Access to affordable medicines after health reform: evidence from two cross-sectional surveys in Shaanxi Province, western China

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Summary

Background Limited access to essential medicines is a global problem. Improving availability and affordability of essential medicines is a key objective of the National Essential Medicine Policy (NEMP) in China. In its initial implementation in 2009, the NEMP targeted primary hospitals with policies designed to increase availability of essential medicines and reduce patients' economic burden from purchasing medicines. We assessed medicine availability and price during the early years of the health reform in Shaanxi Province in underdeveloped western China.

Methods We undertook two public (hospitals) and private (pharmacy) sector surveys of prices and availability of medicines, in September, 2010 and April, 2012, by a standard methodology developed by WHO and Health Action International. We measured medicine availability in outlets at the time of the surveys and inflation-adjusted median unit prices (MUPs), taking 2010 as the base year. We used general estimating equations to calculate the significance of differences in availability from 2010 to 2012 and the Wilcoxon signed rank test to calculate the significance of differences in adjusted median prices.

Findings We collected data from 50 public sector hospitals and 36 private sector retail pharmacies in 2010 and 72 public hospitals and 72 retail pharmacies in 2012. Mean availability of surveyed medicines was low in both the public and private sectors; availability of many essential medicines decreased from 2010 to 2012, particularly in primary hospitals (from 27·4% to 22·3% for lowest priced generics; p<0·0001). The MUPs of originator brands and their generic equivalents decreased significantly from 2010 to 2012 in primary hospitals in comparison with secondary and tertiary hospitals. In the public sector, the median adjusted patient price was significantly lower in 2012 than in 2010 for 16 originator brands (difference –11·7%; p=0·0019) and 29 lowest-priced generics (–5·2%; p=0·0015); the median government procurement price for originator brands also decreased significantly (–10·9%; p=0·0004), whereas the decrease in median procurement price for lowest-priced generics was not significant (–4·9%; p=0·17). In the private sector, the median percentage decrease in price between 2010 and 2012 for 38 lowest-priced generics was 4·7% (IQR 6·3–13·2), compared with 7·9% (4·9–13·9) for 16 originator brands.

Interpretation Although inflation-adjusted medicine prices were numerically lower, there were concerning decreases in availability of lowest-priced generic medicines in both the public and private sectors in 2012 from already low availability in 2010. A long-term, stable, and consistent information system is needed to monitor effects of further implementation of the Chinese Essential Medicine Policy.

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Introduction

Access to low-cost essential medicines

Equitable access to essential medicines is part of the fulfilment of the right to the highest attainable standard of health.[1] However, high medicine prices make medicines unaffordable for many people.[2]

After China's economic reform and opening up the economy to the outside world in the late 1970s, access of most Chinese to basic health care did not keep pace with economic growth.[3] Health services became unaffordable and inaccessible for disadvantaged populations,[4] disparities between regions increased, and out-of-pocket health expenditures grew.[5] In 2009, Chinese national health-care expenditures amounted to US$240 billion, or about 5% of the gross domestic product (GDP), and more than 40% of this expenditure was on medications,[5] one of the highest proportions in the world.[6,7] The high cost of medical products continues to be a major obstacle to access to health care in China.[8,9]

In response to these issues, the Chinese Government announced in 2009 a systematic plan to achieve universal access to health care by 2020; one of the key pillars was the establishment of a National Essential Medicines Policy (NEMP) to ensure drug safety, quality, supply, and affordability.[10,11] The NEMP included specific policies targeting medicine production, pricing, procurement,

prescribing, and reimbursement. A key policy element of the NEMP is a zero mark-up policy under which essential medicines are sold to patients for procurement price plus a fixed distribution cost, with no profit to the health facility for the sale. The central government has also instructed provincial governments to organise public bidding for essential medicines to achieve the lowest possible procurement prices.

Essential medicines system in Shaanxi Province, western China

Shaanxi Province has a population of nearly 38 million people and has 11 cities, with Xi'an the capital. The total provincial GDP was US$196·7 billion in 2011, ranking in the middle to lower level in China.[12] Shaanxi Province is broadly representative of the typical health and health system status of the 12 western provinces of China. As such, in 2012, the Ministry of Health of China and WHO selected Shaanxi Province as one of three pilot regions for the Western Area Health Initiative, which will be implemented from 2012 to 2015 to address key health issues in western China.[13]

The NEMP has been implemented in stages in Shaanxi Province.[14] In September 2010, the Shaanxi Provincial Essential Medicines List (EML) was issued to supplement the 2009 National EML (NEML)[15] and to meet local needs.[16,17] The provincial Health Department emphasised that all primary health-care institutions must acquire and use essential medicines[18] and set specific use targets: in secondary and tertiary hospitals, at least 40% and 30%, respectively, of all medicines used should be on the EML, and the inpatient and outpatient sales of essential medicines should be no less than 30% and 20% of total sales, respectively.[19] In the private sector, improvement of the use and supply of essential medicines was encouraged, but there were no mandatory requirements. Patients can purchase prescribed essential medicines in private retail pharmacies, and in Shaanxi Province the insurance reimbursement of essential medicines is required to be 5–10% higher than that of non-essential medicines.[20]

The zero mark-up policy was implemented in primary hospitals (including urban community health-care centres, rural township hospitals, and village clinics) in two cities (Yulin and Baoji) in June, 2009; primary hospitals in Xianyang, Shangluo, and Tongchuan followed in December, 2009, and primary hospitals in the remaining five cities implemented the policy in November, 2010. By the end of 2011, all 234 community health-care centres and 1725 township hospitals in 107 districts and counties of Shaanxi Province had implemented the zero mark-up policy. The Shaanxi Provincial Government aimed to expand the policy to county-level public hospitals starting in January, 2012,[21] with later extension to secondary and tertiary hospitals (no date set).[10]

A provincial coordinating centre in Xi'an is in charge of "unified bidding, unified distribution, and unified pricing" of essential medicines (three unification policy).[22] In February, 2010, the coordinating centre announced the bidding results for 1034 products from 367 drug suppliers that won the tender;[23] the Shaanxi bidding prices were a mean of 46·1% lower than national reference prices.[23] Distribution costs are set at 5% of drug prices.[22] The replacement of drug sales revenues by the zero mark-up policy in primary hospitals has led to a serious drop in income for hospitals.[24] Direct subsidies by central, provincial, and municipal governments, higher user fees, and higher insurance payments for medical services are intended to offset revenue losses.

Despite these policy measures, to what extent access to affordable essential medicines has been improved in western China is unclear. A small number of studies have attempted to assess the effects of the NEMP,[24–34] but these were based on non-independent authority reports or limited qualitative descriptions. To address this

	2010 survey					2012 survey				
	Public hospitals				Private pharmacies	Public hospitals				Private pharmacies
	Primary	Secondary	Tertiary	Total		Primary	Secondary	Tertiary	Total	
High-income districts*										
Xi'an	2 (4)	2 (3)	1 (1)	5 (8)	5 (7)	3 (6)	2 (4)	1 (2)	6 (12)	6 (12)
Yulin	2 (4)	2 (3)	1 (1)	5 (8)	5 (8)	3 (6)	2 (4)	1 (2)	6 (12)	6 (12)
Middle-income districts*										
Xianyang	2 (4)	2 (3)	1 (1)	5 (8)	5 (5)	3 (6)	2 (4)	1 (2)	6 (12)	6 (12)
Baoji	2 (4)	2 (4)	1 (1)	5 (9)	5 (5)	3 (6)	2 (4)	1 (2)	6 (12)	6 (12)
Low-income districts*										
Weinan	2 (4)	2 (4)	1 (1)	5 (9)	5 (6)	3 (6)	2 (4)	1 (2)	6 (12)	6 (12)
Shangluo	2 (4)	2 (3)	1 (1)	5 (8)	5 (5)	3 (6)	2 (4)	1 (2)	6 (12)	6 (12)
Total	12 (24)	12 (20)	6 (6)	30 (50)	30 (36)	18 (36)	12 (24)	6 (12)	36 (72)	36 (72)

Data are planned (actually surveyed) facilities. According to the WHO and Health Action International survey method, an additional facility is added to the sample if fewer than 50% of medicines were available on the day of the survey in a given facility. *By GDP per person in 2010.

Table 1: **Planned and actual number of sample facilities**

scarcity of empirical knowledge, we undertook two cross-sectional surveys to analyse medicine prices, availability, and affordability in Shaanxi Province during the early years of implementation of the NEMP. We hypothesised that the NEMP would lead to a decrease in prices of essential medicines and a gradual increase in

	NEML	WHO/HAI list	Procurement list*	Public sector availability (%)				Private sector availability (%)			
				LPG		OB		LPG		OB	
				2010	2012	2010	2012	2010	2012	2010	2012
Medicine											
Aciclovir	Yes	S	Yes	0·0%	2·8%	0·0%	0·0%	27·8%	27·8%	0·0%	0·0%
Albendazole	Yes	R	Yes	10·0%	9·7%	32·0%	25·0%	8·3%	5·6%	94·4%	68·1%
Aminophylline	Yes	S	Yes	78·0%	66·7%	0·0%	0·0%	75·0%	65·3%	0·0%	0·0%
Amitriptyline	Yes	G	Yes	16·0%	12·5%	0·0%	0·0%	22·2%	11·1%	0·0%	0·0%
Amlodipine	No	R	No	22·0%	20·8%	32·0%	37·5%	41·7%	38·9%	58·3%	63·9%
Amoxicillin	Yes	G	Yes	16·0%	26·4%	0·0%	0·0%	77·8%	83·3%	2·8%	0·0%
Atenolol	Yes	G	No	0·0%	0·0%	0·0%	0·0%	0·0%	0·0%	0·0%	1·4%
Atorvastatin	No	R	No	2·0%	2·8%	26·0%	37·5%	5·6%	8·3%	63·9%	61·1%
Azithromycin	Yes	S	Yes	52·0%	47·2%	6·0%	4·2%	88·9%	79·2%	8·3%	12·5%
Beclometasone	No	R	No	0·0%	0·0%	14·0%	9·7%	0·0%	0·0%	22·2%	15·3%
Captopril	Yes	G	Yes	82·0%	75·0%	0·0%	0·0%	100·0%	91·7%	0·0%	0·0%
Cefalexin	Yes	R	Yes	18·0%	11·1%	0·0%	0·0%	50·0%	30·6%	0·0%	0·0%
Cefradine	No	S	No	4·0%	2·8%	0·0%	0·0%	19·4%	9·7%	0·0%	0·0%
Ceftriaxone	Yes	G	Yes	76·0%	52·8%	16·0%	26·4%	69·4%	41·7%	2·8%	2·8%
Ciprofloxacin	Yes	G	No	0·0%	1·4%	0·0%	0·0%	11·1%	9·7%	0·0%	0·0%
Co-trimoxazole	Yes	S	Yes	62·0%	27·8%	0·0%	1·4%	83·3%	68·1%	0·0%	1·4%
Diazepam	Yes	G	No	4·0%	0·0%	0·0%	0·0%	0·0%	0·0%	0·0%	0·0%
Diclofenac	Yes	G	Yes	20·0%	1·4%	0·0%	1·4%	27·8%	23·6%	0·0%	8·3%
Digoxin	Yes	S	Yes	68·0%	59·7%	0·0%	1·4%	72·2%	65·3%	2·8%	0·0%
Enalapril	Yes	R	Yes	52·0%	56·9%	0·0%	0·0%	94·4%	87·5%	0·0%	0·0%
Erythromycin	Yes	S	Yes	4·0%	0·0%	0·0%	0·0%	2·8%	11·1%	0·0%	0·0%
Fluconazole	Yes	S	Yes	4·0%	1·4%	0·0%	0·0%	19·4%	22·2%	5·6%	0·0%
Fluoxetine	No	R	No	4·0%	1·4%	8·0%	5·6%	11·1%	2·8%	19·4%	22·2%
Glibenclamide	Yes	G	No	0·0%	0·0%	0·0%	0·0%	5·6%	2·8%	0·0%	0·0%
Gliclazide	No	R	No	28·0%	30·6%	34·0%	19·4%	52·8%	58·3%	61·1%	41·7%
Hydrochlorothiazide	Yes	R	Yes	70·0%	62·5%	0·0%	0·0%	80·6%	63·9%	0·0%	0·0%
Ibuprofen	Yes	R	No	0·0%	0·0%	0·0%	0·0%	2·8%	4·2%	0·0%	1·4%
Ketoconazole	No	S	No	0·0%	0·0%	30·0%	18·1%	0·0%	1·4%	75·0%	56·9%
Lisinopril	No	S	No	2·0%	0·0%	0·0%	0·0%	11·1%	9·7%	2·8%	0·0%
Loratadine	No	S	Yes	18·0%	19·4%	18·0%	9·7%	44·4%	62·5%	91·7%	47·2%
Losartan	No	S	No	6·0%	5·6%	18·0%	19·4%	11·1%	12·5%	33·3%	27·8%
Lovastatin	No	S	No	14·0%	15·3%	0·0%	0·0%	50·0%	50·0%	0·0%	0·0%
Metformin	Yes	R	Yes	6·0%	2·8%	18·0%	20·8%	41·7%	25·0%	50·0%	40·3%
Metronidazole	Yes	R	Yes	98·0%	79·2%	0·0%	1·4%	94·4%	63·9%	0·0%	0·0%
Miconazole nitrate	Yes	S	Yes	4·0%	6·9%	84·0%	65·3%	22·2%	6·9%	94·4%	83·3%
Nifedipine retard	No	R	No	32·0%	25·0%	0·0%	2·8%	61·1%	50·0%	19·4%	23·6%
Ofloxacin	No	S	No	0·0%	0·0%	0·0%	0·0%	8·3%	4·2%	0·0%	0·0%
Omeprazole	Yes	G	Yes	80·0%	63·9%	20·0%	25·0%	86·1%	80·6%	36·1%	41·7%
Paracetamol	Yes	S	Yes	6·0%	2·8%	0·0%	1·4%	13·9%	8·3%	2·8%	2·8%
Ranitidine	Yes	R	Yes	50·0%	40·3%	0·0%	0·0%	91·7%	75·0%	0·0%	0·0%
Rifampicin	Yes	S	Yes	44·0%	30·6%	0·0%	1·4%	83·3%	51·4%	0·0%	0·0%
Salbutamol	Yes	G	Yes	20·0%	4·2%	30·0%	26·4%	61·1%	18·1%	30·6%	34·7%
Simvastatin	Yes	G	No	16·0%	9·7%	24·0%	23·6%	50·0%	58·3%	50·0%	41·7%
Sodium valproate	Yes	R	Yes	32·0%	22·2%	0·0%	0·0%	69·4%	61·1%	2·8%	1·4%

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	NEML	WHO/HAI list	Procurement list*	Public sector availability (%)				Private sector availability (%)			
				LPG		OB		LPG		OB	
				2010	2012	2010	2012	2010	2012	2010	2012
(Continued from previous page)											
Mean availability											
All medicines				25·5%	20·5%	9·3%	8·7%	42·0%	35·3%	18·9%	15·9%
Medicines on Shaanxi provincial procurement list				37·9%	30·2%	8·6%	8·1%	58·0%	47·3%	16·3%	13·2%
Medicines not listed on Shaanxi provincial procurement list				7·4%	6·4%	10·3%	9·6%	19·0%	17·8%	22·5%	19·8%

cap=capsule. G=global core list. HAI=Health Action International. NEML=2009 National Essential Medicines List. LPG=lowest-price generic. OB=originator brand. R=regional core list. S=supplementary list. tab=tablet. *2010–12 Shaanxi provincial medicines procurement list.

Table 2: **Availability of 44 medicines in public sector hospitals and private retail pharmacies**

availability of medicine in health-care institutions, particularly in primary hospitals.

Methods

Study design

We undertook two cross-sectional surveys of medicine availability and prices in Shaanxi Province in September, 2010, and April, 2012, with a standard methodology developed by WHO and Health Action International (WHO/HAI),[35] which has been used in previous studies in eastern and central China.[36–38] In the present study, we focused on changes in medicine availability and price from 2010 to 2012; the reports of the complete survey are available from WHO/HAI.[39,40]

See Online for appendix

All institutions agreed to participate in the study. Shaanxi Provincial Department of Health and Shaanxi Food and Drug Administration approved the study before data collection. Ethical approval was obtained from the Research Ethics Committee at Xi'an Jiaotong University Health Science Centre.

Procedures

We selected health facilities systematically for both surveys. We first classified the ten areas in Shaanxi Province into three income strata (high, middle, and low) according to GDP per capita in 2010. The highest and lowest income areas in each stratum (Xi'an and Yulin, Xianyang and Baoji, and Shangluo and Weinan, respectively) were surveyed in both years. In each survey area, five public sector (hospital) medicine outlets were selected at random from those within a 4 h drive from the main hospital in 2010, whereas six were selected in 2012. A private sector pharmacy near each selected public health facility was also surveyed. Back-up outlets were selected in case availability of the surveyed medicines was less than 50% at a given outlet, a feature of the WHO/HAI survey design. As a result, the actual number of outlets surveyed was larger than the planned sample.

44 medicines were surveyed in both years: 27 from the WHO/HAI core global and regional lists (representing medicines for common acute and chronic disorders) and 17 locally selected supplementary medicines chosen for their local importance and disease burden,[41,42] with input from an advisory committee of practising pharmacists, academics, and experts from the Shaanxi Provincial Center for Medicine Procurement (Xi'an, Shaanxi Province). Of the 44 medicines surveyed, 31 were on the NEML and 26 were on the 2010–12 Shaanxi provincial medicines procurement list. 23 medicines treat acute disorders, whereas 21 treat chronic disorders (appendix).

Data collection and entry are described in detail elsewhere.[39,40] Briefly, data were collected during on-site visits to each public and private facility. As required by the WHO/HAI survey method, data were collected on the availability and price of both the originator brand (OB) and the lowest-priced generic (LPG) equivalent of every medicine. Prices charged to patients were collected in both public and private medicine outlets for all medicines found in the outlet on the day of the survey. Procurement prices for the same products were obtained from the Shaanxi Provincial Center for Medicine Procurement website[43] or, if not listed, at individual medicine outlets.

Statistical analysis

Availability is reported as the percentage of facilities in which each product was found on the day of data collection. Medicine prices are expressed as median unit prices (MUPs) in RMB (yuan; ¥). Unit price refers to the price per individual tablet, capsule, millilitre (eg, for injections or liquids), gram (for creams), or dose (for inhalers).[35] We adjusted 2012 unit prices to 2010 prices by deflating them by 5·186%.[44] To be included in analyses, we required at least two procurement prices or at least two public or private sector prices charged to patients for each medicine. The change in prices over 2 years was

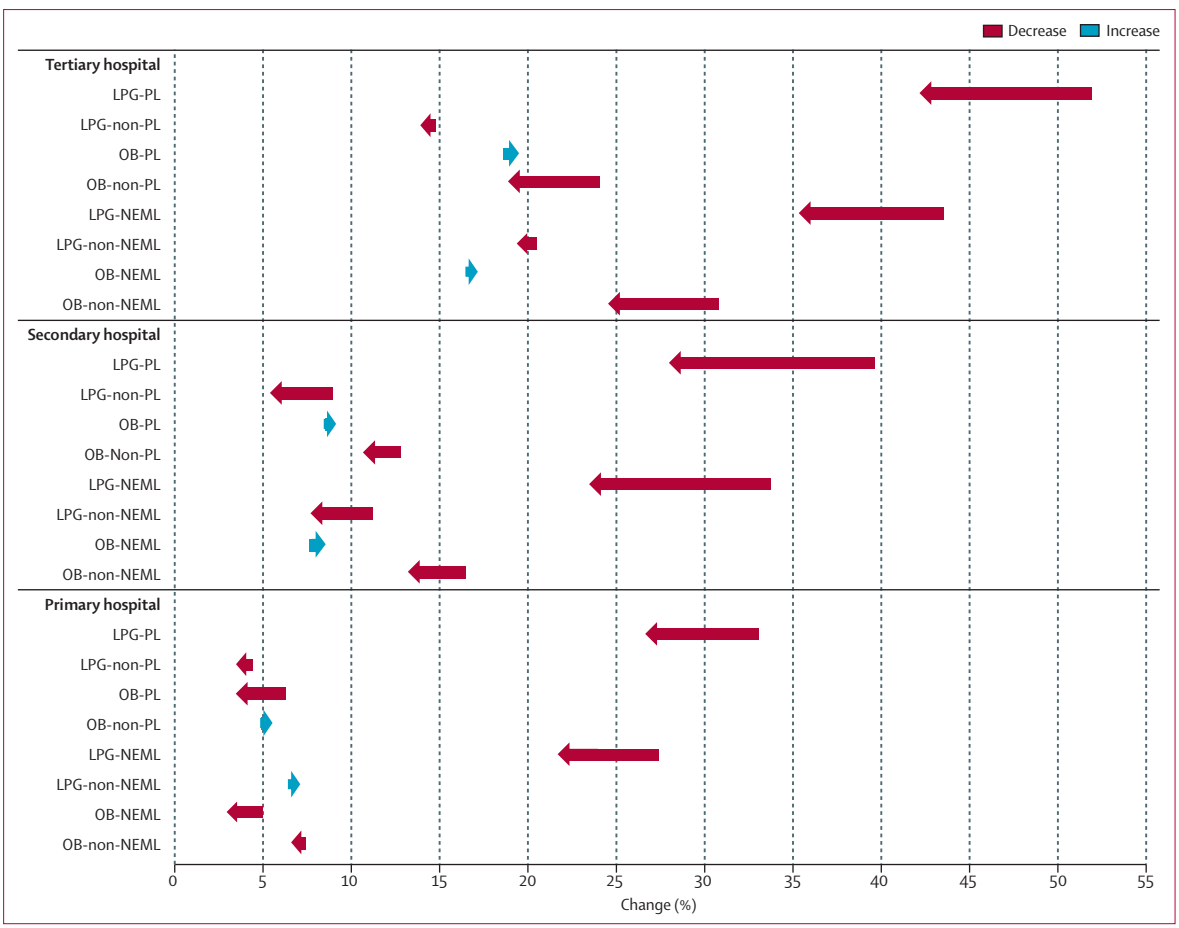

Figure 1: **Change in availability of 44 medicines in the public sector from 2010 to 2012**
LPG=lowest-priced generic. NEML=2009 National Essential Medicines List. OB=original brand. PL=2010–12 Shaanxi provincial medicines procurement list.

computed as the median of the product-specific percentage changes in price from 2010 to 2012.

Our primary analysis compared the availability and prices of products found in both years in all facilities. We compared availability and prices in the subset of public sector facilities that were included in the surveys in both years in a sensitivity analysis.[45] We also compared mean availability and MUPs between groups of medicines (OBs and LPGs; medicines for acute and chronic disorders; medicines on the provincial procurement list and not; and NEML and non-NEML medicines), across years, and across different levels of public facilities (primary hospital versus secondary and tertiary hospitals).

We used generalised estimating equations to test differences in availability of all medicines included in both surveys, with facility specified as a random effect. We used the Wilcoxon signed rank test to identify whether the reductions or increases in adjusted median prices between 2010 and 2012 were significant. To adjust for multiple comparisons, we classed $p<0\cdot01$ as a significant difference in all statistical testing.

Role of the funding source
The funders of the study had no role in study design, data collection, data analysis, data interpretation, writing of the report, or the decision to submit the manuscript. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Results
We collected data from 50 public sector hospitals and 36 private sector retail pharmacies in 2010 and 72 public hospitals and 72 retail pharmacies in 2012 (table 1); data from 26 public hospitals surveyed in both years were used for the sensitivity analysis (appendix).

In the public sector, availability of surveyed medicines was poor in both years. Of the 44 medicines surveyed, numbers of medicines found in more than 10% of public facilities in 2010 and 2012 were 24 and 21 for LPGs and 14 and 12 for OBs, respectively; in private facilities, corresponding numbers were 34 and 29 for LPGs and 15 and 16 for OBs. Additionally, there was a significant decrease in mean availability of LPGs in 2012 (20·5%)

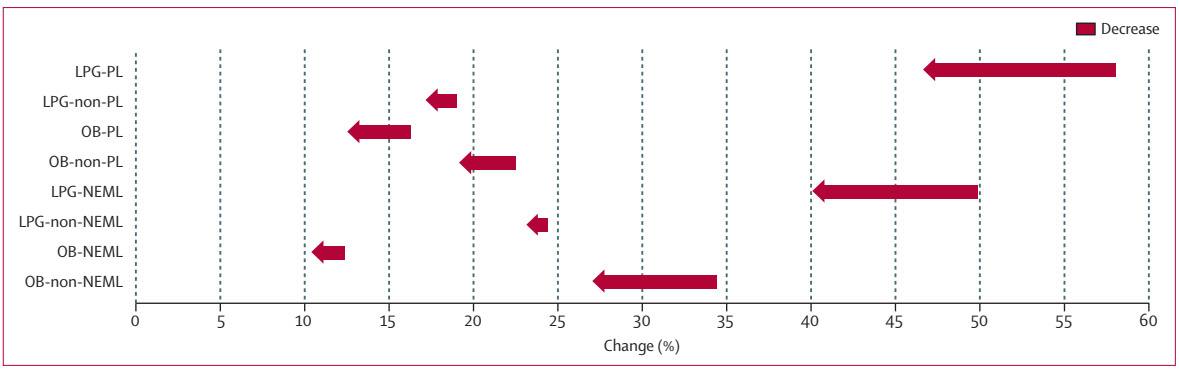

Figure 2: **Change in availability of 44 medicines in the private sector from 2010 to 2012**
LPG=lowest-priced generic. NEML=2009 National Essential Medicines List. OB=original brand. PL=2010–12 Shaanxi provincial medicines procurement list.

compared with 2010 (25·5%; p<0·0001), but no significant change in mean availability of OBs (8·7% *vs* 9·3%, respectively; p=0·40). In the private sector, availability of surveyed medicines in 2012 and 2010 (35·3% *vs* 42·0% for LPGs, p=0·0003; 15·9% *vs* 18·9% for OBs, p=0·012, respectively) was higher than in the public sector, but still very low (table 2). The mean availability of 21 LPGs used for chronic disorders (public 26·2% in 2010 *vs* 22·6% in 2012; private 43·7% *vs* 37·2%) was numerically higher in both sectors than for the 23 medicines for acute disorders (24·8% *vs* 18·6%; 24·8% *vs* 18·4%, respectively). Availability was numerically lower in all cases in 2012 compared with 2010, but only the reduction in LPG availability for chronic medicines in the private sector was statistically significant (p=0·0016). Availability of OBs was less than 10% in both sectors in both years, with no significant changes.

For individual medicines, availability varied by type of medicine and sector (table 2). In the public sector, 11 and eight LPG medicines had at least 50% availability in 2010 and 2012, and 20 and 18 in the private sector, respectively. For OB medicines, one medicine had over 50% availability in each year in the public sector; in the private sector, nine products had at least 50% availability in 2010 which decreased to five in 2012. No public outlet carried any of the assessed formulations of four medicines (atenolol, glibenclamide, ibuprofen, and ofloxacin). Three LPGs (atenolol, beclometasone, and diazepam) were not found in any private outlet.

In primary hospitals, the main target of the NEMP, mean availability of LPGs decreased significantly from 27·4% in 2010 to 22·3% in 2012 for medicines included in the NEML (p<0.0001), whereas availability of medicines not included in the NEML did not change (6·7% in 2012 *vs* 6·8% in 2010; p=048; figure 1). Mean availability of LPGs included on the NEML in secondary hospitals was 33·7% in 2012 and 23·9% in 2013; in tertiary hospitals mean availability was 43·5% and 35·8%, respectively. For LPGs on the Shaanxi provincial medicines procurement list, corresponding numbers were 39·6% and 28·5% for secondary and 51·9% and 42·6% for tertiary hospitals, respectively. By contrast, mean availability of branded products listed on the NEML and Shaanxi provincial medicines procurement list showed slight numerical increases in these settings of between 0·3% and 0·6%. In private sector pharmacies, the mean availability of OBs on the NEML (12·4% *vs* 11·0%) and the provincial procurement list (16·3% *vs* 13·2%) was numerically lower in 2012 than in 2010. Decreases in availability of LPGs listed on the NEML (49·5% *vs* 40·1%; p<0·0001) and provincial procurement list (58·0% *vs* 47·3%; p=0·013) were substantially greater (figure 2).

In the public sector, the mean availability of 26 LPG products on the Shaanxi provincial medicines procurement list was 37·9% in 2010 and 30·2% in 2012 (p=0·064); corresponding percentages for products not on the list were 7·4% and 6·4% (table 2).

For public sector procurement, the adjusted unit prices of all 16 available OBs had decreased by a median of 10·9% (IQR 6·5–14·6; Wilcoxon test p=0·0004) between 2010 and 2012, compared with a median percentage decrease in adjusted prices for all 29 available LPGs of 4·9% (2·7 to –29·3; p=0·17; table 3). Similar reductions in adjusted procurement prices were reported across all three hospital levels, ranging from medians of 8·4% to 10·5% for OB (p=0·0117 for primary, p=0·0063 for secondary, and p=0·0010 for tertiary hospitals), and 3·8% to 5·8% for LPG (all p≥0·01).

As shown in table 4, the median percentage decrease in public sector prices charged to patients for 16 OBs between 2010 and 2012 was 11·7% (IQR 4·9–15·6; p=0·0019), whereas the median decrease for 29 LPGs was 5·2% (4·2–17·3; p=0·0015). We noted significant reductions in retail prices for OBs in all three levels of public hospitals, with median percentage reductions in price ranging from 6·5% to 18·0%. However, adjusted prices of LPGs did not change significantly between 2010 and 2012 in the three levels of hospitals, with small median percentage decreases of 0·2% in secondary hospitals and 4.9% in primary and tertiary hospitals.

In the private sector, the median percentage decrease in price between 2010 and 2012 for 38 LPGs was 4·7%

	All hospitals			Tertiary hospital			Secondary hospital			Primary hospital		
	MUP 2010, yuan (n=50)	MUP 2012, yuan (n=72)	Product-specific % change (%)	MUP 2010, yuan (n=6)	MUP 2012, yuan (n=12)	Product-specific % change (%)	MUP 2010, yuan (n=20)	MUP 2012, yuan (n=24)	Product-specific % change (%)	MUP 2010, yuan (n=24)	MUP 2012, yuan (n=36)	Product-specific % change (%)
Lowest-price generics												
All	0·270 (29)	0·133 (29)	−4·9 (−29·3 to 2·7)	0·195 (20)	0·349 (20)	−3·8 (−5·9 to 7·5)	0·378 (21)	0·216 (21)	−4·9 (−5·8 to 6·6)	0·179 (23)	0·153 (23)	−5·8 (−16·0 to 3·5)
NEML	0·135 (22)	0·103 (22)	−5·6 (−26·5 to −0·4)	0·081 (14)	0·084 (14)	−4·4 (−5·7 to 6·0)	0·110 (16)	0·108 (16)	−4·9 (−5·5 to 8·1)	0·102 (18)	0·116 (18)	−5·9 (−9·7 to 3·6)
Non-NEML	1·005 (7)	1·154 (7)	2·7 (−16·1 to 16·3)	1·120 (6)	1·089 (6)	0·1 (−5·4 to 9·6)	0·610 (5)	0·772 (5)	−5·0 (−29·8 to 6·1)	0·944 (5)	0·772 (5)	−2·4 (−22·2 to −1·0)
Proc list	0·135 (22)	0·103 (22)	−5·6 (−26·5 to 1·0)	0·086 (15)	0·095 (15)	−4·9 (−6·1 to 5·3)	0·110 (16)	0·108 (16)	−4·9 (−5·5 to 8·1)	0·102 (18)	0·116 (18)	−5·9 (−9·7 to 3·6)
Non-proc list	1·031 (7)	1·154 (7)	0·7 (−16·1 to 7·3)	1·031 (5)	1·024 (5)	2·7 (−2·4 to 11·9)	1·100 (5)	0·772 (5)	−5·0 (−29·8 to 6·1)	0·992 (5)	0·772 (5)	−2·4 (−22·2 to −1·0)
Acute	0·253 (12)	0·193 (12)	−5·6 (−33·9 to 8·0)	0·414 (6)	0·397 (6)	−4·4 (−5·3 to 6·0)	0·378 (7)	0·547 (7)	−4·9 (−10·0 to 15·8)	0·206 (10)	0·193 (10)	−5·2 (−14·6 to 6·8)
Chronic	0·368 (17)	0·132 (17)	−4·9 (−12·7 to 1·7)	0·195 (14)	0·349 (14)	−3·1 (−11·8 to 7·5)	0·278 (14)	0·174 (14)	−4·9 (−5·5 to 3·7)	0·179 (13)	0·153 (13)	−5·8 (−15·8 to −1·7)
Originator brands												
All	3·253 (16)	2·931 (16)	−10·9 (−14·6 to −6·5)*	4·111 (14)	3·667 (14)	−9·5 (−14·3 to −6–6)*	2·446 (14)	2·564 (14)	−8·4 (−14·3 to −5·3)*	1·793 (8)	1·640 (8)	−10·5 (−14·0 to −7·4)*
NEML	2·253 (8)	2·024 (8)	−12·5 (−18·8 to −8·5)*	2·253 (8)	2·024 (8)	−12·5 (−18·8 to −8·5)*	1·400 (7)	1·196 (7)	−8·6 (−22·9 to −6·7)	0·777 (4)	0·726 (4)	−8·4 (−14·3 to −7·4)
Non-NEML	4·259 (8)	3·746 (8)	−9·1 (−12·7 to −5·6)*	5·701 (6)	4·957 (6)	−6·7 (−11·0 to −5·9)	2·492 (7)	3·011 (7)	−6·7 (−13·0 to −5·5)	3·759 (4)	3·378 (4)	−13·0 (−14·0 to −10·6)
Proc list	2·400 (8)	2·103 (8)	−13·0 (−18·8 to −9·9)*	1·400 (7)	1·196 (7)	−14·6 (−23·0 to −9·5)	1·400 (7)	1·196 (7)	−8·6 (−22·9 to −5·0)	0·655 (3)	0·598 (3)	−8·6 (−20·0 to −6·9)
Non-proc list	4·111 (8)	3·667 (8)	−7·4 (−12·7 to −5·6)*	5·117 (7)	4·482 (7)	−6·7 (−10·3 to −6·2)	3·106 (7)	2·852 (7)	−8·2 (−13·0 to −6·2)	3·106 (5)	2·852 (5)	−12·4 (−13·6 to −8·2)
Acute	2·900 (6)	2·643 (6)	−10·4 (−13·1 to −6·9)	2·400 (5)	2·275 (5)	−9·5 (−13·6 to −6·1)	2·400 (5)	2·275 (5)	−5·2 (−7·8 to −5·0)	0·900 (3)	0·854 (3)	−5·2 (−6·9 to −5·2)
Chronic	4·111 (10)	3·667 (10)	−12·4 (−14·6 to −6·7)*	5·117 (9)	4·482 (9)	−10·3 (−13·8 to −6·7)*	3·106 (9)	2·852 (9)	−13·0 (−14·8 to −7·8)*	3·106 (5)	2·852 (5)	−13·6 (−8·2 to −12·4)

Data are MUP (number of products found in both years) or median (IQR). MUP=median unit price. n=number of facilities participating in surveys. NEML=2009 National Essential Medicines List. Proc list=2010–12 Shaanxi provincial medicines procurement list. *Wilcoxon signed rank test p<0·01.

Table 3: **Public sector median unit procurement prices of medicines in 2010 and 2012 and median of product-specific price changes**

(IQR 6·3–13·2; p=0·33), whereas the median percentage decrease for the 16 OBs was 7·9% (4·9–13·9; p=0·0019; table 5).

In the 26 public sector hospitals surveyed in both years, only one in eight mean availability values changed direction when analyses were limited to these commonly surveyed facilities (OBs in tertiary hospitals; 20·8% *vs* 19·3% for the full sample, and 20·0% *vs* 21·2% for commonly surveyed facilities). Most values were similar between groups (appendix). In terms of MUPs, the results of the sensitivity analysis were largely consistent with the primary analysis (appendix).

Discussion

Our findings partially support the hypothesis that the early years of NEMP implementation have been associated with decreased medicine prices (panel), especially in primary hospitals. However, more substantial decreases in both procurement prices and prices charged to patients occurred for OBs than for LPGs, despite the fact that generics are the primary target of the NEMP policy. We speculate that this finding occurred because the recently centralised pharmaceutical bidding and distribution system improves procurement efficiency[48] and because of cancellation of the previous 15% mark-up in primary hospitals.[30] Additionally, after the reduction of the prices of medicines (which mostly targeted generic products) nearly 30 times since the late 1990s, the latest government drug price reductions for 2349 products mainly targeted OB products.[49] However, since we adjusted prices for inflation, the reported price decreases might primarily be due to rising living standards.

Although we found lower prices for some types of medicines in 2012, we also noted substantial decreases in medicine availability, which was contrary to our hypothesis. Possible reasons for low public sector availability probably include inadequate funding, limited incentives for maintaining stocks, inability to forecast needs accurately, or inefficient procurement systems.[47] However, the reasons probably also include unintended

	All hospitals			Tertiary hospital			Secondary hospital			Primary hospital		
	MUP 2010, yuan (n=50)	MUP 2012, yuan (n=72)	Product-specific % change (%)	MUP 2010, yuan (n=6)	MUP 2012, yuan (n=12)	Product-specific % change (%)	MUP 2010, yuan (n=20)	MUP 2012, yuan (n=24)	Product-specific % change (%)	MUP 2010, yuan (n=24)	MUP 2012, yuan (n=36)	Product-specific % change (%)
Lowest-price generics												
All	0·280 (29)	0·156 (29)	–5·2 (–17·3 to –4·2)*	0·225 (20)	0·412 (20)	–4·9 (–10·2 to –2·1)	0·460 (21)	0·299 (21)	–0·2 (–5·0 to 13·5)	0·280 (23)	0·170 (23)	–4·9 (–12·6 to 7·7)
NEML	0·155 (22)	0·109 (22)	–4·9 (–12·3 to –2·1)*	0·093 (14)	0·087 (14)	–4·9 (–8·6 to 0·8)	0·124 (16)	0·121 (16)	1·0 (–4·9 to 14·0)	0·128 (18)	0·130 (18)	–4·9 (–13·1 to 2·4)
Non-NEML	1·270 (7)	1·273 (7)	–9·1 (–19·7 to –7·1)	1·395 (6)	1·255 (6)	–6·5 (–12·9 to –4·9)	0·709 (5)	1·070 (5)	–5·0 (–15·8 to 8·3)	1·132 (5)	1·097 (5)	–4·3 (–8·9 to 17·9)
Proc list	0·155 (22)	0·109 (22)	–4·9 (–12·2 to –0·8)	0·099 (15)	0·094 (15)	–4·9 (–7·4 to –0·6)	0·124 (16)	0·121 (16)	1·0 (–4·9 to 16·4)	0·128 (18)	0·130 (18)	–4·9 (–13·1 to 2·4)
Non-proc list	1·400 (7)	1·273 (7)	–10·4 (–19·7 to –8·5)	1·391 (5)	1·179 (5)	–8·0 (–14·6 to –4·9)	1·270 (5)	1·070 (5)	–5·0 (–15·8 to 7·5)	1·146 (5)	1·097 (5)	–4·3 (–8·9 to 15·5)
Acute	0·279 (12)	0·211 (12)	–7·5 (–18·7 to –2·1)	0·476 (6)	0·530 (6)	–4·2 (–10·2 to 5·0)	0·460 (7)	0·753 (7)	13·5 (–0·2 to 29·9)	0·223 (10)	0·211 (10)	–6·4 (–48·1 to 0·1)
Chronic	0·466 (17)	0·153 (17)	–5·2 (–9·7 to –4·9)*	0·225 (14)	0·412 (14)	–4·9 (–9·5 to –4·9)	0·321 (14)	0·232 (14)	–4·9 (–16·4 to 3·5)	0·393 (13)	0·170 (13)	–4·5 (–6·9 to 16·7)
Originator brands												
All	4·250 (16)	3·282 (16)	–11·7 (–15·6 to –4·9)*	4·729 (14)	4·285 (14)	–6·5 (–12·0 to –4·9)*	2·910 (14)	2·778 (14)	–8·5 (–13·1 to –5·7)*	2·066 (8)	1·703 (8)	–18·0 (–25·5 to –12·8)*
NEML	3·105 (8)	2·392 (8)	–14·2 (–27·2 to –7·3)*	2·591 (8)	2·392 (8)	–9·8 (–17·9 to –4·9)	1·624 (7)	1·483 (7)	–8·7 (–22·4 to –8·2)	0·953 (4)	0·846 (4)	–21·8 (–33·7 to –12·4)
Non-NEML	4·893 (8)	4·172 (8)	–8·5 (–12·4 to –4·9)	6·557 (6)	5·793 (6)	–5·0 (–9·7 to –4·9)	2·969 (7)	2·931 (7)	–7·9 (–11·7 to –4·9)	4·296 (4)	3·740 (4)	–18·0 (–20·4 to –15·4)
Proc list	2·755 (8)	2·278 (8)	–14·2 (–21·7 to –7·3)*	1·610 (7)	1·388 (7)	–11·6 (–22·1 to –6·5)	1·624 (7)	1·483 (7)	–8·4 (–19·5 to –6·5)	0·800 (3)	0·694 (3)	–13·3 (–21·8 to –11·5)
Non-proc list	5·243 (8)	4·285 (8)	–8·5 (–12·4 to –4·9)	5·886 (7)	5·175 (7)	–4·9 (–8·1 to –4·9)	3·943 (7)	3·376 (7)	–11·3 (–12·8 to –6·4)	5·821 (5)	3·572 (5)	–19·2 (–23·8 to –16·8)
Acute	3·340 (6)	2·896 (6)	–8·1 (–16·7 to –5·3)	2·760 (5)	2·624 (5)	–6·5 (–10·7 to –4·9)	2·850 (5)	2·624 (5)	–8·0 (–8·3 to –5·6)	1·105 (3)	0·998 (3)	–13·3 (–15·0 to –11·5)
Chronic	5·243 (10)	4·285 (10)	–12·1 (–13·8 to –4·9)	5·886 (9)	5·175 (9)	–8·1 (–12,5 to –4·9)	3·943 (9)	3·376 (9)	–11·7 (–13·7 to –7·8)*	5·821 (5)	3·572 (5)	–23·8 (–30·3 to –19·2)

Data are MUP (number of products found in both years) or median (IQR). MUP=median unit price. n=number of facilities participating in both surveys. NEML=2009 National Essential Medicines List. Proc list=2010–12 Shaanxi provincial medicines procurement list. *Wilcoxon signed rank test p<0·01.

Table 4: **Median unit prices charged to patients for medicines in all public sector hospitals**

consequences of the present policies. First, mandatory price reductions could have led to shrinking revenues from drug sales, which probably caused some manufacturers to reduce production or pull medicines from the market.[34,50] Furthermore, because only the companies that offer the lowest prices can win bids, the new procurement process might drive some producers out of the market.[50] Second, the fixed distribution fee (5% of bidding prices) is probably not adequate because of the geographical distance of many primary hospitals from urban locations. In September, 2012, 187 essential medicines that formerly won tenders (>10% of the total number) were excluded from the procurement list owing to deficiencies or delays in supply.[51] Third, after implementing the zero mark-up policy on drug sales, primary hospitals might not have received timely or sufficient government financial support to compensate for the loss in drug revenue.[30] This factor might contribute to poor availability of some low-cost essential medicines, which results in many patients having to purchase medicines in the private sector or at higher level hospitals.[52] Fourth, the poor perceptions of physicians, pharmacists, and patients about the quality of low cost essential medicines might result in low demand, which contributes to specific medicines going out of stock in public outlets.[46] Finally, if the specific strengths or dosage forms of the medicines surveyed were not included in the provincial medicines procurement list (18 of 44 surveyed medicines were not included), they would not be procured in Shaanxi Province and thus would probably be out of stock in primary hospitals.

The low availability of generic essential medicines noted over the study period was disappointing. One explanation for this low availability might be that health providers have a direct financial incentive to prescribe more expensive medications. This financial incentive, in combination with the perception that generic medicines are lower quality, hinders the selection and use of generic essential medicines.[26]

	MUP 2010, yuan (n=36)	MUP 2012, yuan (n=72)	Product-specific % change (median [IQR])
Lowest-price generics			
All (38)	0·416	0·459	−4·7 (−13·2 to 6·3)
NEML (27)	0·150	0·166	−1·5 (−10·4 to 3·7)
Non-NEML(11)	1·315	1·223	−7·4 (−21·8 to 12·1)
Proc list (25)	0·158	0·178	−1·4 (−9·6 to 6·5)
Non-proc list (13)	1·200	0·970	−8·3 (−20·8 to 5·9)
Acute (17)	0·453	0·442	−1·4 (−12·2 to 13·7)
Chronic (21)	0·380	0·540	−6·2 (−16·0 to 3·2)
Originator brands			
All (16)	3·326	2·424	−7·9 (−13·9 to −4·9)*
NEML (7)	1·388	1·298	−7·5 (−14·0 to −5·3)
Non-NEML (9)	4·214	2·472	−8·3 (−11·3 to −4·9)
Proc list (7)	1·388	1·298	−6·5 (−10·8 to −2·7)
Non-proc list (9)	4·214	2·472	−11·2 (−13·9 to −6·2)*
Acute (5)	2·500	2·377	−4·6 (−6·9 to −1·9)
Chronic (11)	4·214	2·472	−11·2 (−21·9 to −6·9)*

Numbers in parentheses are number of products found in both years. n=number of facilities participating in surveys. NEML=2009 National Essential Medicines List. Proc list=2010–12 Shaanxi provincial medicines procurement list. *Wilcoxon signed rank test p<0·01.

Table 5: **Median unit price for medicines in private sector pharmacies**

***Panel:* Research into context**

Systematic review

We searched PubMed and Google Scholar for published articles and reports with the terms "essential medicine", "price", "availability", "affordability", "pharmaceutical policy", and "healthcare reform". We identified three previous studies[36–38] in which the 2003 Edition of WHO and Health Action International methodology was used to measure medicine prices, availability, and affordability in eastern and central China. Results from two surveys[33,46] showed unsatisfactory manufacturing, supply, and prescribing status in Shandong, Gansu, and Hubei provinces. Results from a secondary analysis[47] of 36 developing and middle-income countries revealed there was much room for increasing availability, reducing prices, and improving affordability. The Chinese Essential Medicine Policy was analysed in five descriptive studies.[8,17,24,31,32] Findings from two reviews[25,30] and three reports[26–28] that tracked China's health-care reform emphasised the necessity of independent, outcome-based monitoring and assessment by a third party. These studies attempted to investigate the effects of the National Essential Medicine Policy (NEMP) but were limited to data before 2009, non-independent authority reports, or qualitative designs. We aimed to study the short-term patterns of medicine availability and prices in Shaanxi Province during the early years of NEMP implementation by undertaking two cross-sectional surveys.[39,40]

Interpretation

This study provides up-to-date evidence of major differences in access to affordable medicines at two timepoints after health-care reform in underdeveloped western China. Although the prices charged to patients have decreased, probably owing to rising living standards, we identified concerning decreases in availability of many essential medicines in both public and private outlets. There is a need to establish a routine information system to monitor the effects of further implementation of the Chinese Essential Medicine Policy.

Mean availability of surveyed medicines was numerically higher in private pharmacies than in the public sector. However, the availability of medicines in the private sector was still insufficient. These findings are similar to those from surveys undertaken in other countries.[47,53,54] In the private sector, generic medicines typically cost more than in the public sector and are often not reimbursed under the medical insurance scheme. Furthermore, shortages of lower cost generic essential medicines might force patients to buy more expensive brand-name drugs. These factors can increase the economic burden for patients. Policies are needed to ensure that first-line generic medicines are available and preferentially prescribed and dispensed in both sectors. In 2012, the availability of 15 products that are commonly surveyed in WHO/HAI surveys was lower in all sectors for all product types than the availability in 36 countries at all income levels.[47]

Our study has several important limitations. First, the validated WHO/HAI methodology has been used in many other national and regional price and availability surveys.[55,56] However, availability and prices are measured for a limited number of specific products to facilitate comparisons across countries;[35,57] therapeutic alternatives or alternate dosage forms are not accounted for in the survey methodology. Thus, some facilities might have had therapeutically comparable products in stock, but with different strengths or dosage forms. Although we included several supplementary medicines, the medicines surveyed might not represent the entire market. Second, the limited number of health facilities and low availability might make the MUPs less robust than hoped owing to the small numbers of prices obtained, especially for less frequently found products. Third, sample facilities were not consistent in the two surveys, which constrained our ability to assess changes between 2010 and 2012. However, our sensitivity analysis in the subset of common facilities mostly confirms the results.

The main limitation of our analyses lies in the fact that we have data at only two timepoints after the 2009 health-care reforms, and no comparable data before the reform. To validly assess the effects of the 2009 reform and future policy adaptations, longitudinal data including many timepoints before and after intervention would be needed.[58] We used publicly reported data to account for price inflation from 2010 to 2012.[44] Changes in prices might be misrepresented, although they are generally consistent with other data on increases in living standards during this period.[44,59]

Based on our findings, research is needed into the effects of policy interventions to improve the availability and reduce the price of essential medicines in Shaanxi Province. This research might involve adjusting provincial essential medicines and procurement lists to match standard treatment guidelines for the most prevalent disorders. Interventions could also aim to target inefficiencies in the distribution chain, improve transparency and efficiency of the bidding system, and

provide better information about product quality. Linking price to quality might stimulate manufacturers to expand production of high-quality low-cost essential medicines. Studies should examine the effects of increasing government subsidies or medical service fees for primary hospitals to compensate for reduced revenue due to the zero mark-up policy. Additional research is needed on the effects of financial incentives by health insurance organisations to encourage appropriate prescribing and use of essential medicines. In the long run, only complementary policies implemented at all levels will achieve the NEMP goal of equitable, affordable, and sustainable access to quality essential medicines.

In summary, the early years of the implementation of the NEMP in one province in western China have been characterised by relative reductions in medicine prices but lower medicine availability in the public and private sectors, especially in primary hospitals. Future policies need to target medicine availability as well as price. There is a need for a system that uses routine data, perhaps combining data from hospitals and insurance systems, to monitor standardised indicators of availability, price, and use of medicines.

Contributors

All authors participated in the manuscript's conception and design, data analysis, and data interpretation, take responsibility for the integrity of the work as a whole, and approved the final version for publication. YF, AKW, and DR-D designed the study. YF, FZ, and DR-D did the statistical analyses. YF wrote the article and all authors revised it critically for important intellectual content. YF and MJ acquired the data; all authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Conflicts of interest

We declare that we have no conflicts of interest.

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