Original Article

Urban–Rural Comparisons in Hospital Admission, Treatments, and Outcomes for ST-Segment–Elevation Myocardial Infarction in China From 2001 to 2011

A Retrospective Analysis From the China PEACE Study (Patient-Centered Evaluative Assessment of Cardiac Events)

Xi Li, PhD; Karthik Murugiah, MD; Jing Li, PhD; Frederick A. Masoudi, MD; Paul S. Chan, MD; Shuang Hu, PhD; John A. Spertus, MD; Yongfei Wang, MS; Nicholas S. Downing, MD; Harlan M. Krumholz, MD*; Lixin Jiang, MD*; for the China PEACE Collaborative Group†

Background—In response to urban–rural disparities in healthcare resources, China recently launched a healthcare reform with a focus on improving rural care during the past decade. However, nationally representative studies comparing medical care and patient outcomes between urban and rural areas in China during this period are not available.

Methods and Results—We created a nationally representative sample of patients in China admitted for ST-segment–elevation myocardial infarction in 2001, 2006, and 2011, using a 2-stage random sampling design in 2 urban and 3 rural strata. In China, evidence-based treatments were provided less often in 2001 in rural hospitals, which had lower volume and less availability of advanced cardiac facilities. However, these differences diminished by 2011 for reperfusion therapy (54% in urban versus 57% in rural; P=0.1) and reversed for angiotensin-converting enzyme inhibitors/angiotensin receptor blockers (66% versus 68%; P=0.04) and early β-blockers (56% versus 60%; P=0.01). The risk-adjusted rate of in-hospital death or withdrawal from treatment was not significantly different between urban and rural hospitals in any study year, with an adjusted odds ratio of 1.13 (0.77–1.65) in 2001, 0.99 (0.77–1.27) in 2006, and 0.94 (0.74–1.19) in 2011.

Conclusions—Although urban–rural disparities in evidence-based treatment for myocardial infarction in China have largely been eliminated, substantial gaps in quality of care persist in both settings. In addition, urban hospitals providing more resource-intensive care did not achieve better outcomes.

Clinical Trial Registration—URL: https://www.clinicaltrials.gov. Unique identifier: NCT01624883.

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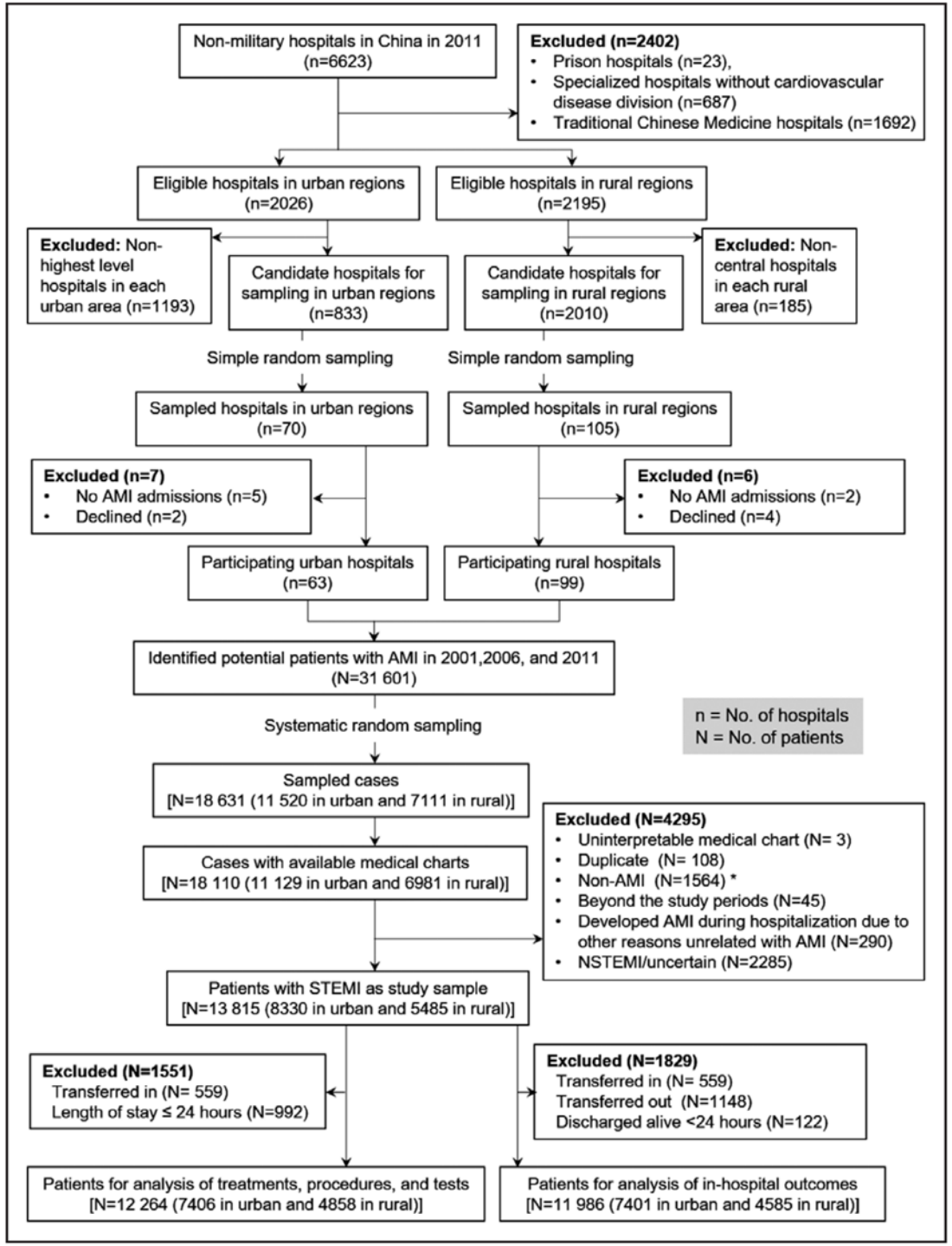

Figure 1. The 2-stage random sampling process in China PEACE (Patient-centered Evaluative Assessment of Cardiac Events), and the selection of the cohort for the present study. NSTEMI indicates non–ST-segment–elevation myocardial infarction; and STEMI, ST-segment–elevation myocardial infarction. *1564 cases were considered as non-acute myocardial infarction (AMI) because the duration from symptom onset to admission was >30 d.

Table 1. Characteristics of Urban and Rural Hospitals

Hospital Characteristics	Urban (n=63)	Rural (n=99)	*P* Value
Level of hospital			<0.001
Tertiary	58 (92%)	7 (7%)	
Secondary or lower	5 (8%)	92 (93%)	
Type of hospital			<0.001
Medical college affiliated	31 (49%)	9 (9%)	
Teaching, but not medical college affiliated	23 (37%)	30 (30%)	
Nonteaching	9 (14%)	60 (61%)	
Annual AMI inpatient volume*			
2001	27 (8–68)	5 (2–13)	<0.001
2006	70 (30–152)	15 (6–30)	<0.001
2011	148 (58–334)	34 (16–63)	<0.001
CCU in hospital in 2011	56 (89%)	38 (38%)	<0.001
Catheterization laboratory in hospital in 2011	55 (87%)	24 (24%)	<0.001
No. of qualified interventionists*	4 (3–6)	1 (0–3)	<0.001
Independent emergency department in 2011	60 (95%)	91(92%)	0.413
CABG capability in 2011	32 (51%)	1 (1%)	<0.001

AMI indicates acute myocardial infarction; CABG, coronary artery bypass graft; and CCU, coronary care unit.

*Median and interquartile range.

Table 2. Characteristics of Patients With ST-Segment–Elevation Myocardial Infarction

	2001			2006			2011			*P* for Interaction
	Urban* (n=1341)	Rural* (n=786)	OR (95% CI)†	Urban* (n=2388)	Rural* (n=1604)	OR (95% CI)†	Urban* (n=4601)	Rural* (n=3095)	OR (95% CI)†	
Demographics										
Age, y‡	65 (56–72)	65 (55–72)		66 (55–73)	67 (56–74)		63 (53–73)	67 (58–76)		
<60	428 (32%)	267 (34%)	0.89 (0.73–1.10)	810 (34%)	514 (32%)	1.10 (0.96–1.25)	1769 (39%)	927 (29%)	1.58 (1.43–1.74)	<0.001
60–69	465 (35%)	246 (31%)	1.19 (0.97–1.46)	622 (26%)	416 (26%)	0.95 (0.83–1.10)	1124 (25%)	811 (27%)	0.93 (0.83–1.03)	0.05
70–79	354 (26%)	216 (28%)	0.94 (0.76–1.17)	752 (32%)	522 (32%)	0.98 (0.85–1.12)	1238 (26%)	915 (30%)	0.82 (0.74–0.90)	0.07
≥80	94 (7%)	57 (7%)	0.99 (0.68–1.44)	204 (9%)	152 (9%)	0.92 (0.74–1.15)	470 (10%)	442 (14%)	0.64 (0.56–0.73)	0.003
Female sex	392 (29%)	222 (29%)	1.02 (0.82–1.26)	679 (28%)	458 (29%)	0.96 (0.84–1.11)	1263 (28%)	984 (33%)	0.80 (0.72–0.88)	0.01
Cardiovascular risk factors										
Hypertension	590 (45%)	276 (36%)	1.45 (1.19–1.77)	1232 (54%)	662 (43%)	1.56 (1.37–1.77)	2451 (54%)	1439 (48%)	1.25 (1.14–1.37)	0.3
Diabetes mellitus	230 (17%)	66 (8%)	2.27 (1.66–3.10)	555 (25%)	192 (12%)	2.50 (2.09–2.99)	1078 (24%)	480 (16%)	1.60 (1.42–1.80)	<0.001
Dyslipidemia	664 (52%)	244 (31%)	2.32 (1.89–2.84)	1329 (57%)	772 (49%)	1.35 (1.19–1.54)	3004 (68%)	1839 (59%)	1.43 (1.30–1.58)	0.004
Current smoker	408 (32%)	221 (28%)	1.16 (0.94–1.44)	807 (36%)	499 (34%)	1.08 (0.94–1.23)	1889 (43%)	965 (33%)	1.54 (1.40–1.70)	<0.001
No. of risk factors										
≥3	169 (13%)	45 (6%)	2.46 (1.71–3.55)	468 (22%)	190 (13%)	1.81 (1.52–2.16)	1126 (26%)	486 (17%)	1.76 (1.57–1.97)	0.2
2	438 (34%)	171 (22%)	1.83 (1.47–2.29)	849 (36%)	459 (29%)	1.38 (1.20–1.58)	1807 (40%)	1071 (35%)	1.27 (1.15–1.39)	0.006
1	496 (36%)	326 (42%)	0.79 (0.65–0.96)	767 (30%)	623 (38%)	0.72 (0.63–0.82)	1289 (26%)	1068 (35%)	0.66 (0.60–0.73)	0.09
None	238 (17%)	244 (31%)	0.46 (0.36–0.58)	304 (11%)	332 (19%)	0.53 (0.44–0.63)	379 (7%)	470 (14%)	0.50 (0.43–0.59)	0.7
Medical history										
Myocardial infarction	154 (11%)	64 (9%)	1.37 (0.99–1.90)	226 (10%)	148 (10%)	1.06 (0.86–1.31)	539 (12%)	275 (9%)	1.37 (1.18–1.59)	0.4
Coronary heart disease	357 (27%)	146 (19%)	1.52 (1.21–1.93)	486 (21%)	304 (19%)	1.11 (0.95–1.30)	977 (22%)	591 (19%)	1.17 (1.04–1.31)	0.1
PCI	8 (1%)	6 (1%)	0.77 (0.27–2.24)	28 (1%)	12 (1%)	1.25 (0.68–2.31)	134 (3%)	46 (2%)	1.91 (1.39–2.63)	0.06
CABG	3 (0%)	7 (1%)	0.29 (0.08–1.05)	6 (0%)	3 (0%)	1.23 (0.40–3.74)	14 (0%)	7 (0%)	0.93 (0.37–2.34)	0.2
Stroke	126 (9%)	72 (10%)	0.97 (0.70–1.34)	276 (12%)	145 (9%)	1.35 (1.10–1.67)	562 (12%)	335 (12%)	1.06 (0.92–1.22)	0.6
Clinical characteristics										
Symptom onset to admission, h‡§	15 (3–72)	14 (3–72)		23 (4–72)	10 (3–48)		20 (4–96)	8 (3–48)		
<3	253 (19%)	152 (20%)	0.94 (0.75–1.17)	436 (17%)	348 (23%)	0.70 (0.60–0.83)	767 (16%)	712 (23%)	0.63 (0.56–0.71)	0.003
3 to <6	232 (18%)	115 (14%)	1.29 (1.01–1.65)	342 (15%)	276 (17%)	0.83 (0.69–0.99)	691 (16%)	560 (19%)	0.82 (0.72–0.93)	0.006
6 to <12	130 (10%)	88 (11%)	0.89 (0.66–1.19)	281 (13%)	185 (12%)	1.03 (0.84–1.26)	517 (12%)	377 (12%)	1.00 (0.86–1.16)	0.6
12 to <24	100 (8%)	73 (9%)	0.85 (0.62–1.17)	145 (6%)	131 (8%)	0.75 (0.58–0.97)	341 (8%)	220 (7%)	1.05 (0.87–1.27)	0.1

CABG indicates coronary artery bypass grafting; CI, confidence interval; eGFR, estimated glomerular filtration rate; GRACE, Global Registry of Acute Coronary Events; OR, odds ratio; and PCI, percutaneous coronary intervention.
*Category variables displayed as number (weighed percentage).
†With patients in rural hospital as the reference group.
‡Median (interquartile range).
§Excluding patients who were transferred in.
¶Among patients with the measurement.

Table 2. Continued

	2001			2006			2011			*P* for Interaction
	Urban* (n=1341)	Rural* (n=786)	OR (95% CI)†	Urban* (n=2388)	Rural* (n=1604)	OR (95% CI)†	Urban* (n=4601)	Rural* (n=3095)	OR (95% CI)†	
≥24	599 (45%)	348 (45%)	1.00 (0.83–1.19)	1093 (49%)	652 (40%)	1.48 (1.29–1.69)	1932 (48%)	1160 (38%)	1.49 (1.35–1.65)	0.001
Chest discomfort	1244 (93%)	726 (93%)	1.09 (0.75–1.58)	2216 (93%)	1464 (92%)	1.28 (1.01–1.63)	4275 (93%)	2843 (92%)	1.23 (1.04–1.47)	0.7
Cardiac arrest	17 (1%)	4 (0%)	2.71 (0.77–9.57)	39 (2%)	10 (1%)	2.88 (1.48–5.59)	88 (2%)	37 (1%)	1.26 (0.88–1.81)	0.04
Cardiogenic shock	53 (4%)	41 (5%)	0.74 (0.47–1.16)	136 (5%)	109 (7%)	0.74 (0.57–0.96)	293 (6%)	215 (7%)	0.91 (0.75–1.09)	0.2
Acute stroke	13 (1%)	5 (1%)	1.43 (0.46–4.43)	39 (2%)	30 (2%)	0.98 (0.60–1.59)	49 (1%)	34 (1%)	0.78 (0.49–1.24)	0.3
Heart rate, bpm‡	78 (66–90)	80 (67–90)		78 (68–90)	78 (64–90)		76 (65–88)	77 (64–90)		
<50	73 (5%)	36 (5%)	1.17 (0.75–1.81)	131 (5%)	90 (5%)	0.92 (0.69–1.22)	201 (4%)	183 (7%)	0.58 (0.47–0.71)	0.001
50–110	1190 (89%)	698 (89%)	0.97 (0.71–1.31)	2099 (89%)	1395 (87%)	1.15 (0.95–1.40)	4188 (92%)	2729 (88%)	1.57 (1.35–1.82)	0.001
>110	78 (6%)	52 (6%)	0.93 (0.63–1.39)	158 (6%)	119 (8%)	0.85 (0.66–1.08)	212 (4%)	183 (6%)	0.74 (0.60–0.91)	0.2
Systolic blood pressure, mm Hg‡	120 (105–140)	128 (105–145)		125 (110–142)	124 (109–143)		127 (110–144)	129 (110–145)		
<90	87 (6%)	67 (8%)	0.73 (0.50–1.05)	132 (5%)	132 (8%)	0.58 (0.45–0.75)	216 (4%)	192 (5%)	0.81 (0.65–1.00)	0.3
90–139	836 (63%)	445 (56%)	1.31 (1.08–1.59)	1473 (63%)	926 (57%)	1.25 (1.10–1.42)	2855 (63%)	1803 (57%)	1.26 (1.15–1.39)	0.8
≥140	418 (31%)	274 (36%)	0.82 (0.67–1.01)	783 (33%)	546 (35%)	0.91 (0.80–1.04)	1530 (33%)	1100 (37%)	0.82 (0.74–0.90)	0.6
eGFR‡¶	73 (57–92)	71 (54–88)		76 (58–97)	73 (56–91)		86 (66–108)	82 (62–104)		
Unmeasured	401 (27)	432 (54)	0.32 (0.26–0.39)	344 (12%)	452 (25%)	0.41 (0.35–0.48)	275 (5%)	343 (10%)	0.49 (0.41–0.58)	0.01
<30	41 (3%)	26 (3%)	0.97 (0.56–1.65)	98 (4%)	42 (3%)	1.55 (1.08–2.25)	139 (3%)	93 (3%)	1.11 (0.85–1.46)	0.8
30–59	223 (17%)	94 (12%)	1.49 (1.13–1.96)	452 (18%)	304 (18%)	1.01 (0.86–1.19)	733 (15%)	530 (16%)	0.93 (0.82–1.05)	0.007
≥60	676 (52%)	234 (30%)	2.50 (2.04–3.07)	1494 (65%)	806 (54%)	1.62 (1.43–1.85)	3454 (76%)	2129 (71%)	1.33 (1.20–1.48)	<0.001
Ejection fraction‡¶	54 (44–62)	55 (44–64)		53 (44–60)	53 (42–62)		55 (46–61)	55 (46–62)		
Unmeasured	1021 (74)	680 (86)	0.45 (0.35–0.58)	1085 (50)	1212 (72)	0.38 (0.33–0.44)	1562 (30)	1813 (55)	0.35 (0.32–0.38)	0.03
<40%	38 (3%)	20 (3%)	1.25 (0.70–2.23)	176 (8%)	69 (4%)	1.86 (1.39–2.48)	295 (7%)	146 (5%)	1.46 (1.19–1.80)	0.7
≥40%	282 (23%)	86 (11%)	2.37 (1.79–3.14)	927 (43%)	323 (24%)	2.42 (2.10–2.79)	2744 (64%)	1136 (41%)	2.58 (2.35–2.83)	0.3
Mini-GRACE risk score‡	139 (121–158)	139 (120–158)		141 (122–160)	142 (124–160)		137 (119–158)	143 (125–161)		
Transfer										
In	27 (2%)	10 (1%)	1.76 (0.77–3.99)	91 (4%)	12 (1%)	4.64 (2.71–7.95)	353 (9%)	66 (4%)	2.74 (2.20–3.41)	0.7
Out	74 (5%)	70 (9%)	0.58 (0.40–0.85)	111 (5%)	164 (11%)	0.39 (0.31–0.51)	232 (4%)	520 (16%)	0.21 (0.17–0.25)	<0.001

CABG indicates coronary artery bypass grafting; CI, confidence interval; eGFR, estimated glomerular filtration rate; GRACE, Global Registry of Acute Coronary Events; OR, odds ratio; and PCI, percutaneous coronary intervention.
*Category variables displayed as number (weighed percentage).
†With patients in rural hospital as the reference group.
‡Median (interquartile range).
§Excluding patients who were transferred in.
¶Among patients with the measurement.

Table 3. Changes in Treatments, Tests, and Procedure Use Among Patients With ST-Segment–Elevation Myocardial Infarction

	2001			2006			2011			*P* for Interaction
	Urban*	Rural*	OR (95% CI)†	Urban*	Rural*	OR (95% CI)†	Urban*	Rural*	OR (95% CI)†	
Reperfusion therapies										
Eligible for reperfusion	46%	46%	1.03 (0.86–1.23)	44%	50%	0.87 (0.76–0.99)	45%	54%	0.81 (0.73–0.89)	
No reperfusion‡	41%	53%	0.60 (0.45–0.81)	42%	50%	0.72 (0.59–0.88)	46%	43%	1.11 (0.97–1.28)	<0.001
Primary PCI‡	17%	0%	…	25%	6%	4.89 (3.51–6.82)	37%	15%	3.21 (2.69–3.83)	<0.001
Fibrinolytic therapy‡	42%	47%	0.83 (0.62–1.12)	33%	43%	0.63 (0.52–0.77)	18%	42%	0.30 (0.26–0.35)	<0.001
Admission-to-needle time, min§	40 (5–130)	50 (0–200)	…	45 (10–95)	40 (4–105)	…	45 (17–90)	40 (10–88)	…	
Acute medications										
Aspirin ≤24 h‡	82%	77%	1.37 (1.07–1.75)	90%	82%	2.08 (1.71–2.53)	92%	89%	1.53 (1.29–1.82)	0.7
Clopidogrel ≤24 h‡	3%	0%	…	63%	23%	5.66 (4.86–6.60)	91%	67%	4.86 (4.25–5.55)	0.5
β-Blockers ≤24 h‡	60%	39%	2.32 (1.71–3.16)	67%	59%	1.37 (1.11–1.68)	56%	60%	0.82 (0.71–0.95)	<0.001
Statins‡	41%	13%	4.45 (3.43–5.78)	83%	65%	2.64 (2.26–3.09)	95%	88%	2.35 (1.96–2.81)	0.4
ACE inhibitors/ARB‡	64%	58%	1.25 (1.02–1.54)	74%	66%	1.41 (1.22–1.64)	66%	68%	0.90 (0.81–1.00)	<0.001
TCM	44%	78%	0.23 (0.18–0.28)	50%	81%	0.23 (0.20–0.27)	61%	82%	0.34 (0.30–0.39)	<0.001
$MgSO_4$	32%	35%	0.90 (0.73–1.11)	19%	19%	0.98 (0.82–1.16)	16%	17%	0.94 (0.82–1.07)	0.9
Procedures										
Cardiac catheterization	20%	2%	15.16 (8.01–28.69)	37%	8%	6.55 (5.31–8.07)	55%	19%	5.27 (4.68–5.92)	0.001
PCI (nonprimary)	5%	1%	6.13 (2.51–14.67)	17%	4%	4.56 (3.45–6.02)	28%	6%	5.87 (4.92–7.00)	0.2
CABG	2%	0%	…	2%	0%	…	1%	0%	…	…
Intra-aortic balloon pump	1%	0%	5.75 (0.61–53.97)	2%	0%	…	4%	0%	9.27 (4.81–17.84)	0.5
Testing										
Troponin	31%	9%	4.82 (3.54–6.56)	55%	34%	2.31 (2.02–2.66)	71%	65%	1.33 (1.20–1.48)	<0.001
Creatinine	74%	48%	3.07 (2.49–3.78)	90%	77%	2.71 (2.25–3.26)	96%	94%	1.49 (1.20–1.86)	<0.001
Echocardiogram	37%	20%	2.32 (1.84–2.93)	57%	33%	2.73 (2.37–3.13)	75%	54%	2.60 (2.35–2.89)	0.5

ACE indicates angiotensin-converting enzyme; CABG, coronary artery bypass graft; CI, confidence interval; OR, odds ratio; PCI, percutaneous coronary intervention; and TCM, traditional Chinese medicine.
*Category variables displayed as weighed percentage.
†With patients in rural hospital as the reference group.
‡Use of treatment among ideal patients.
§Median (interquartile range).

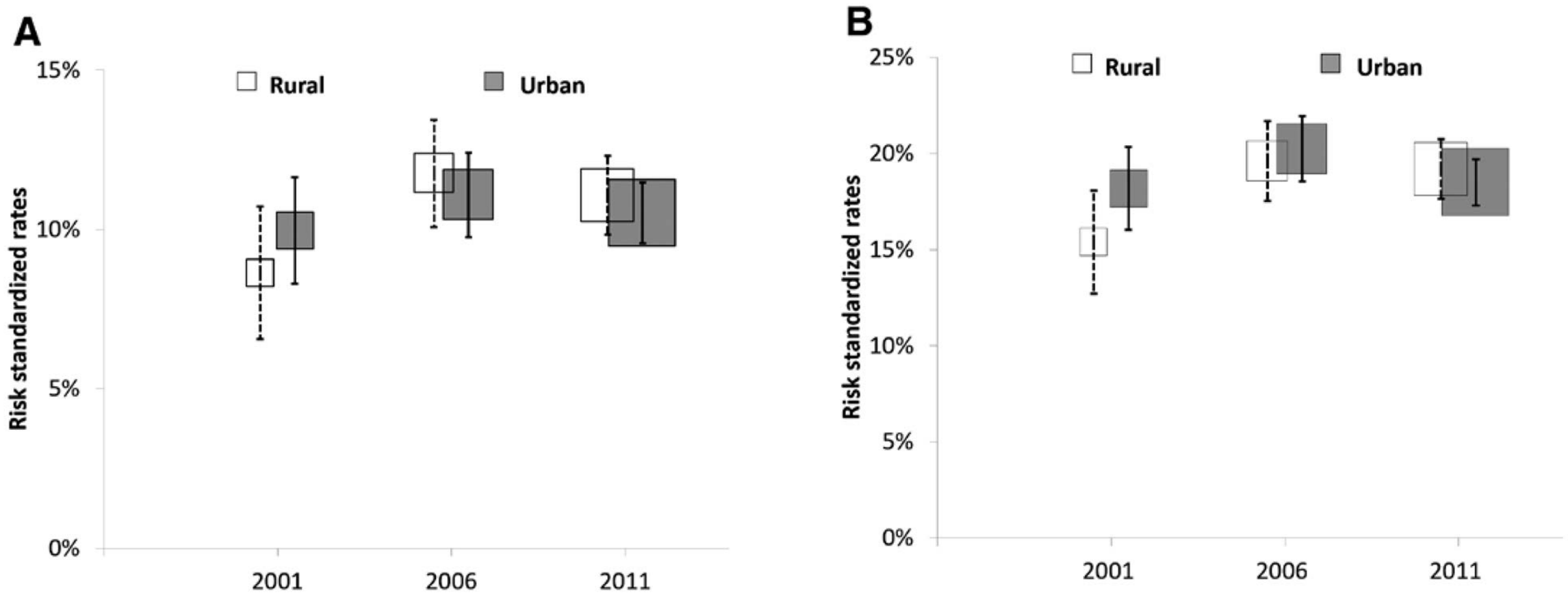

Figure 2. Differences in risk-adjusted rates of in-hospital outcomes between rural and urban hospitals over time.
A, In-hospital death or treatment withdrawal. **B**, In-hospital complications. The covariates included (1) demographic characteristics (age and sex); (2) medical history and risk factors (history of coronary heart disease, myocardial infarction, diabetes mellitus, hypertension, dyslipidemia, and stroke, as well as currently smoking); and (3) clinical features (chest discomfort for >10 min, duration from symptom onset to admission, as well as blood pressure, heart rate, acute stroke, and cardiac arrest at admission). The confidence intervals for risk-adjusted rates were calculated based on the standard error of proportion (the square root of P [1−P]/n).

Conclusion

- Our study demonstrates narrowing treatment gaps and similar patient outcomes after STEMI in urban and rural hospitals in China between 2001 and 2011.
- Although urban–rural disparities in evidence-based treatment for myocardial infarction in China have largely been eliminated, substantial gaps in quality of care persist in both settings. In addition, urban hospitals providing more resource-intensive care did not achieve better outcomes.
- This not only underscores encouraging trends for achieving more equitable care but also highlights substantial opportunities to improve the quality and value of care in both settings.
- To achieve exemplary performance and optimal outcomes, investments to improve capacity and access to care must be accompanied with the implementation of systematic quality measurements and incentive strategies.