Supporting and retaining competent primary care workforce in low-resource settings: lessons learned from a prospective cohort study

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ABSTRACT
Objective Assess whether local health facilities can adequately support the performance of general practitioners (GPs) trained by China’s national compulsory services programme (CSP).
Design Prospective cohort study.
Setting Health facilities in middle and western rural areas in China, 2015–2022.
Participants Cohorts of CSP graduates from 2015 to 2019 in four major medical universities.
Main outcomes Job performance measured by a 12-item Job Performance Scale; productivity measured by outpatient volume per day; turnover measured by ever changing jobs within the past year.
Results 91.2%, 92.0% and 90.5% GPs working in township health centres reported inadequate medication, equipment and external assistance from higher level hospitals, while CSP graduates working in secondary or tertiary hospitals reported a lower rate of less than 60%. The top three tests reported as lacking were blood gases (67.7%), microbiology (61.6%) and cancer biomarkers (49.7%); the top three lacked procedures were CT scan (64.8%), MRI scan (58.1%) and ambulatory BP monitoring (55.8%); and the top three lacked drugs were drugs for hypertension (64.8%), MRI scan (58.1%) and ambulatory BP monitoring (55.8%).
Conclusions The top three tests reported as lacking were blood gases, microbiology and cancer biomarkers. The top three lacked procedures were CT scan, MRI scan and ambulatory BP monitoring. The top three lack of drugs were drugs for hypertension, MRI scan and ambulatory BP monitoring.

WHAT IS ALREADY KNOWN ON THIS TOPIC
⇒ China’s national compulsory services programme has successfully provided more qualified general practitioners (GPs) to underserved rural areas. It is not known whether local health facilities can offer sufficient support for these GPs and how such facility support will influence these GPs.

WHAT THIS STUDY ADDS
⇒ GPs that graduated from CSP experienced a high prevalence of shortage in facility support, including medication, equipment and external assistance from other hospitals. Facility support was significantly associated with job performance and productivity.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY
⇒ Facility support must be improved to achieve better performance, higher productivity and higher retention of GPs in rural and remote areas.

INTRODUCTION
Competent health workforce is the cornerstone of any health system to provide high-quality healthcare services. Effective universal health coverage is dependent on an adequate, competent and well-performing primary healthcare (PHC) workforce.1 However, PHC in low-and-middle income health systems is often lacking qualified health workers. Optimising performance and quality of health workforce is the first objective of global strategy on human resources for health.2

China has established a notable PHC system in the early 1950s, substantially reducing infectious, neonatal and maternal diseases burden, and was proposed as a successful case in the Declaration of Alma-Ata in 1978. 3 However, this system nearly broke down after the market-oriented social economic reform nationwide. PHC workforce lost their institutional and financial support. They had to become private practitioners and earn...
income by treatment of a single disease, leading to negligence of public health services that brought no economic profit. Widening inequalities, surging costs and poor access led to widespread social problems. Since 2009, China launched a new round of health system reform, and one of the major goals was to enhance PHC system. The government injected more funding to PHC facilities, increasing by 354% from 2009 to 2018. The total number of equipment at or above 10 000 CNY (about US$1380) in PHC facilities also increased by 189% during this period.

In 2010, the WHO recommended key interventions to attract health workers to rural, isolated or underserved areas, and updated the guideline in 2021. One of the major strategies recommended is targeted education admission policy. Countries have localised WHO recommendations and explored strategies to recruit and retain health workers. For example, Sri Lanka, Thailand, Vietnam and China all issued national policies to implement compulsory services programmes (CSP) that include compulsory service in a rural areas, with financial, professional and personal compensation. In 2010, China started to implement a national CSP that aims to provide qualified general practitioners (GPs) for rural areas in low-resource central and western areas. Medical universities mainly recruit students from rural backgrounds. A compensation package is offered, including rendering a lower admission score in national university entrance exam, waiving tuition fees, offering subsidies at school, and so on. On matriculation, students need to sign contracts with local health administrations and universities, committing to practice in assigned township health centres in rural areas for 6 years. After graduation, students should fulfil their contracts. They will be offered permanent public service posts (bianzhi) and a faster promotion path.

Adequate facility resources are cardinal to achieve employees’ performance. The job demands resources model in psychology emphasised that job resources are ‘functional in achieving work goals’ and will ‘stimulate personal growth, learning and development’. Job performance refers to the ‘aggregated value to the organisation of discrete behaviour episodes that an individual performs over a standard interval of time’. The definition for health worker performance has been adapted to encompass availability, clinical competence, responsiveness and productivity. Poor PHC worker performance can lead to low patient satisfaction, low use of PHC services and bypassing PHC facilities to use expensive secondary or tertiary care. A survey covering 17 provinces in China found that poor capacity and skills of PHC workers (31.7%), inadequate drugs (19.7%) and poor equipment (19.7%) were the top three reasons patients bypassed PHC facilities. The job performance framework published by WHO in 2006 summarised that suboptimal performance can be attributed to individual-level factors (such as living areas or work experience), facility support (such as availability of equipment, drugs and supplies) or system-level factors (such as financing scheme or health workforce planning and deployment). Facility support is an overarching concept that includes availability of equipment and supplies, supervision, evaluation, communication and so on. For low-resource settings, necessary equipment and medical supplies are preconditions to provide healthcare services.

China’s CSP has provided more than 5000 GPs for middle and western rural areas. Some provinces also launched similar CSP programmes within province or prefecture. As of 2022, China’s CSP has recruited students for 12 years. Early results have shown that CSP graduates have demonstrated good job performance, exhibiting the capacity to provide high-quality care for local populations. Staffing rural areas with GPs is just the beginning; the next crucial step is to ensure that these GPs are able to work effectively and sustainably. It is vital to strengthen the capacity of healthcare facilities by guaranteeing the availability of medical supplies and providing other necessary support at the facility level to improve their performance. However, studies and policies have mainly focused on recruiting health workers for rural areas without evaluating the support provided by local healthcare facilities for these GPs.

This study aims to address the knowledge gaps in support provided by health facilities for young GPs who have been trained by China’s national CSP. By incorporating performance theories from psychology and the health human resources field, this study aims to answer the following research questions: (1) Can low-resource areas offer sufficient support and retain young GPs trained by the CSP? (2) How does facility support influence the performance, productivity and retention of young GPs? The findings of this study will contribute to knowledge on enhancing support for young GPs in the future, ultimately leading to improvements in their performance, productivity and retention.

METHODS
Study design and population
The Cohort Study of Medical Graduates with Compulsory Services in Rural Areas Studies aims to investigate the medical study, residency training, employment and career development for medical graduates. The study was launched in 2015 and has established five subcohorts in four medical universities in three middle and western provinces in China. The three provinces, Guangxi, Jiangxi and Qinghai, are all below the national average level in GDP and household consumption (online supplemental appendix, table A1). We established the first subcohort in 2015 medical graduates, and then established another four subcohorts in 2016, 2017, 2018 and 2019 graduates. All CSP classes in the four universities were included in the baseline, and the participation rate was 100% at recruitment. CSP classes were matched with corresponding same-year non-CSP classes at 1:1 ratio. The study included 3620 baseline participants. After baseline, we conducted online follow-up surveys annually. Detailed
study design has been published elsewhere. Till 2022, we have completed six follow-up surveys for 2015 graduates (online supplemental figure A1).

Since 2021 wave, we added questions on how health workers perceive their availability of medication, equipment and external assistance from other hospitals. We asked participants to assess whether the medication and external assistance from other hospitals was adequate. Those who rated six or seven for each question were identified as ‘adequate facility support’ and were coded as ‘1’, otherwise coded as ‘0’. Summarising the first two ratings together and the other together is a common strategy to allow for simple interpretability of the results for data in 5-point or 7-point Likert Scale. To examine the results’ sensitivity to explanatory variables’ definition, we also performed additional analyses using different methods: (1) those who rated 5, 6, or 7 for each question were identified as ‘adequate facility support’ and was coded as ‘1’, otherwise coded as ‘0’; (2) those whose rating for each question above the mean of that question were coded as ‘1’, otherwise coded as ‘0’.

Outcome variables
Three main outcome variables were employed. First, job performance was measured by the 12-item Job Performance Scale measured by 7-point Likert Scale. All respondents who were currently working were asked to rate their job performance. Studies on human capital and psychology have provided well-established conceptual knowledge on defining and measuring job performance. Job performance is generally measured from task and context perspectives. Literature and practice have also emphasised the importance of employee’s learning capability in recent years. The scale we adopted included measurements on all the three dimensions. This scale was developed based on widely used international job performance scale and has been localised based on China’s context. The scale has been used to measure rural health workers and GPs’ job performance, and has proved valid cultural adaptation. A doctor’s total performance score was calculated by adding the 12 items directly. The total performance score ranges from 1 (lowest job performance) to 84 (highest job performance). Detailed description of the scale can also be found elsewhere.

Second, productivity was measured by outpatient volume. All GPs who worked in public or private hospitals/township health centres/community health centres/village clinics were asked to estimate how many patients they often see a day. Third, turnover was measured by whether a doctor changed his/her job in the preceding 12 months before survey.

Control variables
The following confounding variables were controlled: gender, marital status (married, not married and other), residence before entering college (metropolitan, county, village, other), years of graduation (2015, 2016, 2017, 2018, 2019), schools (Qinghai, Guangxi, Jiujiang, Gannan). GPs in the same graduation year had similar
age, so we did not control for age to avoid perfect collinearity. A binary variable for whether a GP had formally funded positions was also controlled.

There are deep differences in structure, finance and regulation of the healthcare sector in China. Township health centres are fully covered by fiscal subsidy from the central government and local governments, while secondary and tertiary hospitals are partially covered and need to operate and finance on their own. The service portfolio in township health centres is less profitable because they need to allocate a large amount of time and resources on providing public health services, especially after China’s 2009 New Health System Reform. Therefore, we divided the analysis by the types of health facilities.

**RESULTS**

**Basic characteristics of the cohort**

In total, 2406 follow-ups (1491 CSP graduates) were included. One thousand five hundred seventy-nine non-CSP graduates were excluded; 100 CSP graduates were excluded because they were not employed or worked in companies or other non-health-related organisations; 449 CSP graduates were excluded for loss to follow-up in both the 2021 and the 2022 wave, 1 CSP graduate (two follow-ups) was excluded for missing of key variables of job performance. The 2022 wave included 915 graduates, and the 2021 wave included 1491 graduates. 52.8% were male and 48.2% were married. 69.1% lived in villages before going to college. 79.4% of CSP graduates worked in township health centres (table 1).

**Facility-level medication, equipment and external assistance availability**

In total, around 84% GPs and doctors reported a lack of facility support. GPs in township health centres had higher ratings on lack of facility support than secondary or tertiary hospitals. 91.2% GPs in township health centres reported a lack of medication, while 56.6% doctors in secondary or tertiary hospitals reported a lack of medication. 92.0% GPs in township health centres reported a lack of equipment, while 57.1% doctors reported a lack of equipment. 90.5% GPs in township health centres reported a lack of external assistance from other hospitals, while 59.6% doctors reported a lack of external assistance (figure 1).

China’s national standards requested lists of tests and procedures for township health centres in 2022. In the requested lists, 49.7% GPs reported their health facility did not have tests for cancer biomarkers, 61.6% did not have tests for microbiology and 67.7% did not have tests for blood gases; 58.1% did not have MRI scan, 64.8% did not have CT scan and 55.8% did not have ambulatory BP monitoring (online supplemental appendix, table A3). China’s national standards also requested lists of essential drugs for township health centres. 23.3% GPs reported inadequate drugs for cardiovascular diseases, 17.7% for systematic hormonal preparations and 13.0% for traditional Chinese medicines (online supplemental appendix, figure A2).

**Facility support and job performance**

Table 2 shows the unadjusted job performance score by facility support. The mean score of total job performance was 63.0 (SD=11.1). Those who reported the facility support were adequate had significantly higher job performance than their counterparts. Those who reported adequate medication had a job performance score of 65.7 (compared with 62.5 in inadequate group, p<0.001). Those who reported adequate equipment had a job performance score of 65.8 (compared with 62.5 in inadequate group, p<0.001). Those who reported adequate external assistance had a job performance...
The association between facility support and job performance remained consistent after controlling for confounders. Adequate medication and external assistance were significantly associated with higher job performance score in township health centres. The job performance score of those who rated facility support as adequate were 2.2–3.3 higher than their counterparts. Adequate medication, equipment and external assistance were significantly associated with higher job performance in higher-level hospitals (2.4–3.2 higher than inadequate groups) (figure 2).

Facility support showed different relationship with task, learn and contextual performance. The adequacy
of medication, equipment and external assistance all had significant association with task performance, increasing task performance by 0.7–1.2 (online supplemental appendix, table A4). The adequacy of external assistance had significant association with learn performance for township health centres ($\beta$=1.04, 95% CI 0.60 to 1.49, $p<0.001$) (online supplemental appendix, table A55). The adequacy of medication and external assistance was significantly associated with improved contextual,

### Table 2  Job performance score, productivity and turnover by facility support

<table>
<thead>
<tr>
<th>Facility support characteristics</th>
<th>Task performance</th>
<th>Learn performance</th>
<th>Contextual performance</th>
<th>Total job performance</th>
<th>No. of patients seen/day</th>
<th>Retention</th>
<th>Turnover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>20.9 (4.0)</td>
<td>15.8 (3.3)</td>
<td>26.3 (4.9)</td>
<td>62.97 (11.1)</td>
<td>18.0 (24.9)</td>
<td>456 (81.6%)</td>
<td>103 (18.4%)</td>
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<tr>
<td>Adequate medication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>20.7 (4.0)</td>
<td>15.7 (3.3)</td>
<td>26.1 (4.9)</td>
<td>62.5 (11.0)</td>
<td>17.3 (22.8)</td>
<td>336 (69.6%)</td>
<td>46 (44.2%)</td>
</tr>
<tr>
<td>Yes</td>
<td>22.0 (3.8)</td>
<td>16.4 (3.0)</td>
<td>27.4 (4.6)</td>
<td>65.7 (10.6)</td>
<td>22.0 (30.0)</td>
<td>153 (31.7%)</td>
<td>58 (55.8%)</td>
</tr>
<tr>
<td>P value</td>
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<td>0.003</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.004</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adequate equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>20.7 (4.0)</td>
<td>15.7 (3.2)</td>
<td>26.1 (4.9)</td>
<td>62.5 (11.0)</td>
<td>17.3 (22.8)</td>
<td>336 (69.6%)</td>
<td>46 (44.2%)</td>
</tr>
<tr>
<td>Yes</td>
<td>22.0 (4.0)</td>
<td>16.5 (3.3)</td>
<td>27.4 (4.8)</td>
<td>65.8 (11.2)</td>
<td>22.8 (34.7)</td>
<td>147 (30.4%)</td>
<td>58 (55.8%)</td>
</tr>
<tr>
<td>P value</td>
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<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.011</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Adequate external assistance</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>20.7 (4.0)</td>
<td>15.7 (3.2)</td>
<td>26.1 (4.9)</td>
<td>62.4 (11.0)</td>
<td>17.5 (24.1)</td>
<td>346 (71.6%)</td>
<td>51 (49.0%)</td>
</tr>
<tr>
<td>Yes</td>
<td>22.0 (3.9)</td>
<td>16.7 (3.1)</td>
<td>27.4 (4.7)</td>
<td>66.0 (10.9)</td>
<td>20.8 (28.9)</td>
<td>137 (28.4%)</td>
<td>53 (51.0%)</td>
</tr>
<tr>
<td>P value</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.026</td>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

(1) 2011 wave and 2022 wave were pooled for the analysis. (2) for turnover, those who were under contract were excluded. Turnover refers to turnover in the past year. (3) THC, township health centres.

### Figure 2  The association between facility support and job performance by health facilities (coefficient, 95% CI). Multiple linear regression models were used. Schools, years of graduation and survey-wave fixed effects were controlled in all regression models; gender, marital status and formally funded positions were also controlled in all regressions. The results of these confounders were not reported to relevance of interests and space limitation. Full results of the regressions can be found in online supplemental appendix, table A8. Frequency weights were accounted in all regression models.
increasing contextual performance by 0.8–1.5 (online supplemental appendix, table A6).

**Facility support and productivity**

The outpatient volume varied by facility support. Doctors that rated adequate medication saw 22.0 outpatients per day (vs 17.3 outpatients, p=0.004). Doctors who rated adequate equipment saw 22.8 outpatients per day (vs 17.3 outpatients, p=0.011). Doctors who rated adequate external assistance saw 20.8 outpatients per day (vs 17.5 outpatients, p=0.026) (table 2).

After adjusting for confounders, medication and equipment adequacy were significantly associated with outpatient volume in township health centres. GPs who rated medication as adequate saw 20% (95% CI 0.09 to 0.31, p<0.001) more outpatients per day, and those who rated equipment as adequate saw 12% more outpatients per day (95% CI 0.00 to 0.24, p=0.049). External assistance was not associated with outpatient volume. Facility support was not associated with outpatient volume in higher-level hospitals after controlling for confounders (figure 3).

**Facility support and turnover**

In doctors who changed jobs in the past year, 55.8% reported inadequate medication, 55.8% reported inadequate equipment and 51.0% reported inadequate external assistance (table 2).

After adjusting for confounders, facility support had no impact on turnover. GPs who rated medication as adequate in 2021 did not vary in turnover of 2022 (OR=2.47 (95% CI 0.56 to 10.88)). Equipment and external assistance also showed similar results (figure 4). Doctors who changed jobs in the past year were 1.86 times (95% CI 1.34 to 2.57, p<0.001) more likely to report adequate medication, 1.91 times (95% CI 1.39 to 2.63, p<0.001) more likely to report adequate equipment, and 2.25 times (95% CI 1.63 to 3.11, p<0.001) more likely to report adequate external assistance (online supplemental appendix, table A7).

Sensitivity analyses showed that the associations between facility support and outcomes were consistent under different definitions of facility support (figure 5).

**DISCUSSION**

People in LMICs often have poor access to high-quality care. Competent health workers with well-trained skills are the core to resolve this complex challenge. Starting from 2010, China’s CSP have recruited and trained competent GPs for rural and remote areas for 12 years. When these students graduate and practice in township health centres, it is important to secure the best performance, the highest productivity and least turnover from them. The wider literature in psychology and management has long recognised the importance of a supportive and favourable organisation on employees. To our knowledge, this study is the first to evaluate health facility support for doctors trained by China’s national CSP and
the relationship between facility factors and job performance, productivity and turnover.

Three findings were highlighted. First, despite staffing more competent GPs in low-resource areas, they received poor support from their facilities. More than 90% GPs reported that the medication, equipment and external assistance from outside hospitals were inadequate. Second, the availability of facility resources significantly was significantly associated with GPs’ job performance and productivity. Third, the availability of facility resources did not lead to turnover directly, but GPs perceptions on the availability of facility resources significantly improved after turnover.

Our findings are in line with global evidence. A systematic review on the performance of community health workers (CHW) identified that the availability of stocks and supplies is cardinal for enhancing performance. Over 50% CHW reported rapid diagnostic test drugs were inadequate due to malaria peak and difficulty to anticipate quantities to conduct reactive case detection, which limit their work and motivation greatly. Another systematic review analysing the effect of context on performance also pointed out the importance of adequate facility resources: health workers get frustrated when they observed sick patients not being initiated treatment due to lack of drugs. Rowe et al’s systematic review pointed out that multifaceted policies combining strengthened infrastructure (provision of medicines, equipment, information system, etc) tend to have large effects on improving performance in LMIC. The Root-Stem Model for analysing health workforce retention summarised the importance of workforce environment, including adequacy of medical supplies. Facility support is among the motivating factors for job satisfaction and retention.

Figure 4 The association between perceived facility support on turnover in township health centers (OR, 95% CI). (1) Logistic regression models were used. Schools, years of graduation and survey-wave fixed effects were controlled in all regression models; gender, marital status and formally funded positions were also controlled in all regressions. The results of these confounders were not reported to relevance of interests and space limitation. Full results of the regressions can be found in online supplemental appendix, table A10. Frequency weights were accounted in all regression models. (2) Workplace was not included in the regression models because turnover and workplace were collinear. The majority of doctors (60.1%) in township health centers who changed jobs in the past year went to higher-level hospitals.

Figure 5 Sensitivity analysis of the association between facility support and outcomes. (1) we used the first method for sensitivity analysis: those who rated 5, 6, or 7 for each question were identified as “adequate facility support” and was coded as “1”, otherwise coded as “0”. (2) we used the second method for sensitivity analysis: those whose rating for each question above the mean of that question were coded as “1”, otherwise coed as “0”.

<table>
<thead>
<tr>
<th>Health facilities</th>
<th>OR 95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Township health centers</td>
<td></td>
</tr>
<tr>
<td>Adequate medication</td>
<td>2.47 [0.56 to 10.88]</td>
</tr>
<tr>
<td>Adequate equipment</td>
<td>1.60 [0.39 to 6.50]</td>
</tr>
<tr>
<td>Adequate external assistance</td>
<td>1.97 [0.47 to 8.28]</td>
</tr>
</tbody>
</table>

Panel A: Job performance

Panel B: Productivity

Panel C: Turnover

Less turnover

More turnover

0 1 2 3
The availability of drugs was significantly associated with GPs’ job performance and productivity. China introduced the national essential drug lists (referred to as ‘the lists’) in the 2009 national health system reform, and updated the lists in 2018.21 31 The procurement system for drugs was established at provincial level, so township health centres cannot procure medicines on their own or decide prices. This major policy aimed to curb the rampant irrational use of medicines like antibiotics in PHC facilities and improve quality. While there is inadequate nationwide evidence of its improvement in PHC facilities, a regional study found that use of antibiotics in PHC facilities in a northern province dropped for 15% 4years after reform.32 Qualitative studies in township health centres also found improvements in rational use of medicine in township health centres.33 However, the lists restrict use of drugs in township health centres and reduces accessibility to some advanced drugs. Since procurement, price and circulation of drugs are strictly centralised and controlled. Township health centres had less discretion of its own, which reduced competition inside township health centres and outside township health centres, and could harm organisational vitality.34 The lists posed restrictions on GPs’ practice to they can only prescribe within the lists. GPs cannot be rewarded with more workload (they can receive more bonus for prescribing more medicines before the reform).

The availability of equipment was also significantly associated with GPs productivity. China published standards for township health centres in 2018 and revised in 2022.35 However, township health centres in western and middle China often cannot meet the standards. A study focused on chronic obstructive pulmonary disease examined 8176 PHC facilities across 31 provinces. This study found that only 6.41% of township health centres had spirometers available, and only 10.03% of township health centres were able to offer pulmonary function tests in 2021.35 Additionally, GPs trained by CSP may have a less favourable perception of equipment support than other GPs in township health centres. This could be attributed to their previous residency in secondary or tertiary hospitals where they had access to adequate medicines and equipment. Besides, township health centres’ laboratory cannot provide high-quality reports supporting GPs’ clinical decision.36 Laboratory technicians are often not well trained. Some laboratory tests are contracted to health workers from other departments as part-time work. China has no quality control standards or guidelines on laboratories in township health centres.36 Therefore, inadequate equipment, inadequate technicians’ capacity and poor quality-control management all contributed to poor equipment support for GPs.

GPs experienced a low external assistance from other health facilities, indicating that the medical alliances were not functioning. China encouraged counties to explore medical alliances since 2015, aiming to improve quality of care in PHC facilities. For GPs in PHC facilities, medical alliances can retain a greater patient volume that helps them to build expertise, keep skills and remain alert to patient signs. In 2019, the National Health Commission launched compact medical alliances in the mainland. As of 2020, 4028 medical alliances were established, of which 71% were compact.37 China’s medical alliances are similar with ‘networks of care’ in global context,38 in which PHC facilities and secondary hospitals or tertiary hospitals in a certain area deliberately interconnected through administrative and clinical management.39 One major policy in medical alliances is to build a unified information system which enables interconnection of tests or examinations across facilities. It will improve efficiency, reduce redundant services and improve continuity and coordination. Medical alliances in developed areas have established such system.40 However, building information system requires massive funding, which is often not the priority for budget-constraint areas. Starting with less expensive support, such as redesigning incentives for GPs tailored to local context, is more realistic for low-resource areas. External assistance from medical alliances should be strengthened to enhance GPs’ commitment and confidence.

We did not find a significant association between facility support and GPs’ turnover. Turnover is a result of many complex preceding factors involving low job satisfaction, poor career development, career choice regrets, productivity loss and so on.41 Unfavourable facility support may not lead to turnover directly. Another explanation is the short observation time (we only analysed the impact of facility support on turnover in the next year). It is possible that the effect varies by time: GPs can endure the unfavourable physical environment in the short run, but they would leave PHC facilities once the negative effect reached a threshold after several years. Especially for GPs graduating from CSPs, their well-trained experience makes them popular in secondary hospitals.42

These findings have implications for future policies and research in China and other low-resources areas. First, while essential drugs remain dominant, the proportion of non-essential drugs that tailored to local healthcare need may be increased in PHC facilities. The allocation of essential drugs should also be adjusted timely to provide more support for GPs. Second, ensuring basic equipment, enhancing training for laboratory technicians, and establishing a quality control system for laboratories could be an effective way to strengthen PHC capacity and improve support for GPs. Third, secondary or tertiary hospitals in medical alliances could provide more support for GPs in PHC facilities. Staff rotation and training could provide more support for GPs. Health information systems could be connected with more cost-effective ways instead of building a new system. A clearly defined career path within medical alliances could be set for GPs graduating from CSPs. Those GPs are well trained, and have proved the capacity to provide high-quality care in PHC facilities. Secondary hospitals or tertiary hospitals could provide more opportunities for those GPs retaining those talents in low-resource areas.

Shortage of drugs, equipment and external assistance is also common in other low-resource areas. For example, in
Jordan, one-third PHC centres had no functional glucometers in 2022\textsuperscript{43}; in Ethiopia, PHC facilities only scored 2.3 out of 4 for drugs, supplies and facility infrastructure, lowest in all health system inputs in 2023.\textsuperscript{44} Health workers are also experiencing low job performance, low productivity and high turnover intention in resource-constrained areas. Our findings would have implications for not only China but also other areas that endure shortages in resources of health facilities.

This study has several limitations. First, job performance was measured by self-rated data, which might be subject to self-report bias. We have tried to mitigate this bias by including productivity and turnover. Second, our time of observation was not sufficiently long to observe career movement in the long run. For example, facility support may have varying effect on turnover depending on time. Future research could explore more on the time-varying effect of facility support on turnover. Third, we cannot observe other non-physical facility support that could also affect job performance, productivity or turnover, such as team climate, job security, role clarity, autonomy and so on. Those non-physical factors also play a role in the development of job strain. Future studies could also explore more on the non-physical facility support on health workers’ performance. This paper primary focused on equipment, medication and external assistance to represent facility support, but there are also other elements of facility support, such as training or supervision.\textsuperscript{45} Future study could explore more on the association between other elements of facility support and outcomes. Lastly, GPs’ answers to the questionnaires might be subject to reporting bias because those who leave PHC facilities or do not like working in primary care settings may hide their true thoughts. Future research should examine the existence and extent of the reporting bias to determine its impact on results.

CONCLUSION

CSP graduates working in township health centres as GPs experienced high prevalence of shortage in medication, equipment and external assistance from other hospitals. The identification of a potential association between facility support and performance and productivity has implications for future research and resources deployment in PHC. Facility support must be improved to achieve better performance, higher productivity and higher retention of GPs trained by CSP in China. More research should be conducted across LMICs to explore the constraint of facility support on health workers and explore solutions tailored to local healthcare need and social economic development.

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Contributors ML drafted the manuscript, conducted the data analysis and interpretation. HT, HZ and YT conducted the data analysis and managed the data. ML, HT, HZ, XC, HC, XZ and DH collected and managed the data. XL designed the study and made critical interpretations and revisions on intellectual contents of the article. All authors read and approved the final manuscript. ML and XL accepted full responsibility for the work and the conduct of the study, had access to the data, and controlled the decision to publish.

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