

Co-designing interventions to strengthen the primary health care system for the management of hypertension and type 2 diabetes in China



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Summary

Background Policy makers and researchers are tasked with exploring ways to strengthen primary health care (PHC) to address the growing burden of non-communicable diseases (NCDs). This study aims to use a co-design approach (i.e., meaningful involvement of research end users in study planning and design) to develop PHC interventions to improve the management of hypertension and type 2 diabetes (T2DM) in four study sites in China.

Methods The study adopted a three-step co-design approach, including (1) a two-round Delphi panel with health system and NCD professionals to identify prioritised health system challenges, (2) three co-design workshops (in each study site) with local health administrators, PHC providers, and residents with hypertension and/or T2DM, respectively, to develop interventions and identify factors influencing implementation, and (3) another round of co-design workshops with local health administrators to summarise findings and reach consensus. Qualitative synthesis was conducted to analyse results from the workshops.

Findings Thirteen experts were involved in the two-round Delphi panel, which identified three prioritised health system challenges, including limited capacities of PHC providers, suboptimal service quality and evaluation mechanisms, and unreliable health information systems. The co-design workshops involved 116 local stakeholders in 16 sessions (four in each site), and developed three groups of interventions to address the challenges: (1) empowering PHC providers through on-the-job training for capacity building; (2) empowering patient communities through health education on healthy lifestyles and NCD self-management; and (3) empowering health administrators through local health data monitoring and strengthening governance for local PHC programs. Site-specific interventions were also considered to cater for different local contexts. Several recommendations were further identified for the implementation of these interventions, emphasising the importance of local customisation, community participation, and cross-sectoral collaborations.

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Interpretation By engaging multiple stakeholders in priority setting and solution generation, this study summarised several key areas for change in health workforce, service delivery, and health information. Future research should examine the effectiveness and implementation of these interventions to improve NCD management in PHC in China.

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Keywords: Primary health care; Non-communicable disease; Hypertension; Type 2 diabetes; Co-design; China

Research in context

Evidence before this study

We searched international academic databases including the PubMed on existing evidence in China about strengthening primary health care (PHC) for non-communicable disease (NCD) management. Current literatures suggest that China's central government has invested continuously and substantially in reforming PHC during the past decade, including policy and financial input, building and upgrading infrastructure, cultivating PHC workforce, and launching national public health service programs, to increase the access to hypertension and type 2 diabetes mellitus (T2DM) care. However, many major barriers remain, including gaps in health governance and deficiencies in PHC infrastructure, personnel, and service quality. Several cluster-randomised controlled trials have been conducted to explore interventions to address some of the challenges, but concerns were raised for the interventions' long-term sustainability and compatibility with different health system contexts in China, and the lack of inputs from interventions' end-users.

Added value of this study

The study used the "co-design" approach to develop interventions for strengthening PHC in managing hypertension and T2DM in China. This approach has been rarely explored and documented in low-and middle-income

countries. We conducted a two-round Delphi panel with experts in the field, and a series of co-design workshops engaging key stakeholders including PHC providers, people living with hypertension and/or T2DM, and local health administrators. This process identified three PHC challenges to be prioritised, yielded a three-component intervention package corresponding to the challenges (i.e., strategies to empower PHC providers, patient communities, and health administrators), and identified recommendations for the implementation of the interventions. The study provided meaningful insights to strategies to improve hypertension and T2DM management in China, with strong alignment with the context of China's current PHC system.

Implications of all the available evidence

Co-design is a promising approach for engaging multiple stakeholders in priority setting and solution development, particularly for complex health issues such as NCD management in PHC. The co-designed intervention strategies, including PHC workforce capacity building, patient health literacy enhancement, and local health governance strengthening, suggested prioritised areas of change in China's health system, to which future efforts should be directed.

Introduction

Primary health care (PHC), a whole-of-society approach focusing on primary care services, community engagement, and cross-sectoral coordination,¹ has been globally considered a cost-effective approach in preventing and managing non-communicable diseases (NCDs).^{2,3} In China, driven by the substantial burden from NCDs, the central government has invested continuously and substantially in reforming PHC during the past decade, including cultivation of primary care providers, establishing and expanding essential medicines, and increasing financial input and strengthening the infrastructure of PHC facilities.⁴ One of China's key policies is the National Essential Public Health Service

Package (NEPHSP), a government funded program launched in 2009, which requires PHC facilities to provide (in addition to primary care services) a minimum set of public health services for all residents, including resident health records archive, health education, and (for those aged ≥ 35) screening and routine management for hypertension and type 2 diabetes mellitus (T2DM).⁵ However, PHC facilities pertain to be bypassed by residents, in pursuit of health services from higher-level hospitals.^{6,7} Our previous research – a comprehensive evaluation of China's PHC system for NCD management, incorporating policy, primary care facility, and patient perspectives, found that various systemic challenges remain in China's PHC, including

gaps in health governance, and deficiencies in primary care infrastructure, personnel, and service quality.^{8–10}

There have been several successful interventional studies in China to improve NCD management using PHC-based interventions. These studies utilised a range of complex interventions such as training for non-physician community health providers, health coaching, and performance-based financial incentives,¹¹ integrated mobile health applications linking village doctors and stroke patients,¹² and community-based education programs to increase residents' health literacy.¹³ Most of these interventions have been developed based on international theoretical frameworks and/or empirical evidence, led by researchers throughout the planning, implementation, and evaluation processes. Despite the demonstrated effectiveness, concerns were raised for some of the studies about the long-term sustainability and compatibility with different health system contexts.¹²

Emerging in the recent decade, “co-design” is a promising approach in research, service, and system development. In health research, co-design is defined as the meaningful involvement of research users during the study planning phase, through participation in an explicitly described, defined and auditable role or task that is necessary to the planning and/or conduct of health research.¹⁴ By engaging multiple stakeholders in

creating a common vision for change, co-design can address public concerns and needs, amplify voices of the disadvantaged, and recognise and utilise people's experiential knowledge.¹⁵ Co-design has been adopted in a wide range of health disciplines, including health services,^{16,17} aging services,¹⁸ mental health,^{18,19} and health technology development.^{20,21} However, most existing co-design studies have been conducted in high-income countries/regions, with few addressing PHC management of NCDs, and few conducted in China.

Using the co-design approach, the primary goal of this study is to develop PHC-based interventions to improve the management of hypertension and T2DM in four selected sites in China. Specific objectives include: (1) to collectively identify and prioritise health system challenges; (2) to design interventions to address these challenges; and (3) to identify factors that may facilitate or impede subsequent implementation of these interventions and to generate recommendations to optimise implementation.

Methods

Study design

Drawing on a participatory research design,²² this study adopted a three-step approach (Fig. 1). First, by consulting with health system experts in NCD

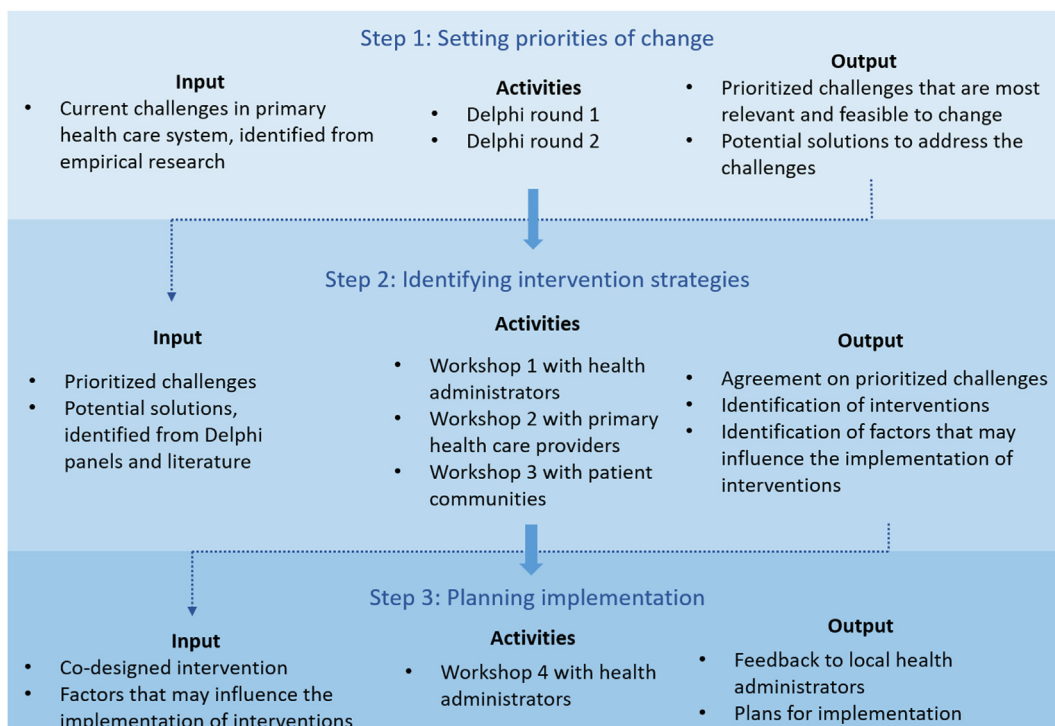


Fig. 1: Overview of the co-design process*. * Step 2 and step 3 were conducted at each study site, with a sum of 16 workshops in total (four in each site).

management through a two-round Delphi panel, we identified PHC challenges to be prioritised in hypertension and T2DM management in China. Second, we conducted three separate workshops with local health administrators, PHC providers, and residents living with hypertension and/or T2DM at each study site, to design interventions to address these challenges and to explore factors that may influence the implementation. In the final step, site-specific workshops were conducted with local health administrators to summarise findings and reach consensus.

We purposively selected four study sites in mainland China, including Xiling District of Yichang City, Hubei Province (Central China), Wenjiang District of Chengdu City, Sichuan Province (Western China), and Acheng District of Harbin City and Jiao District of Jiamusi City, Heilongjiang Province (Northeast China). The study sites were selected based on the diversity of geographical locations, population sizes, residents' socio-economic statuses, and previously established collaborations.

Theoretical frameworks

Two health system frameworks were used to guide our study—(1) the World Health Organisation (WHO) six health system building blocks (i.e., health governance, health financing, health workforce, health information, essential medicines and infrastructure, and health service delivery) were used to categorise health system challenges²³; and (2) the “WHO strategies for integrated people-centred health services” was used to identify and develop potential solutions.²⁴ This latter framework provides five strategies to strengthen the integration and people-centredness of a health system in order to achieve universal health coverage, including engaging and empowering people and communities, strengthening governance and accountability, reorienting the model of care, coordinating services within and across sectors, and creating an enabling environment.²⁴

Delphi panel

Participants

For the Delphi panel, we invited experts from academic institutes, government sectors, medical institutions, social organisations, and professional societies in China. To be eligible, participants had to have at least 10 years' working experience in either NCD prevention and control or health systems science. All Delphi expert participants were identified and approached through the three authors' (MT, WJ, YW) professional networks. Participants provided informed consent prior to participation.

Data collection

Prior to the first round of Delphi, a summary of current health system challenges, generated from three previous studies from our team,^{8–10} was prepared to guide the expert consensus building exercise. These studies

conducted a comprehensive evaluation of China's current PHC system in selected sites, with essential input from local PHC providers, health administrators, and residents living with hypertension and/or T2DM. The studies identified 22 major health system challenges to be addressed to improve NCD management in China's PHC. These challenges were categorised into the six health system building blocks, such as limited capacities of PHC providers in “health workforce”, laggard digitisation of information systems in “health information”, and lack of coordination/continuity of services in “service delivery”.

Delphi panel participants were asked to prioritise these health system challenges by assessing their relevance for NCD management in China's PHC, and the feasibility to address them. The first round of Delphi adopted a two-step scoring process using the 100-point method.^{25,26} Each expert participant was first asked to distribute 100 points to the WHO health system six building blocks, based on their perceived relevance of each building block for NCD management in China's PHC (i.e., a total of 100 points across the six building blocks). Then, *within* each building block, participants were asked to distribute 100 points to the individual health system challenges identified in our previous research, again, based on their perceived relevance of each challenge (i.e., a total of 100 points per building block). The same two-step scoring process was repeated to assess the panellists' perceptions on the *feasibility* to address the health system challenges.

In the second round, participants were presented with results from round one and then asked to assign a 10-point score for each health system challenge, based on perceived relevance (0 = not relevant at all, 10 = highly relevant) and feasibility (0 = not feasible to address at all, 10 = highly feasible).

For both rounds, open-ended questions were also included to collect free text suggestions for strategies and approaches to address any of the listed health system challenges.

Data analysis

Data from round one were used to generate the rankings of relevance and feasibility of the listed challenges, separately. Detailed information on the ranking calculations is provided in [Appendix 1](#). Challenges that fell in the upper half of the relevance ranking were considered relevant, and likewise for the feasibility ranking. Those deemed neither relevant nor feasible were then excluded. In the second round, rankings of the health system challenges were generated based on panellists' 10-point scores for relevance and feasibility. Likewise, challenges that fell in the upper half of the rankings were considered relevant/feasible to address. Challenges deemed both relevant and feasible to address in the second round of Delphi were then prioritised for the subsequent co-design workshops.

Co-design workshops

Participants

Three stakeholder groups were involved in the co-design workshops at each study site: (1) local health administrators currently working at either Centres for Disease Control and Prevention (CDCs) or health bureaus; (2) PHC providers, including village doctors (i.e., non-professional rural health workers with basic medical training), public health workers, and general practitioners working at local PHC facilities; and (3) local residents aged 35 years or older, who had been diagnosed with hypertension and/or T2DM. Participants were excluded if they were: (1) unwilling to provide informed consent, (2) unable to communicate due to limited audio-visual capacities, or (3) severely impaired in daily self-care functions. In addition, for health administrators and PHC providers, they were also excluded if they were on annual or maternity leave or were new to the related position (i.e., with \leq three months of working experience in the role).

The study adopted purposive and snowball sampling for the co-design workshop participants. The local health administrators were identified and subsequently invited through the research team's professional network. Eligible PHC providers were then recruited by the participating local health administrators from the corresponding CDCs. Eligible residents living with hypertension and/or T2DM were recruited by the participating PHC providers. To ensure adequate representation, for PHC providers and residents with hypertension and/or T2DM, we aimed to recruit equal numbers of participants from urban and rural areas.

Data collection

Prior to the co-design workshops, a background briefing was conducted, listing potential solutions to each of the prioritised health system challenges derived from the Delphi panel. The list of potential solutions were compiled on the basis of the literature, primarily from the recommendations of the WHO five strategies for integrated people-centred health services.²⁴ It was also supplemented by the free-text suggestions provided by Delphi participants.

At each workshop, participating stakeholders were presented with the study rationale, the health system challenges, and the background briefing of potential solutions. An experienced moderator then guided the discussion (MT, WJ and XZ), assisted by trained researchers (SX, TL, and YM). At each workshop, stakeholders were asked to share their views about the proposed solutions, to propose alternative local interventions or adaptations to address the challenges, and to consider factors that could influence local implementation. At the end of each workshop, researchers summarised the key findings and reported back to the participants on the proposed intervention, its adaptation

to the local context, and factors that may influence the implementation of the intervention.

After three separate workshops with local health administrators, PHC providers, and residents living with hypertension and/or T2DM, a fourth and final co-design session was conducted again with the local health administrators (the same as the first workshop, i.e., a loop-back workshop). On this occasion, the moderator summarised findings from previous separate workshops, proceeded to determine the health administrators' perceptions (e.g., concerns and recommendations) informed by all stakeholders' perspectives on implementing the interventions locally.

This process was repeated at each of the four sites. Each co-design workshop (16 in total) lasted for around one hour. A variety of tools were utilised, such as formal power-point presentations, real-time notetaking on white boards, and the use of sticky-notes to collect and record individual responses.

Data analysis

Two researchers (SX and MT) conducted qualitative synthesis through analysing meeting notes, audio-recordings, and photo-captured stakeholder written responses during the co-design workshops. Key messages were summarised into four pre-determined themes: health system challenges, selection of potential solutions, proposed alternative local interventions and adaptations, and key factors influencing local implementation and recommendations to address these factors. Regular team meetings were held (MT, SX, WJ, XZ, TL, JW, YM, and PY) to debrief, synthesise, and resolve any discrepancies in data coding and interpretation until consensus was reached.

Ethical considerations

The study was approved by the ethics committees of University of New South Wales (HC200058), Chinese Centre for Disease Control and Prevention (202008), and the Second Affiliated Hospital of Harbin Medical University (KY2021-319). All participants provided informed consent before participation.

Role of the funding sources

The funders had no role in the study design, data collection, data analysis, interpretation, or writing of the manuscript.

Results

Delphi panel

Participant information

A total of 13 experts were consulted in the first round of Delphi, with the majority also participating in the second round ($n = 11$, 85% retention rate). Five experts worked at universities (38%), three at medical institutions (23%), two at national government sectors (15%), two at social

organisations (15%), and one at a civil society (8%). Four Delphi experts had a PhD as their highest degree (31%), eight with a master's degree (61%), and one bachelor's degree (8%). They had a median of 15 years' working experience (ranging from 10 to 38 years), in the field of NCD prevention and control (n = 11, 85%) or health systems science (n = 2, 15%).

Prioritisation of health system challenges

At the first round of Delphi, the relevance scores of the 22 initial health system challenges ranged from 50.5 to 113.9 (median = 73.6, IQR = 31.7) and feasibility scores 62.9–105.7 (median = 80.5, IQR = 19.4). Fourteen challenges were retained, with three of them deemed relevant but not feasible, three feasible but not relevant, and eight both relevant and feasible. Eight challenges were excluded, being neither relevant nor feasible, such as limitations in health insurance policies (relevance: 57.8, feasibility: 49.1, Fig. 2).

For the 14 challenges consulted during the second round, the relevance scores ranged from 6.2 to 9.1 (median = 7.7, IQR = 1.1) and feasibility scores 5.2–7.0 (median = 6.4, IQR = 0.8). This yielded three prioritised challenges that were deemed both feasible and relevant (Fig. 2), including limited capacities of PHC providers (i.e., primary care capacities such as diagnosis and treatment for NCDs and other common conditions, relevance score = 9.1, feasibility score = 6.5); suboptimal service quality & evaluation mechanism (i.e., performance evaluation driven by the quantity of services in the NEPHSP, relevance score = 8.3, feasibility score = 7.0); and unreliable health information system (relevance score = 8.2, feasibility score = 7.0).

Co-design workshops

Participant information

A total of 116 key stakeholders, recruited from four study sites, participated in 16 sessions of co-design workshops

(four in each site). The numbers of workshop attendees of the study sites ranged from 24 to 34 (Table 1). Most health administrators were from local city CDCs, with a few from city health bureaus in Acheng and Wenjiang Districts. A nearly equal numbers of PHC providers and residents living with hypertension and/or T2DM were recruited in all sites except for Xiling District, where all areas were considered urban.

Identification of potential interventions

Based on recommendations from the WHO five strategies for integrated people-centred care,²⁴ and supplemented by data from the Delphi panel, twelve potential solutions to the three prioritised health system challenges were initially identified. These were discussed at the workshops and distilled to three groups of key interventions organised by three primary goals: (1) empowerment of PHC providers, (2) empowerment of patient communities, and (3) empowerment of local health administrators (Fig. 3).

For empowering PHC providers, both PHC providers and residents with hypertension and/or T2DM identified that the key PHC provider capacity to improve was related to clinical skills in diagnosing and treating hypertension and T2DM. Health administrators added that PHC providers' "soft skills" such as communication with patients and their families also needed to be strengthened.

"When I go to see the doctors, I hope to get 'real' clinical services, getting treatment, getting cured ... Not just to get my blood pressure measured, or just asking me some questions."

– Local resident with hypertension, female, Jiao District

For empowering patient communities, the main intervention suggested by most participants was health

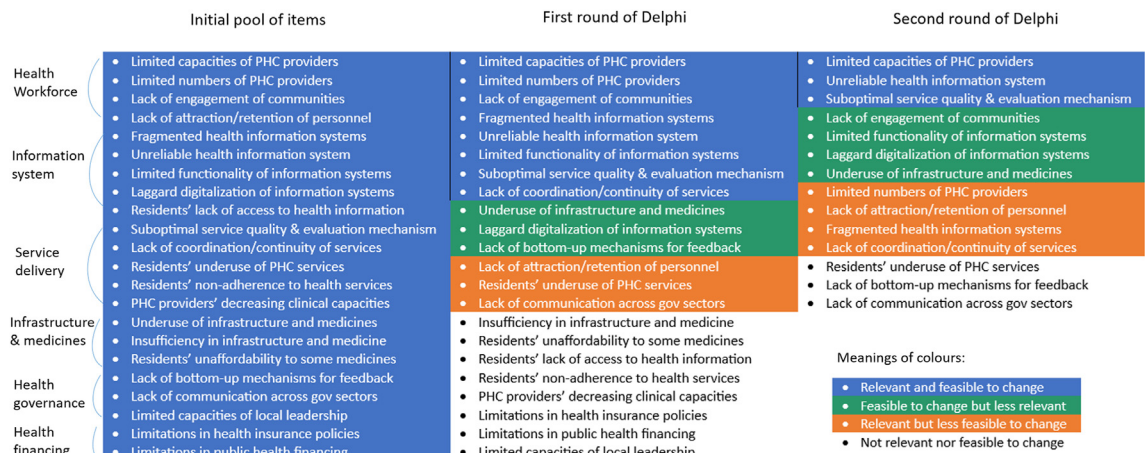


Fig. 2: Results on the prioritisation of health system challenges from the Delphi panel.

	Xiling District	Acheng District	Jiao District	Wenjiang District	Total
Geographic location in China:	Central	Northeast	Northeast	Western	
Urbanisation:	Urban	Mixed	Mixed	Mixed	
Number of participants:					
Workshop 1: health administrators					
• From city CDCs	5	7	10	8	30
• From city health bureaus	–	2	0	2	4
Workshop 2: PHC providers					
• From urban areas	8	2	3	4	17
• From rural areas	–	3	3	4	10
Workshop 3: residents living with hypertension and/or T2DM					
• From urban areas	8	4	4	5	21
• From rural areas	–	4	4	5	13
Workshop 4: health administrators					
• From city CDCs	3	5	6	4	18
• From city health bureaus	–	1	0	2	3
Total	24	28	30	34	116

Table 1: Study site and participant information of the co-design workshops.

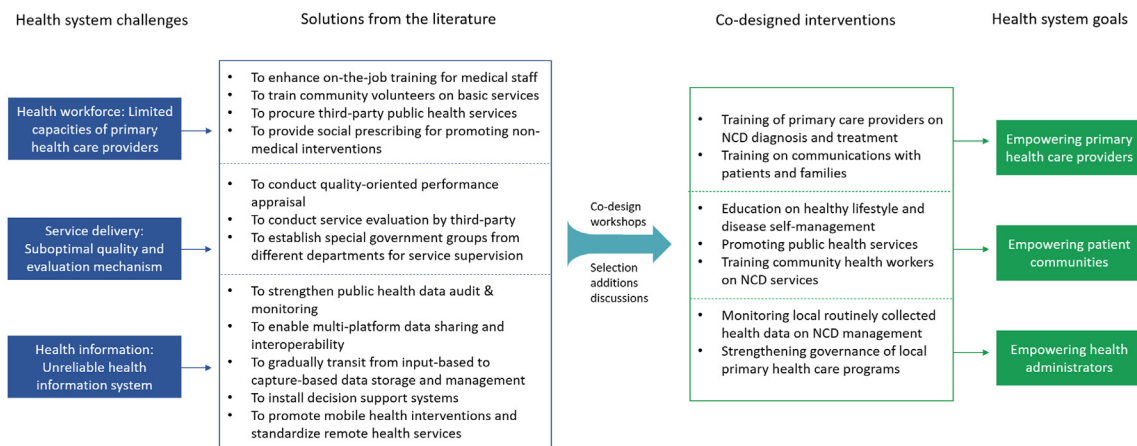


Fig. 3: Identification of intervention strategies from co-design workshops.

education to increase people’s health literacy, including the promotion of healthy lifestyles and improving NCD self-management capabilities. PHC providers added the importance of increasing people’s awareness of and adherence to PHC services.

“Not just (to educate people on) what to do, what to eat, because I think many people already know those things nowadays. We need to also increase their awareness for our PHC services. For example, to keep their appointments, to participate in our health checks, and so on.”

– PHC provider, Wenjiang District

For empowering local health administrators, a major intervention applying to all study sites was the training

of local health administrators on using local routinely collected data to monitor and assess PHC performance for hypertension and T2DM management, and to oversee the quality of data entered into the local health information systems.

In addition, several site-specific interventions were proposed. First, in Xiling and Wenjiang Districts, an alternative intervention was proposed to empower patient communities by training non-professional community health workers in urban areas to assist PHC providers in NCD service delivery. The community health workers could be trained to provide direct reminders for residents to attend and adhere to PHC services, promote health education, and deliver essential medicines. Second, a range of ongoing, locally initiated PHC programs were aligned with the priority

goals and could be integrated with interventions to empower health administrators. In Xiling District, for example, the local government was setting up “community clinics” in most residential areas, supervised by community health centres, to increase PHC service coverage and quality. In Wenjiang District, a “provincial public health committee” was established to strengthen multi-sectoral collaboration across government sectors (in particular the Provincial Health Commission and Department of Civil Affairs) to improve the delivery and uptake of public health services in the province.

Factors influencing local implementation of interventions

As shown in Table 2, in order to empower PHC providers, several factors were identified that may influence intervention implementation, including alignment with local government strategic goals, support from upstream hospitals, and use of digital health technologies. While many PHC providers reported being overburdened by numerous training programs, a few recommendations emerged, including the creation of training modules tailored to providers’ needs, and better use of effective evaluation mechanisms to boost interest and uptake for the training.

“There really isn’t a shortage of training opportunities for our doctors (PHC providers). Some were mandatory and some voluntary. A key issue here is to make good use of these trainings to help their (PHC providers)

actual work, and to avoid ‘training for the sake of training’.”

– Health administrator, male, Acheng District

For empowering patient communities, both health administrators and PHC providers reported challenges in encouraging community participation in onsite, face-to-face health education seminars. Further, although people’s wide access to smart phones and internet was an important enabling factor to multi-media health education, low digital literacy among older adults and the lack of sustainable financial and technological resources were regarded as major challenges.

“It’s pretty much always the same group of people who show up to these (health education) seminars. We’d be glad to see some new faces from time to time, but that usually takes some extra effort, like giving away some gifts.”

– PHC provider, female, Xiling District

In addition, while training non-professional community health workers to deliver basic PHC services was identified as a viable solution by some health administrators and PHC providers, some residents also expressed unwillingness to seek service from community health workers due to a lack of trust.

As for the empowerment of health administrators, there was consensus that the strong political commitment and increased financial investment for PHC

Facilitators for implementation	Barriers for implementation	Recommendations for implementation
Primary goal 1: Empowering primary health care providers		
Targeted interventions: 1. Training on NCD diagnosis and treatment; 2. Training on communications with patients and families		
<ul style="list-style-type: none"> Alignment with local government goals Connection with higher-level hospitals that have capacity and resources to train personnel Digitisation of health systems to enable health service auditing and supervision 	<ul style="list-style-type: none"> Training programs not fit-for-purpose and lacking utility Mismatch between current training contents and provider routines and responsibilities Overloaded training programs that may increase provider workload and be demotivating 	<ul style="list-style-type: none"> Create localised training modules to cater to the needs of different PHC providers Conduct regular evaluation of the uptake of the training modules
Primary goal 2: Empowering patient communities		
Targeted interventions: 1. Health education and disease self-management; 2. Promoting PHC services; 3. Training community health workers on NCD services		
<ul style="list-style-type: none"> Ubiquitous access to smart phones and internet Patient familiarity and trust with peer community members Workload reduction at PHC facilities through task sharing with community health workers 	<ul style="list-style-type: none"> Low technology literacy among the elderly Difficulty in mobilizing community members for participation Low trust in non-physician community members due to insufficient professional training Unsustainability of financial and technological support for training programs 	<ul style="list-style-type: none"> Resolve information security issues to enable people’s use of digital health tools Provide incentives to encourage participation in community activities
Primary goal 3: Empowering health administrators		
Targeted intervention: 1. Monitoring local routinely collected health data on NCD management; 2. Strengthening governance of local PHC programs		
<ul style="list-style-type: none"> Continuous political commitment to NCD management in recent years Increased financial support for and expansion of public health services provided in PHC facilities 	<ul style="list-style-type: none"> Conflicts of interest among health facilities and industrial entities in data sharing Unsustainability and discontinuity of local health programs due to changes in local leaderships Insufficient funding to maintain local public health programs 	<ul style="list-style-type: none"> Lobby local government officials to resolve conflicts of interest among different health facilities and industrial entities Increase multi-sectoral collaboration among government sectors

Table 2: Influencing factors and recommendations for the implementation of identified interventions.

strengthening in recent years were major facilitators for implementing the interventions. However, several barriers were also reported, including the conflicts of interest among health facilities and industrial entities, which could prohibit successful use of routinely collected health data for performance monitoring. Furthermore, several health administrators at some study sites observed the substantial impact of senior leadership changes, which often led to priority shifting and sometimes discontinuation of local PHC programs. Key recommendations were to increase multi-sectoral collaboration among government sectors and to align the interests of various stakeholders in supporting local health governance.

Discussion

By engaging multiple experts and key stakeholders, this study co-designed PHC-based interventions to improve the management of hypertension and T2DM in four sites in China. The two-round Delphi panel first identified three prioritised health system challenges, including limited capacities of PHC providers, suboptimal service quality and evaluation mechanisms, and unreliable health information systems. The co-design workshops further developed interventions in these three priority areas to empower local stakeholders, including (1) on-the-job training for PHC providers, (2) health education interventions for people with hypertension and/or T2DM, and (3) routine health data monitoring and local PHC program strengthening for health administrators. Finally, factors that may influence the implementation of these interventions were appraised, which emphasised the importance of customising training contents for PHC providers, enhancing community participation, and the need for multi-sectoral collaboration among government sectors.

Although there are no rigid procedures for co-design methods, there are several key principles documented in the literature—meaningful user engagement where participant inputs are treated equally as professional/researcher input, developing a shared vision for change, reaching consensus, and joint decision-making.^{17,27} The present study applied these principles and engaged health professionals, administrators, PHC providers, and residents living with hypertension and/or T2DM through a two-round Delphi panel and co-design workshops. Although the specific activities conducted were unique to this study, both Delphi studies with professionals and end user workshops are common strategies to facilitate co-design work.¹⁴ This also resonates with a recent systematic review on research co-design (which was referred to as “designathons”), stating that it promotes collaboration across various stakeholders, including research end users and experts from diverse fields, in developing solutions.²⁸ In addition, some researchers observed the co-design activities to be “fun

and empowering” for older participants in a study on depression.¹⁹ Therefore, it has the potential to be an effective method to proactively engage multiple stakeholders to generate mutually agreed solutions, particularly in the PHC system, where it naturally involves a myriad of grassroots stakeholders.

The prioritised health system challenges (i.e., PHC workforce, service quality evaluation, and health information systems) are common in both China and other low-income and middle-income countries.^{29–32} Most components of the co-designed interventions are grounded in strong evidence. For the empowerment of PHC providers through on-the-job training, several international trials have demonstrated that interventions led by trained PHC providers significantly improved hypertension management in Argentina,³³ Malaysia and Colombia,³⁴ and Bangladesh, Pakistan, and Sri Lanka.³⁵ In China, a recent cluster randomised controlled trial (cRCT) found that their interventions, including training of rural village doctors as one component, were strongly effective in improving cardiovascular disease outcomes.^{11,36} However, it should be noted that training PHC providers was only one part of a multi-component intervention package in all these mentioned studies. In particular, the cRCT in China may have achieved its positive outcomes through provision of free medications and home monitoring devices for patients in the intervention arm, which is resource-intensive and may not be sustainable.¹² This emphasises the need for multifaceted and scalable interventions that are not only effective, but also can be integrated in the current health systems and sustainably implemented over the long term.

For empowerment of patient communities, there is ample evidence for the effectiveness of health education in facilitating lifestyle changes and NCD self-management.³⁷ Our findings on factors influencing the implementation of these interventions have also been mentioned in other studies. Specific to digital health interventions for improving health literacy, the evidence is mixed. One systematic review found the incorporation of digital health technologies and group-based activities are effective implementation strategies for improving health literacy among older people.³⁸ However, another scoping review found highly mixed effects from text and multi-media messages (e.g., educational contents and reminders for health behaviours) in improving clinical and behavioural outcomes for people with NCDs.³⁹ Implementation strategies for health education thus need to be explored and optimised to ensure effective delivery and uptake. For training of non-professional community health workers, several studies have demonstrated positive outcomes. Examples include enlisting female community health volunteers in Nepal to support lifestyle changes for people with hypertension,⁴⁰ and the use of “link workers” (community-based non-health-professionals) in the United

Kingdom National Health Service to increase community resident access to health services and social activities.⁴¹ In China, a recent study found that community-based disease self-management interventions had long-term effects on promoting health behaviours and improving self-efficacy for people with T2DM.⁴² Future efforts to engage and empower patient communities should be customised to China's local health systems, for example, by leveraging the current roles of village doctors in rural areas and residential committees in urban areas.

By contrast, the evidence for interventions to empower health administrators is scant. A recent systematic review of China's 2009 health reforms found that many of China's policy initiatives lacked rigorous evidence and robust evaluations, which may explain the variable effects on health and health system outcomes.⁴³ In our study, the co-designed intervention could potentially address knowledge gaps by supporting the governance of local PHC programs and monitoring routinely collected local health data. This could generate real-world empirical evidence to inform strategies to strengthen local health governance. Of note, a previous study in the same locations as our study demonstrated the successful use of routinely collected data for monitoring hypertension and T2DM care in the local populations,⁸ and this could potentially be automated and incorporated into routine practices of local health administrators.

The main study strength is the application of the co-design approach itself to explore and develop research priorities and interventions to strengthen NCD management in China's PHC, based on multiple perspectives from health care providers and people with lived experience. According to a recent systematic review, the co-design approach has strong adaptability in its delivery modes, output types, and could cater to diverse stakeholders, which could be further explored and implemented in a wide range of health issues.²⁸ Second, our inclusion of multiple diverse study sites created a coherent set of shared goals while also taking into consideration regional variation and the need to customise interventions to local contexts. Third, the intervention components highly align with China's existing health system and services, particularly the NEPHSP provided at PHC facilities, which increases the relevance, feasibility, and scalability of the interventions.

Several limitations should also be noted. First, given the paucity of co-design studies of this nature in China, it is difficult to critically appraise the rigor of our study design and validity of findings. Nonetheless, both Delphi studies and the qualitative methods used in the co-design workshops are well established methods to canvass diverse stakeholder views, develop prioritised actions, and identify optimal strategies to implement those actions. Second, the purposive sampling of study

participants might limit the generalizability of the results. We tried to mitigate this issue by ensuring the representation of stakeholders from different backgrounds (e.g., disciplinary diversity of professionals and a mix of urban and rural PHC providers and residents). Third, this study followed on from three previous studies we conducted on the evaluation of China's PHC system in NCD management, and this previous work may have introduced biases and assumptions that influenced the co-design process (e.g., the provision of the initial list of potential interventions to the participants). We sought to mitigate this by maximising stakeholder ownership of the co-design process, such as encouraging discussions on unlisted challenges and suggestions for additional interventions, and inviting considerations about local adaptations. Fourth, PHC strengthening is a complex process involving a myriad of inter-related health system factors and stakeholders beyond the scope of the present study. Nevertheless, this study's focus on three collectively identified PHC challenges could provide some in-depth insights and shed lights to future health system research and practices. Finally, the study was focused on PHC, with limited consideration with its association with higher level hospitals in NCD management. Future research should further explore effective strategies to integrate PHC, secondary, and tertiary hospitals, to improve the quality, efficiency, and continuity of NCD care.

Conclusion

Although relatively new to health services research in China, co-design has the potential to be a meaningful approach for engaging and empowering multiple stakeholders, including research end users, in priority setting and solution development. In our study, the identified areas of change, including PHC workforce strengthening, patient health education, and local health governance strengthening, emerged as priority areas for intervention development across all four study sites, and we suggest that future efforts to improve NCD management in PHC be directed toward these priorities (with appropriate tailoring for context specifics). Once such interventions are developed, rigorous evaluation of both their effectiveness and implementation is needed to fully appraise the value of co-designed solutions.

Contributors

MT, DP, LM, and SX led the conception of this study. WJ, YW, GW, CH, MB, and FL provided critical suggestions for the protocol of this study. SX, JY, HH, NP, QW, and RJ contributed to data collection and cleaning. XZ, YM, TL, and JW provided coordination and management of data collection and management. SX led the data analysis and drafted the manuscript, verified by MT and XZ who had access to the raw data. MT, DP, LM, and PY made critical suggestions and edits to the draft. MT was responsible for the final decision to submit for publication, and all co-authors approved the submission of this paper.

Data sharing statement

Access to data will be available following publication upon reasonable request to corresponding author Maoyi Tian, to ensure that use of data is in line with the terms of ethics approvals and principals.

Declaration of interests

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.lanwpc.2024.101131>.

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