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Assessment of sanitation facilities in primary healthcare institutions across seven provinces in China: a cross-sectional study

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Abstract

Objective This study aims to assess the current status of sanitation facilities across primary healthcare institutions in China, offering valuable insights for improving sanitary facilities in middle-income settings.

Methods Data were draw from the ACACIA project (March 2021-April 2023) across seven provinces in China. A total of 2139 visits were made to 1167 primary healthcare institutions. Unannounced standardized patients (USPs) were utilized to covertly assess the sanitation facilities during clinical visits.

Results Toilet sanitation facilities were available in 70.4% of visits. 95% had access to piped water. The probability of having a handwashing sinks in toilet and examination room is 79.2% and 50.8%. Significant regional disparities were observed, with southern regions exhibiting higher facility coverage compared to northeastern regions. Public primary healthcare institutions have more sanitary facilities than private ones. Higher-tier institutions have higher rates of sanitary facilities. Regarding quality, adverse event rates show minimal differences between clinic-level and center-level institutions. And the urban institutions is obviously better than that in rural areas.

Conclusions China's policy initiatives have improved sanitation facilities within primary healthcare institutions, but gaps persist in essential components and maintenance. Continued efforts are needed to enhance sanitation infrastructure to meet higher standards and ensure comprehensive coverage. The study's insights can inform both domestic and global strategies for improving healthcare sanitation, contributing to the achievement of international health goals. Future research should focus on identifying barriers to sanitation improvements and developing targeted interventions to standardize sanitary facilities in primary healthcare settings.

Keywords Sanitation facility, Hygiene, WASH, Primary health care, Toilet revolution, Assessment

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Introduction

Adequate sanitation facilities are essential for primary healthcare institutions, with significant implications for public health. Deficiencies in water, sanitation, and hygiene (WASH) undermine healthcare delivery and pose serious health risks, such as increased healthcare-associated infections (HAIs), the transmission of antimicrobial resistance, and disease outbreaks, particularly in low-and-middle-income countries (LMICs) [1]. According to the latest WASH-related burden of disease estimates, 1.4 million people die each year due to inadequate drinking water, sanitation, and hygiene [1]. Improving WASH facilities could prevent up to 10% of the global disease burden and reduce HAIs by over 50% [2]. In East Asia and the Pacific, where over 95% of births occur in healthcare institutions, the state of WASH in these facilities directly impacts maternal and newborn survival [3].

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) Joint Monitoring Programme (JMP) have established standardized global indicators for benchmarking and tracking progress on WASH in healthcare facilities [4]. Although global monitoring reveals persistent disparities in these fundamental services, some countries have made incremental improvements [5].

China has made sustained efforts to improve environmental sanitation. In the 1950s, the Chinese government initiated the Patriotic Health Campaign to address issues such as fecal contamination and related disease outbreaks. In 2019, to further advance the "Toilet Revolution", China launched a national policy, titled the *Notice on Launching a Special Action for Improving Cleanliness of Toilets in Medical and Healthcare Institutions* (hereafter referred to as the "Notice") [6]. This initiative emphasized the renovation of toilet facilities and enforcement of hygiene standards across the healthcare system. In 2021, standards for general hospital construction explicitly required sanitation facilities, including toilets, to meet patient needs, aiming to enhance the patient experience through improved toilet environment [7]. Assessing China's progress following these major policy investments can provide valuable insights both domestically and globally. However, existing research has largely focused on household or public sanitation in rural and some urban areas [8]. The adequacy and quality of sanitation facilities in China's primary healthcare facilities remain unclear, leaving a critical evidence gap. Moreover, while previous studies have assessed WASH from a global or regional perspective, few have explored how the Chinese context contributes to or diverges from international trends [2]. The WHO's 2023 data update on WASH in healthcare facilities includes China, but the available data remains insufficient [9]. To address this, a reliable and valid measurement method and a representative sample are needed.

Therefore, the main purpose of this study is to assess the availability and quality of sanitation facilities in primary healthcare institutions across seven representative provinces in China. The findings aim to bridge the data gap regarding sanitation facilities in China healthcare settings and provide valuable support for global sanitation monitoring and evaluation. Moreover, they may inform future improvements in China's sanitation infrastructure and serve as a reference for other developing countries pursuing similar advancements.

Methods

Study design and participants

This cross-sectional study was conducted from March 2021 to April 2023, is part of a larger study assessing primary care quality in China (ACACIA study) [10].

Primary care institutions in this study include(1) outpatient services in the departments of internal medicine, obstetrics/gynecology and pediatrics at level 1 and level 2 hospitals (hospitals are classified into three levels in China with increasing focus on specialty care; most rural/county hospitals are level 2 hospitals) and (2) outpatient services at community health centers, health stations, and clinics in urban areas, as well as township health centers and village clinics in rural area. We exclude level 3 hospitals, the hospitals not yet designated a level (normally new institutions with unstable operations), and other specialty care hospitals or clinics, such as those focused solely on dentistry or ophthalmology.

In accordance with the analytical methodology used in this study, we employed the classification standards outlined in the "China Health Statistics Yearbook 2022" (hereinafter referred to as the "Yearbook") [11]. Additionally, government documents [12, 13] provide a classification framework and codes for different types of healthcare institutions, enabling effective categorization in this research. Healthcare institutions were categorized along three domains: public-private, three-level institutions [14], and urban-rural, based on registration type, healthcare service levels, and geographical area (Attachment 1, Table 1).

Sampling method

The sampling method aims to establish a representative sample of primary health care across China, as detailed in our protocol [10]. The process involved 2 stages. In stage I, we used purposive sampling to select seven provinces from north to south—Gansu, Guizhou, Hunan, Inner Mongolia, Shaanxi, Sichuan and Guangdong. This provinces represent different health, socioeconomic, geographic and ethnic conditions (Attachment 1, Fig. 1). In stage II, we randomly selected primary healthcare

institutions within each province for USP-clinician encounters. To account for variation in clinician numbers across institutions, multiple institutions were grouped into pseudo-groups of comparable size for random selection. This approach resulted in a final sample comprising 2200 expected visits across 1226 primary healthcare institutions in the seven selected provinces.

Observed variables

This study incorporated indicators from the Joint Monitoring Programme (JMP), developed by WHO and UNICEF [4]. The JMP provides an international framework for assessing and monitoring sanitation facility development. It also includes key components of China's current policies and guidelines for primary healthcare institutions. This ensured both international comparability and national relevance. Sanitation facilities were categorized into five types: Sanitation, Hygiene, Water, Waste Management, and Environmental Cleaning. These types focus on key dimensions of WASH, including *Availability*, *Accessibility*, and *Acceptability*. All variables were categorical (Attachment 1, Table 2).

Data collection

This study used unannounced standardized patients (USPs) as a data collection tool. After completing the clinic visits, USPs conducted survey of sanitary facilities (see Attachment 2 for details). A standardized patient (SP) is a trained healthy person who consistently portray clinical conditions across various clinical encounters. In this study, SPs simulated 11 common primary care conditions (Asthma, Gastritis, Angina, Low back pain, Migraine, Postpartum depression, Child diarrhea, Stress urinary incontinence, Common cold, Hypertension, Type2 diabetes). They visited primary care providers unannounced, following routine procedures to consult with doctors, fill prescriptions, and observe the sanitary conditions. After each visit, they completed a checklist evaluating the sanitary facility immediately. USPs offer a reliable and objective methodology, as these covertly conduced assessments are performed by rigorously trained individuals using a standardized checklist. This approach allowed data collectors to enter examination areas naturally and helped minimize reporting bias and observer effects, enabling accurate audits of infrastructure availability and quality [10].

Statistical analysis

Due to the sampling strategy based on the number of clinicians across different healthcare institutions, certain types of institutions (e.g., hospital-level institutions) were visited more frequently. To provide a more comprehensive perspective, data were analyzed at two levels: (1) Visits level, which represent individual assessments conducted by USPs. These were binary variables and were described using frequencies, percentages, and 95% confidence intervals; chi-square tests were used to analyze differences between public-private, three categories of healthcare institutions, and urban-rural areas. (2) Institution level, which aggregate data from multiple visits to the same institution. These were continuous variables. Due to the skewed distribution, the median and IQR were used for descriptive statistics. For comparisons across the previously mentioned dimensions, nonparametric tests (Mann-Whitney U test & Kruskal-Wallis test) were applied. Statistical inferences were made using SPSS20.0 software. A p-value of <0.05 indicated statistical significance.

To account for population differences across institutions, weights based on population density were incorporated. Population density data were derived from the Gridded Population of the World, Version 4 (GPWv4): Population Density, Revision 11 dataset [15]. Each institution's GPS coordinates were used to assign corresponding population density as its weight. Outcome variables, such as sanitation and hygiene indicators, were transformed into binary variables. Both weighted and unweighted rates, along with their 95% confidence intervals, were calculated using the *survey* package in R.

Results

Visits to primary healthcare institutions

During the visits, USPs accessed a total of 1254 primary healthcare institutions and collected 2157 sanitation data points. After quality control procedures, the study included data from 2139 visits across 1167 healthcare institutions (Fig. 1).

Disparities in sanitary facility visits across primary healthcare institutions in China reveals trends based on ownership, location, and institutional levels. The proportion of visits recorded in public healthcare institutions (71.9%) is higher compared to private institutions (28.1%). Urban healthcare institutions accounted for 28.5% of the visits, while rural institutions make up 71.5%. Among institutional level, clinic-level institutions have the highest visits (45.6%), followed by hospital-level institutions (30.7%) and center-level (23.7%).

Overview of sanitary facilities in China's primary healthcare institutions

The majority of healthcare institutions provide flush toilets for patients (70.4%, 95% CI: 0.684–0.723), while the provision of sanitary facilities such as toilet seats (19.5%, 95% CI: 17.6-21.4%) and emergency call buttons is notably low (7.8%, 95%CI: 6.5-9.1%). Additionally, unpleasant odors and floor puddling occur at rates close to 20% (21.3%, 95% CI: 19.4-23.3%; 19.7%, 95% CI: 17.8-21.6%). Other aspects of poor toilet quality exhibit

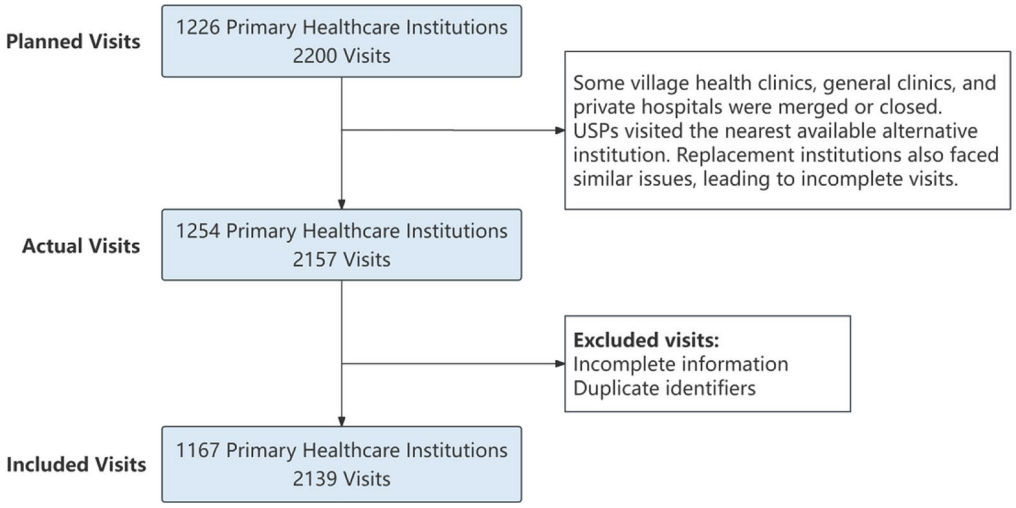

Fig. 1 Flowchart of primary healthcare institution visits

Table 1 Ownership of sanitary facilities in primary healthcare institution in China

Indicator			Visits level *n*(%)	Institution level	
				Unweighted Proportion[CI]	Weighted Proportion[CI]
Sanitation	Toilet for Patients	Flush Toilet	1505(70.4)	0.51[0.48,0.54]	0.69[0.61,0.77]
		Pit Latrines	154(7.1)		
	Lockable Private Room [a]		1451(87.5)	0.80[0.77,0.83]	0.93[0.87,0.96]
	Toilet Seat [a]		324(19.5)	0.07[0.05,0.09]	0.05[0.03,0.09]
	Safety Handrails [b]		248(76.5)	0.60[0.51,0.69]	0.70[0.50,0.85]
	Emergency Call Button [a]		129(7.8)	0.02[0.01,0.03]	0.05[0.02,0.13]
	Trash Bin [a]		1293(77.9)	0.69[0.66,0.73]	0.79[0.70,0.85]
	Toilet Bowl with Residual Waste [a]		214(12.9)	0.15[0.13,0.18]	0.03[0.02,0.05]
	Noticeable Odor [a]		354(21.3)	0.22[0.19,0.25]	0.11[0.06,0.17]
	Presence of Flies [a]		160(9.6)	0.13[0.11,0.16]	0.05[0.02,0.12]
	Trash on the Toilet Floor [a]		193(11.6)	0.13[0.10,0.15]	0.06[0.03,0.13]
	Foreign Objects on Walls [a]		168(10.1)	0.13[0.10,0.15]	0.12[0.04,0.28]
	Standing Water on the Floor [a]		327(19.7)	0.19[0.16,0.22]	0.23[0.14,0.36]
Hygiene	Handwashing Sink-Toilet [a]		1314(79.2)	0.68[0.64,0.71]	0.79[0.65,0.88]
	Automatic Handwashing Facility [c]		330(25.1)	0.15[0.12,0.18]	0.18[0.11,0.28]
	Handwashing Supplies [c]		523(39.8)	0.37[0.33,0.41]	0.54[0.44,0.64]
	Handwashing Sink-Examination Room		1087(50.8)	0.28[0.25,0.30]	0.44[0.35,0.53]
	Hand Sanitizer		1484(69.3)	0.53[0.50,0.56]	0.61[0.52,0.69]
Water	Safe Water Supply Equipment		2032(95.0)	0.94[0.93,0.95]	0.95[0.91,0.98]
Waste management	Medical Waste Bin		1335(62.4)	0.49[0.46,0.52]	0.64[0.55,0.71]
	General Waste Bin		1762(82.4)	0.77[0.75,0.80]	0.86[0.80,0.91]
Environmental cleaning	Trash on the Examination Room Floor		52(2.4)	0.03[0.02,0.04]	0.04[0.01,0.10]
	Overflowing Waste Bins		39(1.8)	0.02[0.01,0.03]	0.04[0.01,0.10]

[a]The denominator is the number of "Toilet for patients"

[b]The denominator is the number of "Toilet seat"

[c]The denominator is the number of "Handwashing sink – Toilet"

rates around 10%. Handwashing facilities are also inadequate, with only 39.8% (95% CI: 37.2-42.5%) of toilets providing handwashing supplies. In terms of water safety, most healthcare institutions have installed tap water system (95%, 95% CI: 94.1-95.9%). The provision of medical waste bins and general waste bins in examination rooms ranges between 60% and 85% (62.4%, 95% CI: 60.4-64.5%; 82.4%, 95% CI: 80.8-84%). The occurrence of waste in the examination rooms is below 5% (Table 1).

Weighted by the service population of healthcare institutions, the availability of toilets for patients and handwashing sinks shows significant regional variation. The

southern region, for instance, has a higher concentration of facilities with full coverage (100%, blue dots), whereas the northeastern region contains a larger proportion of facilities entirely lacking such amenities (0%, red dots) (Fig. 2).

Disparities in sanitary facilities across different domains of primary healthcare institutions

In terms of the provision of specific sanitary facilities, public healthcare institutions have notably higher percentages for indicators such as toilet for patients (82%), handwashing sinks in examination rooms (57.1%),and some supporting facilities, like handrails (79.8%) and toilet seats (21.2%) compared to private institutions. However, private institutions outperform in areas such as flush toilet (92.2%) and lockable private room (90.5%). Urban institutions generally perform better than rural ones (P<0.001). Higher-tier institutions also tend to have better sanitary facilities (Attachment 3, Fig. 1–3).

Regarding the quality of toilet facilities, private hospitals generally report higher quality (7.0%, 15.1%, 6.3%, 8.8% vs. 14.8%, 23.3%, 10.7%, 12.5%; P<0.05). The sanitary conditions in urban areas are also significantly better than in rural ones (P<0.001). However, there is no significant difference in adverse event rates between clinic-level and center-level primary healthcare institutions (P>0.05) (Table 2).

After consolidating the visit counts for the same primary healthcare institution, changes are observed in several indicators. The disparities between public and private institutions for indicators such as "Toilet for Patients" and "Medical Waste Bin" shift from significant to insignificant. Conversely, differences in "Trash Bin", "Handwashing Sink-Toilet". and "General Waste Bin" change from insignificant to significant. In comparing urban and rural areas, only the "Safe Water Supply Equipment" shift from insignificant to significant, while other indicators remained unchanged. Among three-level healthcare institutions, the differences in "Safety Handrails", "Handwashing Supplies", and "General Waste Bin" change from significant to insignificant, while "Safe Water Supply Equipment" shift from insignificant to significant (Table 3).

Discussion

Our study employed the JMP standards to assess sanitary facilities in primary healthcare institutions. Key findings indicate that while the majority of institutions provide toilets, critical components such as hand hygiene facilities and age-appropriate equipment remain inadequate addressed. Regional disparities in sanitation facilities highlight the influence of socioeconomic, geographic, and policy-driven factors. And the provision of sanitation facilities is marginally better in hospital-level institutions, public primary healthcare institutions, and urban settings. This section further interprets the findings and compares them with global benchmarks to provide evidence-based references for policy interventions and improvements.

Domestic analysis: sanitation facilities in China

Toilet revolution in primary healthcare institutions

Our findings indicate that the *Availability* of toilets for patient use in China is 77.5%. However, 7.1% of these toilets remain pit latrines without proper fecal disposal systems, representing a significant gap in sanitation services. This shortfall creates environments conducive to mosquitoes and flies, heightening the risk of diseases such as dysentery and hepatitis A [5].

Accessibility-related facilities, such as toilet seats, call buttons, and safety handrails – are relatively better, yet remain insufficient. Culture habits also influence this issue: in China, squat toilets are more prevalent, and despite the fact that seated toilets are

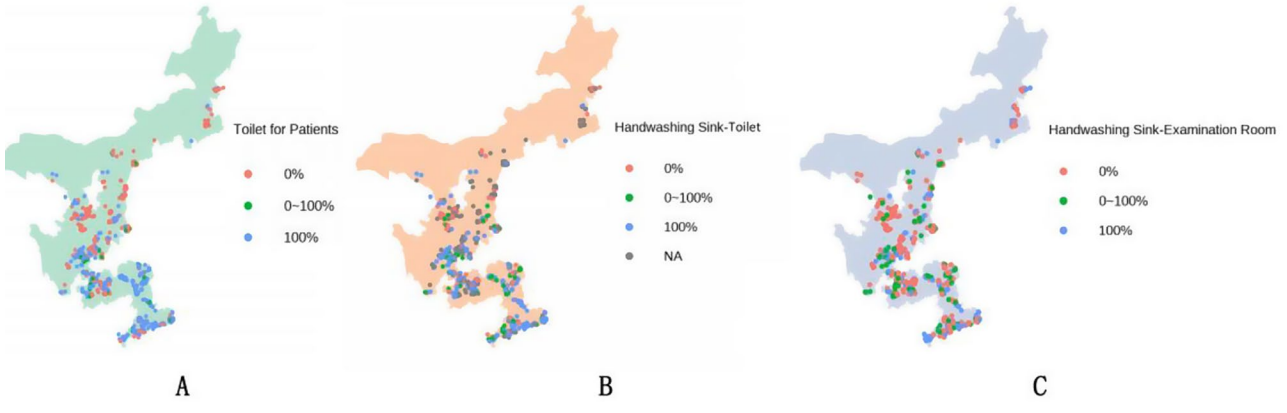

Fig. 2 Geographical Distribution of Key Indicators. **A**, **B**, and **C** illustrate the population-weighted distribution of three key sanitation facilities across seven provinces in China: "toilets for patients", "handwashing sinks in toilet", and "handwashing sinks in examination rooms". The distribution within the region is categorized by availability in healthcare facilities as 0% (red), 0–100% (green), and 100% (blue)

Table 2 Disparities in sanitary facilities of primary healthcare institutions in China across various domains (unit:visits counts)*

Indicator	Public Healthcare Institutions [n(%)]	Privacy Healthcare Institutions [n(%)]	χ^2	*P*	Urban Healthcare Institutions [n(%)]	Rural Healthcare Institutions [n(%)]	χ^2	*P*	Clinic-level Healthcare Institutions [n(%)]	Center-level Healthcare Institutions [n(%)]	Hospital-level Healthcare Institutions [n(%)]	χ^2	*P*
Visits	1537(71.9)	602(28.1)	-	-	609(28.5)	1530(71.5)	-	-	976(45.6)	506(23.7)	657(30.7)	-	-
Toilet for Patients	1261（82.0）	398（66.1）	63.070	<0.001	556（91.3）	1103（72.1）	92.319	<0.001	515(52.8)[a]	490(96.8)[b]	654(99.5)[c]	635.189	<0.001
Flush Toilet	1901(86.5)	366(92.2)	8.376	0.004	547（98.4）	958（86.9）	58.330	<0.001	410(79.6)[a]	443(90.4)[b]	652(99.7)[c]	138.068	<0.001
Lockable Private Room	1901(86.5)	360(90.5)	4.269	0.039	538（96.8）	913（82.8）	65.963	<0.001	418(81.2)[a]	419(85.5)[a]	614(93.9)[b]	44.920	<0.001
Toilet Seat	267(21.2)	57(14.3)	9.038	0.003	170（30.6）	154（14.0）	64.923	<0.001	20(3.9)[a]	60(12.2)[b]	224(37.3)[c]	228.311	<0.001
Safety Handrails	213(79.8)	35(61.4)	8.830	0.003	136（80.0）	112（72.7）	2.380	0.123	7(35.0)[a]	40(66.7)[b]	201(82.4)[c]	27.109	<0.001
Emergency Call Button	123(9.8)	6(1.5)	28.689	<0.001	74（13.3）	55（5.0）	35.708	<0.001	2(0.4)[a]	15(3.1)[b]	112(17.1)[c]	134.102	<0.001
Trash Bin	986(78.2)	307(77.1)	0.196	0.658	475（85.4）	818（74.2）	27.308	<0.001	341(66.2)[a]	385(78.6)[b]	567(86.7)[c]	70.469	<0.001
Toilet Bowl with Residual Waste	186(14.8)	28(7.0)	16..026	<0.001	34（6.1）	180（16.3）	34.258	<0.001	77(15.0)[a]	71(14.5)[a]	55(8.6)[b]	13.883	<0.001
Noticeable Odor	294(23.3)	60(15.1)	12.236	<0.001	63(11.3)	291(26.4)	49.894	<0.001	114(22.1)[a]	128(26.1)[a]	112(17.1)[b]	13.792	0.001
Presence of Flies	135（10.7）	25（6.3）	6.796	0.009	17(3.1)	143(13.0)	41.636	<0.001	71(13.8)[a]	61(12.4)[a]	28(4.3)[b]	36.148	<0.001
Trash on the Toilet Floor	158（12.5）	35（8.8）	4.107	0.043	33(5.9)	160(14.5)	26.414	<0.001	64(12.4)	63(12.9)	66(10.1)	2.541	0.281
Foreign Objects on Walls	138（10.9）	30（7.5）	3.856	0.050	23(4.1)	145(13.7)	32.968	<0.001	65(12.6)[a]	60(12.2)[a]	43(6.6)[b]	15.002	<0.001
Standing Water on the Floor	240（19.0）	87（21.9）	1.527	0.216	83(14.9)	244(22.1)	12.087	<0.001	117(22.7)[a]	116(23.7)[a]	94(14.4)[b]	19.580	<0.001
Handwashing Sink- Toilet	989（78.4）	325（81.7）	1.914	0.166	513(92.3)	801(72.6)	86.623	<0.001	335(65.0)[a]	369(75.3)[b]	610(93.3)[c]	145.755	<0.001
Automatic Handwashing Facility	278（28.1）	52（16.0）	19.072	<0.001	189(36.8)	141(17.6)	61.547	<0.001	49(14.6)[a]	58(15.7)[a]	223(36.6)[b]	79.385	<0.001
Handwashing Supplies	377(38.1)	146(44.9)	4.726	0.030	234(45.6)	289(36.1)	11.864	<0.001	154(46.0)[b]	113(30.6)[a]	256(42.0)[b]	19.488	<0.001
Handwashing Sink-Examination Room	878(57.1)	209(34.7)	86.894	<0.001	404(66.3)	683(44.6)	82.055	<0.001	201(20.6)[a]	322(63.6)[b]	564(85.8)[c]	712.490	<0.001
Hand Sanitizer	1145(74.5)	339(56.3)	67.322	<0.001	500(82.1)	984(64.3)	64.879	<0.001	462(47.3)[a]	413(81.6)[b]	609(92.7)[c]	427.020	<0.001
Safe Water Supply Equipment	1463(95.2)	569(94.5)	0.405	0.524	577(94.7)	1455(95.1)	0.114	0.736	917(94.0)	485(95.8)	630(95.9)	4.108	0.128
Medical Waste Bin	1017(66.2)	318(52.8)	32.833	<0.001	455(74.7)	880(57.5)	59.910	<0.001	459(47.0)[a]	363(71.7)[b]	513(78.1)[c]	185.988	<0.001
General Waste Bin	1274(82.9)	488(81.1)	0.993	0.319	537(88.2)	1225(80.1)	19.744	<0.001	743(76.1)[a]	428(84.6)[b]	591(90.0)[c]	53.940	<0.001
Trash on the Examination Room Floor	35(2.3)	17(3.8)	0.545	0.460	12(2.0)	40(2.6)	0.762	0.383	25(2.6)[b]	5(1.0)[a]	22(3.3)[b]	6.843	0.033
Overflowing Waste Bins	27(1.8)	12(2.0)	0.135	0.713	13(2.1)	26(1.7)	0.461	0.497	15(1.5)[a]	4(0.8)[a]	20(3.0)[b]	8.933	0.011

Note: 1. χ^2:Chi-square test statistic; P:P-value.

2.Among the three levels, different superscript letters ([a],[b],[c]) indicate statistically significant differences between groups, based on chi-square test with post hoc comparisons.

3.Green background indicates physical infrastructure; blue background indicates sanitation environment.

more elderly-friendly, squat toilets remain the predominant option. With the aging population accelerating, the elderly made up a significant proportion of healthcare users [16], enhancing the accessibility of sanitary facilities is crucial. In terms of *Acceptability*, primary healthcare institutions have made notable progress, with approximately 87.5% of toilets being standalone units that ensure user privacy.

In terms of *Quality*, primary healthcare institutions are generally satisfactory, but there is still room for improvement. Poor toilet conditions, such as stains and odors, present potential health risks [17], as minor quality issues are often linked to infection risks.

These findings indicate that the *availability* of sanitary toilet has improved compared to 2018, with significant progress since 2012, driven by the Toilet Revolution [18]. Increased government investment in the environmental sanitation of primary healthcare institutions, especially township health centers, has helped narrow the urban-rural gap. While rural ares still lag slightly behind cities, the overall difference is not substantial.

Comparison between public and privacy healthcare institutions

From the perspective of visit counts, sanitation facilities in private primary healthcare institutions are generally less available. In some private clinics, toilet facilities are exclusively designated for healthcare personnel, and disparities also exist in the general availability of hygiene facilities. This may be because private healthcare institutions in China, especially at the primary level, are not necessarily associated with high-end healthcare but often offer affordable services. In contrast, public hospitals dominate the Chinese healthcare system, benefiting from substantial financial support. Particularly concerning is the inadequate attention given to the sanitary facilities within examination rooms, the lack of hand hygiene management among healthcare workers in non-infection control-focused departments—a findings corroborated by other studies [19]—and the handling of medical waste.

However, when considering healthcare institutions as units, no significant disparity exists between public and private hospitals in terms of patient-accessible toilets. In fact, private institutions even outperform public ones in areas such as the provision of trash bins and handwashing sinks. Based on regular observations, this discrepancy may stem from poor facility maintenance in public healthcare institutions after initial installation, leading to issues of disrepair or non-functionality. As a result, information inconsistencies reported by investigators within the same healthcare institution may widen.

The probability of encountering sanitation quality issues in public primary healthcare institutions is nearly double that of private institutions. According to the "Yearbook" statistics, public hospitals manage five times the number of patients compared to private hospitals.

Table 3 Disparities in sanitary facilities of primary healthcare institutions in China across various domains (unit:healthcare institutions)*

Indicator	Public Healthcare Institutions [Median±IQR]	Privacy Healthcare Institutions [Median±IQR]	*U*	*P*	Urban Healthcare Institutions [Median±IQR]	Rural Healthcare Institutions [Median±IQR]	*U*	*P*	Clinic-level Healthcare Institutions [Median±IQR]	Center-level Healthcare Institutions [Median±IQR]	Hospital-level Healthcare Institutions [Median±IQR]	*H*	*P*
Toilet for Patients	50.00 (0.00,100.00)	100.00 (0.00,100.00)	157414.000	0.251	100.00 (100.00,100.00)	0.00 (0.00,100.00)	74579.000	<0.001	0.00 (0.00,100.00)	100.00 (75.00,100.00)	100.00 (100.00,100.00)	154.571	<0.001
Lockable Private Room	100.00 (74.43,100.00)	100.00 (100.00,100.00)	55440.500	<0.001	100.00 (100.00,100.00)	100.00 (73.85,100.00)	42903.500	<0.001	100.00 (100.00,100.0)	100.00 (61.68,100.00）	100.00 (100.00,100.00)	9.630	0.008
Toilet Seat	0.00 (0.00,0.00)	0.00 (0.00,0.00)	59015.000	0.002	0.00 (0.00,4.80)	0.00 (0.00,0.00)	46073.000	<0.001	0.00 (0.00,0.00)	0.00 (0.00,11.05)	16.70 (0.00,50.00)	168.352	<0.001
Safety Handrails	100.00 (0.00,100.00)	0.00 (0.00,100.00)	807.000	0.009	81.80 (0.00,100.00)	100.00 (0.00,100.00)	1476.000	0.562	0.00 (0.00,100.00)	100.00 (0.00,100.00)	87.80 (0.75,100.00)	5.412	0.067
Emergency Call Button	0.00 (0.00,0.00)	0.00 (0.00,0.00)	61326.500	0.003	0.00 (0.00,0.00)	0.00 (0.00,0.00)	49113.500	<0.001	0.00 (0.00,0.00)	0.00 (0.00,0.00)	0.00 (0.00,13.53)	125.594	<0.001
Trash Bin	100.00 (0.00,100.00)	100.00 (0.00,100.00)	55931.000	<0.001	83.30 (0.00,100.00)	100.00 (0.00100.00)	44310.500	<0.001	100.00 (0.00,100.00)	100.00 (57.10,100.00)	95.45 (80.00,100.00)	0.061	0.970
Toilet Bowl with Residual Waste	0.00 (0.00,18.80)	0.00 (0.00,0.00)	53140.500	<0.001	0.00 (0.00,0.00)	0.00 (0.00,6.75)	44380.500	<0.001	0.00 (0.00,0.00)	0.00 (0.00,35.10)	0.00 (0.00,12.90)	16.494	<0.001
Noticeable Odor	0.00 (0.00,57.83)	0.00 (0.00,0.00)	52771.000	<0.001	0.00 (0.00,0.00)	0.00 (0.00,100.00)	42837.500	<0.001	0.00 (0.00,0.00)	10.50 (0.00,59.28)	0.00 (0.00,27.53)	29.463	<0.001
Presence of Flies	0.00 (0.00,0.00)	0.00 (0.00,0.00)	54795.000	<0.001	0.00 (0.00,0.00)	0.00 (0.00,0.00)	44472.500	<0.001	0.00 (0.00,0.00)	0.00 (0.00,31.23)	0.00 (0.00,0.00)	16.972	<0.001
Trash on the Toilet Floor	0.00 (0.00,0.00)	0.00 (0.00,0.00)	57533.500	<0.001	0.00 （0.00,0.00)	0.00 (0.00,0.00)	46754.500	<0.001	0.00 (0.00,0.0)）	0.00 (0.00,33.30)	0.00 (0.00,12.25)	27.720	<0.001
Foreign Objects on Walls	0.00 (0.00,0.00)	0.00 (0.00,0.00)	57185.500	<0.001	0.00 (0.00,0.00)	0.00 (0.00,0.00)	47058.000	<0.001	0.00 (0.00,0.0)）	0.00 (0.00,31.23)	0.00 (0.00,3.38)	21.409	<0.001
Standing Water on the Floor	0.00 (0.00,25.00)	0.00 (0.00,100.00)	62078,000	0.273	0.00 (0.00,15.70)	0.00 (0.00,33.3)	50826.500	<0.001	0.00 (0.00,0.0)）	0.00 (0.00,40.00)	0.00 (0.00,20.00)	10.522	0.005
Handwashing Sink-Toilet	100.00 (0.00,100.00)	100.00 (81.28,100.00)	54591.000	<0.001	100.00 (100.00,100.00)	100.00 (0.00,100.00)	38750.500	<0.001	100.00 (0.00,100.0)）	100.00 (42.50,100.00)	100.00 (100.00,100.00)	15.813	<0.001
Automatic Handwashing Facility	0.00 (0.00,25.00)	0.00 (0.00,0.00)	30745.000	0.014	0.00 （0.00，33.30)	0.00 (0.00,0.00)	26609.500	<0.001	0.00 (0.00,0.00)	0.00 (0.00,20.00)	22.05 (0.00,44.68)	48.965	<0.001
Handwashing Supplies	0.00 (0.00,92.5)	33.3 (0.00,100.00)	29940.500	0.011	50.00 (0.00,100.00)	0.00 (0.00,100.00)	24540.000	<0.001	0.00 (0.00,100.00)	12.50 (0.00,50.00)	31.00 (0.00,63.08)	4.373	0.112
Handwashing Sink-Examination Room	0.00 (0.00,95.4)	0.00 (0.00,50.00)	150440.000	0.007	33.30 (0.00,50.00)	0.00 (0.00,50.00)	87480.500	<0.001	0.00 (0.00,0.00)	60.00 (0.00,100.00)	94.90 (66.70,100.00)	220.313	<0.001
Hand Sanitizer	100.00 (0.00,100.00)	50.00 (0.00,100.00)	151233.000	0.018	100.00 (0.00,100.00)	66.70 (0.00,100.00)	96824.000	<0.001	0.00 (0.00,100.00)	100.00 (50.00,100.00)	100.00 (83.30,100.00)	66.686	<0.001
Safe Water Supply Equipment	100.00 (100.00,100.00)	100.00 (100.00,100.00)	159714.500	0.214	100.00 (100.00,100.00)	100.00 (100.00,100.00)	107254.000	0.038	100.00 (100.00,100.0)	100.00 (100.00,100.0)	100.00 (100.00,100.00)	27.314	<0.001
Medical Waste Bin	66.7 (0.00,100.00)	29.15 (0.00,100.00)	155125.000	0.118	100.00 (0.00,100.00）	50.00 (0.00,100.00)	95441.500	<0.001	0.00 (0.00,100.00)	100.00 (37.50,100.00)	83.30 (50.00,100.00)	30.147	<0.001
General Waste Bin	100.00 (66.70,100.00)	100.00 (100.00,100.00)	152428.500	0.015	100.00 (100.00,100.00)	100.00 (61.25,100,0)	100938.000	<0.003	100.00 (66.78,100.00)	100.00 (66.70,100.00)	100.00 (85.70,100.00)	1.276	0.528
Trash on the Examination Room Floor	0.00 (0.00,0.00)	0.00 (0.00,0.00)	161986.500	0.567	0.00 (0.00，0.00)	0.00 (0.00,0.00)	110740.000	0.461	0.00 (0.00,0.00)	0.00 (0.00,0.00)	0.00 (0.00，0.00)	45.617	<0.001
Overflowing Waste Bins	0.00 (0.00,0.00)	0.00 (0.00,0.00)	162039.000	0.556	0.00 (0.00,0.00)	0.00 (0.00,0.00)	110477.000	0.331	0.00 (0.00,0.00)	0.00 (0.00,0.00)	0.00 (0.00，0.00)	58.796	<0.001

Note:1.U:Mann-Whitney U test statistic; H: Kruskal-Wallis test statistic; P:P-value.

2.Green background indicates physical infrastructure; blue background indicates sanitation environment.

Public hospitals contend with factors such as higher patient volumes and varying patient behavior [20]. Conversely, private primary healthcare institutions may prioritize patient experience and maintain higher standard of cleanliness in their healthcare environments [21].

International comparison: China and the global context

The JMP report estimated that in 2023, 81% of healthcare institutions had usable sanitation facilities (available, functional and private) [9]. China is close to the global standard, but *availability* remains insufficient, particularly in terms of *accessibility* and the *quality* of supporting facilities. However, as an upper-middle-income country, China has a significantly higher sanitation coverage rate compared to the average of other countries (53.93%) [2]. In contrast, Sub-Saharan Africa needs to focus more on sanitation issues, with only 13% of institutions having basic sanitation facilities and 20% still experiencing open defecation [2]. While pit latrines are often considered a cost-effective sanitation solution in low-income countries [22], it is recommended that flush toilets or retrofitted alternatives be used to better contain pathogens [23].

In 2022, 57% of healthcare institutions globally had basic hygiene service [9]. China's situation is similar

(78.4% of toilets had sinks, and 58.1% of examination room had sinks), However, the functionality of automatic handwashing facilities and handwashing supplies, especially in toilets, is somewhat lacking. In the least developed countries, access to basic hygiene services drop to 32%. Hand hygiene facilities are a crucial strategy for reducing HAIs [24], but their availability is not ideal.

The JMP report also shows that 78% of healthcare institutions globally had access to basic water supply [9]. China's water supply coverage rate (95%) is significantly higher than the global average.

Recommendation

China has made notable progress in improving sanitation facilities though some challenges remain. Recommendations for sanitation infrastructure improvements at both the regulatory and implementation levels are necessary, and even developed nations require enhancements [25]. One key challenge is addressing the conceptual gaps that persist among relevant departments. In response to societal changes, these department should provide clear guidance and make adjustments to critical hardware, such as the number and placement of facilities, to ensure they meet evolving needs. To achieve sustained improvements, continuous monitoring, community engagement, and sustained funding are essential.

The following integrated recommendations aim to enhance sanitation facility quality: (1) Increased funding and resources should be allocated strategically. For example, increase funding and resources for rural healthcare institutions, focusing on facilities upgrades and regular maintenance. This should include guidance on adjusting hardware elements, such as emergency call buttons and toilet seats, to meet current needs. (2) Implement routine hygiene audits and maintenance schedules, incorporating regular sanitation inspections as part of daily operations. Adequate staffing should be allocated to ensure thorough cleanliness and functionality of the facilities. (3) Establish awareness and training programs for healthcare workers and the public to emphasize the importance of sanitation. This would foster an understanding of why maintaining cleanliness in primary healthcare institutions is critical for public health and improve the practical management of sanitary conditions.

Strengths and limitations

To the best of our knowledge, this study is the first to describe the status of sanitary facilities in primary healthcare institutions in China. Official health statistics also lack detailed disclosures regarding these facilities. Due to the multicenter, multistage sampling method employed in this study, along with data collection by systematically trained USPs, enhances the reliability and scientific rigor of the data.

This study has the following limitations: (1) The ACACIA project primarily focuses on the quality of physician services, with clinical doctors as the target population. The selection of healthcare institutions may be subject to bias, as the number of doctors in each institutions was used as a sampling criterion, potentially leading to overrepresentation of larger institutions. (2) The standards for drinking water include monitoring requirements for microbiology and toxicity. However, due to data collection limitations, this study could not access relevant information, resulting in a relatively limited assessment of safe water domain. (3) Seasonal variation in patient volume may influence sanitation conditions in healthcare institutions, potentially introducing bias in environmental assessments. Although visit dates were recorded during data collection, the non-standardized format of this information limited the ability to control for seasonal effects in the analysis. Nevertheless, data for the ACACIA project were collected continuously throughout the year across seven provinces, with USPs randomly assigned to institutions regardless of season. This design helps to reduce the risk of systematic seasonal bias. However, the potential influence of seasonal variation should still be considered when interpreting the findings. (4) This study is cross-sectional, which limits the strength of causal inference. While it identifies differences in sanitary facilities across institutions, it does not fully explore the underlying mechanisms driving these disparities. Further analysis of the barriers and facilitators to sanitary facility construction and the development of targeted intervention measures are needed to promote the standardization of sanitary facilities in primary healthcare institutions.

Conclusion

In summary, this study highlights the critical importance of adequate sanitation facilities in primary healthcare institutions for ensuring patient safety and quality healthcare delivery. While national reports on sanitary facilities in China's primary healthcare institutions are limited, recent policy initiatives have led to some improvements. However, significant gaps remain, particularly in the provision of essential sanitary facilities and the maintenance of hygiene standards. As China continues to advance its WASH infrastructure, the lessons learned can inform global strategies and contribute to the achievement of international health goals. Policymakers, healthcare providers, and international organizations must prioritize WASH improvements in primary healthcare settings to ensure patient equitable access to safe healthcare environments, and enhance patient satisfaction with their healthcare experiences [26].

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions
Zizhen Huang and Wenjun He conceived the study concept and defined the paper's objectives. Wenjun He also provided statistical expertise, prepared Fig. 2, and contributed to the study design. Qing Zhao, Wenjun He, Zhang Lanping, and Zizhen Huang participated in and supported the implementation of the ACACIA project. Zizhen Huang and Duqiao Li conducted the data analysis. Zizhen Huang wrote the initial drafts, which were revised with inputs from Qing-Qing Li, Lanping Zhang, and Dong (Roman) Xu. Roman provided the overall study concept and guided the exposition. All authors reviewed and approved the final version of the manuscript.

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Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study received ethical approval from the Ethics Committee of the School of Public Health, Sun Yat-sen University (Ethics Approval [2017] No.011 and Ethics Approval [2019] No.024). The USPs in this study were solely as data collectors and signed an informed consent agreement, outlining the study requirements and associated rights and obligations. Informed consent was waived for the surveyed healthcare institutions for the following reasons: (1) the study focused on sanitation facilities and did not involve direct interaction with human participants or collection of personal data; (2) requiring informed consent from institutions could have led to selection bias and a higher risk of detecting the SP; and (3) the study did not intend to identify or expose any institution or individual, and all analyses will be conducted at the broader health system level. The study complies with national ethical standards and the Helsinki Declaration.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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