.001
IQR	[35–1040]	[48–774]	[15–246]	[6–192]	[52–499]	[52–326]	
Median OOP cost (RMB)	1909	3332	1626	2299	1636	2795	<0.001
IQR	[934–3925]	[1905–6226]	[1034–2787]	[1426–4029]	[801–3635]	[1287–5758]	
Median drug cost (RMB)	5435	5771	5415	4027	6429	4233	<0.001
IQR	[2750–10,402]	[3016–10,869]	[2879–9467]	[1789–7074]	[3553–10,581]	[1993–11,627]	
Median medical service cost (RMB)	3399	2684	2611	2309	3261	4621	<0.001
IQR	[1290–6289]	[1474–5329]	[1530–5497]	[1445–4260]	[1845–8305]	[3024–8498]	
Median LOS	8	10	11	11	11	13	<0.001
IQR	[3–11][4–11]	[5–16.25]	[4–15][7–18]	[4–14][7–17]	[7–19.25]	[8–20.5]	

IQR interquartile range; LOS length of stay; UEBMI Urban Employees' Basic Medical insurance; URBMI Urban Residents' Basic Medical Insurance

**Table 5** The impact of insurance type and city on patients' cost

Characteristics	Medical costs		Outside-insurance OOP expenses		OOP expenses	
	Coef.	95% CI	Coef.	95% CI	Coef.	95% CI
Insurance type (Ref: URBMI)						
UEBMI	0.233***	[0.196,0.271]	0.267***	[0.134,0.400]	-0.319***	[-0.371,-0.267]
Cities (Ref:City A)						
City B	-0.044	[-0.097,0.009]	-1.842***	[-2.052,-1.632]	-0.503***	[-0.576,-0.43]
City C	0.166***	[0.075,0.257]	-1.353***	[-1.678,-1.027]	-0.439***	[-0.565,-0.314]

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

UEBMI Urban Employees' Basic Medical insurance, URBMI Urban Residents' Basic Medical Insurance; All models were adjusted for gender, age group, hospital level, comorbidity, and year



outside-insurance OOP expenses and OOP expenses, the differences between cities were greater than the differences between UEBMI and URBMI. Patients covered by UEBMI had 30.60% higher outside-insurance OOP expenses than patients covered by URBMI, while patients in city B had 84.15% ( $=1-\exp^{-1.842}$ ) lower outside-insurance OOP expenses than patients in city A. The UEBMI group had 27.31% ( $=1-\exp^{-0.319}$ ) lower OOP expenses than the URBMI group, while a gap of 39.53% ( $=1-\exp^{-0.503}$ ) for OOP expenses appeared between city A and city B and a gap of 35.53% ( $=1-\exp^{-0.439}$ ) between city A and city C. After adding the urban per capita disposable income as a covariate, similar results were found (Supplementary Table 6).

## Discussion

Based on claims data from CHIRA, this study revealed differences in medical costs for lung cancer patients with two health insurance schemes, UEBMI and URBMI, and in different cities. Overall, compared with the URBMI group, the UEBMI group had higher medical costs (including drugs, medical service, and medical consumable) and higher mean outside-insurance OOP expenses, but lower OOP expenses, which means that the UEBMI group has utilized more comparatively (or more expensive) health services and bore less individual financial burden. The differences varied by cities—differences in insurances among cities were greater than the differences in insurances within cities. In addition, our study specifically showed that the differences in OOP expenses among cities were greater than the differences between UEBMI and URBMI. Regarding the overall outside-insurance OOP expenses, the mean and median values had opposite performance when comparing the UEBMI and URBMI. Using the median value, overall, UEBMI had lower outside-insurance OOP expenses than URBMI, but URBMI had higher ones when using the mean value. However, these two types of results were not contradictory. This is because compared to those in the URBMI groups, the upper-most quartiles of median outside-insurance OOP expenses in the UEBMI groups were higher; thus, despite more comprehensive service coverage of UEBMI a few patients with the UEBMI insurance scheme might have utilized health services that were out of range. Further, health services not supported by UEBMI were usually more expensive and of higher quality compared to those not covered in UEBMI.

The results regarding differences between UEBMI and URBMI were consistent with prior studies [17]. Using the China health and retirement longitudinal study (CHARLS) data, Wang et al. [18] reported that UEBMI had a greater effect in improving healthcare utilization and causing higher medical costs compared with URBMI.

Based on claims data from Guangzhou province in China, Zhang et al. [19] found that the UEBMI dementia patients had higher hospitalization costs compared with the URBMI counterparts. Similarly, Chen et al. [20] revealed that the UEBMI diabetic patients incurred higher expenditure compared to the URBMI patients. The present finding that UEBMI lung cancer patients have lower OOP, was also similar to that of Yang et al. [12], who reported that the UEBMI stroke patients had fewer direct economic burdens than the URBMI counterparts. The differences in expenditure between the UEBMI and the URBMI patients were due to several possible reasons. From the patients' socioeconomic status perspective, those in the UEBMI group were all urban workers or retired workers, compared with the disabled residents and unemployed patients who were covered by URBMI, usually having higher income (or pension), and better education. Income was an important contributor to healthcare utilization inequity, and people with high income had stronger incentive to utilize expensive health services and assume corresponding high medical costs [21, 22]. This was also the reason that some UEBMI patients had higher outside-insurance OOP expenses (paying medical services, drugs, and medical consumables which were not supported and compensated by the insurance schemes) compared with the URBMI patients in this study. As UEBMI's service packages were more comprehensive compared to URBMI's service packages, the above-mentioned medical services, drugs, and medical consumables that were not supported by health insurance scheme were generally non-basic and expensive. The URBMI patients with low income could be more conservative when utilizing health services and drugs. Thus, differences in income between the UEBMI and the URBMI groups may lead to differences in medical costs. Further, we speculate that people with better education had more knowledge of health and were more willing to pay for it [23, 24], which attributed the UEBMI group's higher medical costs to their better education.

From the perspective of the financial protection ability of insurance schemes, UEBMI provided a higher reimbursement rate and higher reimbursement ceiling compared to URBMI. Prior studies have proved that patients covered by health insurances with better financial protection tend to seek better quality health services in higher-level of hospitals [25]. The present results indicated that more patients in the UEBMI groups accepted treatment in tertiary hospitals, subsequently causing higher medical costs. Health insurance schemes with better financial protection had a greater effect on motivating patients to utilize more health services [19]. By disregarding catastrophic health expenditure, the UEBMI beneficiaries were more willing to use expensive drugs and medical

consumables compared to the URBMI patients. In addition, patients with different insurances may choose different therapeutic schedules, naturally resulting in differences in the medical costs, drug costs, medical service costs, and medical consumable costs [26]. Conversely, doctors may also provide more reasonable treatments to reduce the economic burden for patients with URBMI [27]. The present findings regarding the differences in the composition of medical costs supported these two speculations indirectly. We believe that the higher reimbursement rate and higher reimbursed ceiling also caused the UEBMI patients to incur fewer OOP expenses than compared with URBMI patients. In brief, the UEBMI funding pool has incurred the highest medical costs for its beneficiaries, while URBMI funding pool was not as generous.

From the population characteristics perspective, the UEBMI group had more male patients than the URBMI group. Compared with female patients, male patients were more likely to smoke, which is the most threatening risk factor for lung cancer [28]. Therefore, male patients had a larger population attributable fraction (PAF) of lung cancer deaths caused by smoking, and higher medical costs compared to female patients [29, 30]. The higher medical costs for male lung cancer patients may have contributed to higher medical costs for the UEBMI group. Second, compared to the URBMI group, more patients in the UEBMI group had comorbidity, which has been proved to be significantly associated with high medical costs [31].

The present study also found that the differences in medical costs among cities were greater than the differences in medical costs by insurances within cities; the same case applies to the OOP expenses. First, the different cities had separate UEBMI and URBMI funding pools, leading to the different service coverage and benefits packages. Hence the differences in financial protection between these two insurance schemes primarily played a role in the differences in medical costs and OOP expenses among cities [8]. Second, with different economic development levels, the UEBMI workers in different cities also had different levels of salaries, which caused the variance in medical costs and OOP expenses. Third, the prevalence of comorbidities such as hypertension and diabetes mellitus differed between cities. The comorbidity was associated with an increased risk of disease severity and medical costs [31–33]. Fourth, hospitals' health resources and medical technologies varied by cities in China, including the three cities above [34]. We believe that in some cities poor medical technology could have prolonged LOS for patients. Table 4 shows that patients in city A had shorter median LOS than patients in city C, which proved this speculation

directly. The prolonged LOS was significantly associated with medical costs [35].

In 2016, the Chinese government officially integrated URBMI and the new rural cooperative medical insurance (NCMS, initially designed for rural patients) to establish a unified health insurance scheme, Urban-Rural Residents Basic Medical Insurance (URRBMI), covering rural residents and those earlier covered by URBMI. Although URRBMI has significantly promoted equity in access to health care utilization especially for rural residents [36, 37], it did not significantly improve benefit packages for the original URBMI residents. Gaps between URBMI and UEBMI remain. Differences among lung cancer patients regarding medical costs and OOP expenses called for further integration of the fragmented insurance schemes in China. Notably, the current insurance integration in China was implemented within each municipal city, which improved the NCMS funding pools from county level to upper municipal level. A broader funding pool could resist economic risk more strongly [8]. The integration was conducive to changing the status quo of fragmented management involving health insurance schemes in China; however, it failed to counteract the role of income, or the presence of the UEBMI, in increasing inequality on healthcare utilization [38]. Our results indicate that the level of the UEBMI and URBMI funding pools could be further merged and improved to province level (even national level), providing residents with equal benefit packages and financial protection to reduce the gap between UEBMI and URBMI, and between different cities for lung cancer patients.

This study had several limitations. First, since URBMI and NCMS have been merged, a comparison between UEBMI and URRBMI could be a better choice. While the new insurance scheme did not drastically improve the benefit packages for the URBMI patients, the present results still reflect the differences between UEBMI and URBMI. Second, the claims data lacked clinical outcomes for lung cancer patients, thus, it was unclear whether UEBMI patients had a higher survival rate after paying higher medical costs. Third, this study did not include the indirect medical costs between the UEBMI and URBMI groups. Finally, owing to lacking detailed information regarding the cancer stage, histology type of lung cancer, and detailed lung cancer treatment, it was unclear how the cancer characteristics shaped the medical costs.

## Conclusion

This study offers a comprehensive evaluation of the differences in medical costs for lung cancer inpatients covered by different health insurance schemes. The UEBMI group was found to have higher medical costs, TCM costs, drug costs, medical consumable costs,



and mean outside-insurance OOP expenses, but lower OOP expenses compared to the URBMI group. That is, the UEBMI patients have obtained more or better services and enjoyed less individual financial burden. In addition, differences in insurances among cities were greater than differences in insurances within cities, which were hitherto ignored. Under the health insurance schemes with different benefit packages, differences in OOP expenses between cities were higher compared with those between UEBMI and URBMI. The present results provide critical information for consolidating the fragmented insurance schemes in China and reducing differences between patients with different health insurance schemes.

### Abbreviations

UEBMI: Urban Employees' Basic Medical Insurance; URBMI: Urban Residents' Basic Medical Insurance; NCMS: New rural Cooperative Medical insurance; URRBMI: Urban-Rural Residents Basic Medical Insurance; TCM: Traditional Chinese medicine; CPM: Chinese patent medicine; CHM: Chinese herbal medicine; GLM: Generalized linear model; IQR: Interquartile range; OOP: Out-of-pocket.

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12913-022-07957-9>.

Additional file 1.

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None.

### Authors' contributions

Y.Y. and X.F.S. initially designed the study, Y.C.L. analyzed data and prepared the original manuscript, L.Y.H., J.Y. and Y.M. provided advice on research design and critically revised the manuscript. All authors have read and approved the final manuscript.

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### Availability of data and materials

The data are third-party data and were provided by China Health Insurance Research Association. Authors in this study have the right to use this dataset, but not the right to share and distribute. A de-identified minimal dataset of the quantitative data is available upon request to researchers who meet the criteria for confidential information, by sending a request to CHIRA.

### Declarations

#### Ethics approval and consent to participate

All methods were performed in accordance with the relevant guidelines and regulations. The study methods were carried out following the CHEERS guidelines for reporting observational studies. Since we used anonymized and de-identified data, and no interventions were involved, written consent was neither required nor possible. The Ethics Committee of Beijing University of Chinese medicine deemed this study as exempt from ethical approval (No.2019BZHYYL0201).

#### Consent for publication

Not Applicable.

### Competing interests

The authors declared that they have no competing interests.

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