

# BMJ Open Challenges of epidemiological investigation work in the COVID-19 pandemic: a qualitative study of the epidemiology workforce in Guangdong Province, China

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## ABSTRACT

**Objectives** This study sought to identify the epidemiological investigation challenges of the COVID-19 pandemic and offer insights into the underlying issues.

**Design** An exploratory qualitative study used thematic analysis of semistructured and in-depth individual interviews.

**Setting** This study was conducted in Centers for Disease Control and Prevention in Guangdong Province.

**Participants** Twenty-four participants consented to participate in an in-depth interview. Transcribed recordings were managed using NVivo software and analysed using inductive thematic analysis.

**Results** The qualitative analysis revealed five key themes: high-intensity epidemiological investigation task, emergency management requiring improvement in the early stage, respondent uncertainty, impact on work and social life and inadequate early-stage Joint Prevention and Control Mechanism.

**Conclusion** This survey focuses on the epidemiology workforce at the forefront of the COVID-19 pandemic and qualitatively describes their experiences, vocational issues and psychological stressors. We found that the problems of epidemiological investigation posed intense challenges to the epidemiology workforce. These findings highlight the epidemiological investigation challenges associated with this pandemic. We have provided some suggestions that may help improve the efficiency and quality of the epidemiology workforce in China.

## INTRODUCTION

In December 2019, many unknown cause pneumonia cases were identified in Wuhan, Hubei, China, with clinical manifestations similar to those of viral pneumonia. Further sequencing analysis of the virus samples confirmed the presence of a novel coronavirus.<sup>1</sup> The WHO declared that the outbreak constituted a public health emergency of international concern on 30 January 2020.<sup>2</sup> The COVID-19 pandemic has spread rapidly throughout China and the world and has garnered global attention.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This survey focuses on the epidemiology workforce at the forefront of the COVID-19 pandemic and qualitatively describes their experiences, vocational issues and psychological stressors.
- ⇒ The study used qualitative methods and recruited practice participants, providing a rich exploration of the epidemiology workforce experience.
- ⇒ The study took place in the Guangdong Province, and the experience of the epidemiology worker in different provinces or cities may vary from those reported in Guangdong.

The Central Committee and State Council triggered a national emergency response on 25 January 2020. Rigorous intervention measures were quickly implemented. These measures included surveillance, rapid identification of suspected cases, patient isolation, fast diagnosis and contact tracing. The health sector emphasised social distancing, using masks and personal hygiene. Despite COVID-19 having high infectivity and concealment, China contained the spread of the epidemic within 2 months and halted it in 3. On 28 February 2020, the WHO-China Joint Mission on Coronavirus Disease 2019 report fully affirmed China's effectiveness in fighting the epidemic.<sup>3</sup> Aggressive strategy, hierarchical management, rational resource reallocation, efficient epidemiological investigation and voluntary Chinese citizen cooperation contributed to this rapid and efficient control.<sup>4</sup>

District-level Centers for Disease Control and Prevention (CDC) epidemiological teams are first responders when infected patients are admitted to a hospital or isolation facility. Our CDC system is set up vertically according to the national, provincial, city, district and county levels. Due to territorial management,

the district-level CDC is the first response unit when a new case is discovered. The epidemiological investigation work team played an essential role in implementing the containment strategies and series of control measures generated by the Chinese government in the early stage of the pandemic. They conducted on-site surveys and inquiries with patients and related personnel, asking about their exposure history, contact history, activity trajectory and medical treatment before diagnosis. The investigation determines the transmission trajectory and identifies possible sources of infection and the affected population. The information they collected helped confirm close contact and centralised isolation, which broke the chain of COVID-19 transmission.<sup>4</sup> A cohort study highlighted that a series of multifaceted public health interventions was associated with improved control of the COVID-19 outbreak in Wuhan, China.<sup>5</sup>

China has national and provincial on-site epidemiology training courses. However, the number of trainees is limited, and in a city-level CDC, very few staff members have received such training. The unit will conduct annual training on emerging infectious diseases to better complete emergency tasks for all CDC employees. During the outbreak, CDCs at all levels immediately organised a special epidemiological investigation team from their internal personnel. This epidemiology workforce has short-term emergency training from existing guidelines established from experiences during previous outbreaks, such as SARS. They are exposed to high risk and heavy workloads during their front-line work against COVID-19.<sup>6</sup> Although antipandemic laws (the Law of the People's Republic of China on prevention and control of infectious diseases and the National Emergency Plan for Public Health Emergencies) empowered CDCs to collect specific information during a pandemic, there were still many uncooperative cases reported. In addition, few studies have described and discussed the experience of the epidemiology workforce during the emergency pandemic response. Therefore, this study seeks to identify the challenges faced by the epidemiology workforce surrounding this pandemic and offer insights into the underlying issues.

## METHOD

### Patient and public involvement

No patient involved.

### Design

This study adopted an exploratory qualitative research design in 2020 to understand the challenges of the epidemiological investigation surrounding the COVID-19 pandemic. Researchers with expertise in infectious-disease control developed semistructured interview questions (online supplemental file 1). The guide was used to structure the interview but remained sufficiently flexible in exploring unforeseen topics and concerns. Three epidemiology workforces pretested the interview guide for readability and comprehension. The participants were asked to describe their experiences with the epidemiological investigation. Changes in their lives during

this period and the effects on psychological and physical aspects were explored. Purposive sampling was used to determine the study samples.

### Participants

Participants were recruited if they met all following study criteria: (1) participation in the prevention and control of the COVID-19 epidemic since January 2020, and experience in all aspects of epidemiological field investigations, including case investigation, identification of close contacts, case tracking, completion of epidemiological reports and providing corresponding intervention measures and (2) being a leader of the epidemiological field investigation team and has been engaged in field investigation for over 4 months.

### Interviews

The research team conducted semistructured in-depth interviews with participants using an interview schedule to guide the conversation. Trained interviewers conducted interviews, each lasting approximately 30–80 min. The broad time disparity was because some participants elaborated more on their needs and experiences, while others were limited in their responses. All interviews were digitally recorded after obtaining written consent from participants. New participant interviews were conducted until data saturation was achieved, that is, no new themes emerged.<sup>7</sup>

### Qualitative data analysis

Interview recordings were transcribed verbatim, anonymised and checked against field notes for accuracy by two researchers (PZ and BH). NVivo V.12 was used to manage, store and collate all data. Data were analysed, and themes were derived through rigorous and structured analyses. Thematic analysis<sup>8</sup> was executed in several stages to (1) read and reread the transcripts, (2) discuss and identify emerging topics, (3) develop a topic index, (4) use the index to code the data into broad preliminary codes, (5) consolidate the topics into themes, (6) further consolidate these themes into analytical categories or clusters and (7) translate the analysis obtained into a narrative. Researchers discussed the themes and concepts until consensus was reached, resulting in a set of themes and subthemes that systematically and thoroughly explained the data. The themes were then defined and refined.

## RESULTS

### Participant characteristics

A total of 24 participants were interviewed, including 11 females and 13 males. Among the participants, five had ≤5 years of work experience, eight had 6–10 years of work experience, three had 11–15 years of work experience and eight had ≥16 years of work experience. Participant characteristics are presented in [table 1](#).

### Finding

Our findings reveal the complexity of epidemiological work and its many challenges. Through the interview,

**Table 1** Participant characteristics

Characteristics	%
Gender	
Male	13 (54.17)
Female	11 (45.83)
Educational background	
Undergraduate	9 (37.5)
Master's degree	15 (62.5)
Work experience (years)	
1–5	5 (20.83)
6–10	8 (33.34)
11–15	3 (12.5)
≥ 16	8 (33.4)

participants provided insightful, descriptive accounts of their experiences during the early stages of the COVID-19 pandemic. The findings of this study are presented across five themes (see [table 2](#) and online supplemental file 2). Excerpts that best represent the five identified themes are discussed.

### Theme 1: high-intensity epidemiological investigation task

Epidemiological investigations are urgent and cumbersome. Generally, the CDC must immediately send an epidemiological investigation team to the patient's location when receiving a notification of a COVID-19-positive test result, even at midnight. One participant noted, 'The preliminary epidemiological investigation usually takes at least an hour and at most 3–4 hours. (Participant 8)' Once

**Table 2** Themes and subthemes

Theme	Subthemes
1. High-intensity epidemiological investigation task	1a Heavy workload
2. Emergency management requiring improvement	2a Imperfect organisational framework
	2b Shortage in the epidemiology workforce
	2c The shortage of personal protective equipment
	2d Outdated information technology
3. Respondent uncertainty	3a Recall bias
	3b Uncooperative respondents
	3c Language barrier with foreign cases
4. Impact on work and social life	4a Poor physical and mental health
	4b Work-family conflict
5. Inadequate early-stage Joint Prevention and Control Mechanism	5a Insufficient multidepartment collaboration
	5b Poor information sharing

a case of COVID-19 is confirmed, it should be reported to the infectious disease network system immediately.

An epidemiological investigation must be conducted within 24 hours. The identification of close contacts is the most challenging task. High-quality epidemiological investigation relies on a detailed patient interview, including the 14-day activity history before diagnosis. Poor recall or concealment of key information obstructs close contact tracing and places a heavy burden on workers to investigate the patient's activity history. The epidemiology workforce must interview the receiving doctor or relevant personnel, review video surveillance and analyse these with big data. Some participants said,

"Usually, the patient names some places that he has been to, and then we review the video surveillance and the tracking data from the big data sources. Sometimes, video surveillance is checked repeatedly to verify the information, and patients are asked several times. (Participant 2)"

"The patient can't know who he has been in close contact with in a restaurant or public transportation, so we have to look for the transaction records and surveillance video and send these evidence to the police to analyze with big data. In a word, the most difficult task of an epidemiological investigation is to find out the close contacts. (Participant 4)"

This seemingly simple work is very time- and labor-intensive:

"It takes me too much time to check the surveillance video. Sometimes I spend a night on it. (Participant 16)"

"It is common for me to work until two or three o'clock at night and get up at 7:00 the next day to continue working. (Participant 13)"

In addition to the work mentioned above, workers must keep up to date on the most current COVID-19 infection prevention and control strategies:

"The COVID-19 infection prevention and control strategy was updated once every week or two at the beginning of the pandemic. Therefore, we had a meeting to learn the strategy every week or every two weeks. (participant 2)"

### Theme 2: emergency management requiring improvement

The CDC serves as an organisation for developing and performing disease prevention and control. While emergency management problems had been exposed in the immediate response to the COVID-19 pandemic, they were soon resolved within a month.

#### Imperfect organisational framework

Efficient human resource management and work procedures need to be established in a timely manner to quickly respond to an outbreak. However, most participants experienced frequent changes to their organisation and

work processes: ‘From the end of January to the beginning of February, our organisational structure changed frequently (Participant 22)’; ‘My duty changed every three days at the fastest. (Participant 18)’ One of the participants added, ‘The work content and processes I have been familiar with may change the next day. (Participant 10)’ The unclear task distribution contributed to reduced effectiveness in the emergency response.

### Shortage in the epidemiology workforce

The main obstacle for the epidemiological teams was the limited experience and insufficient number of personnel:

“In the early stages, there were 38 new confirmed cases of COVID-19 reported in Guangzhou on the peak day. We did not have enough workforce to optimally conduct the epidemiological investigation. We didn’t have enough workforce, and some colleagues lacked experience. (Participant 13)”

One of the participants expressed his opinion on the causes of this situation:

“In the past few years, the CDC has employed many contract workers. They have a low income and high turnover rate, which results in their rarely engaging in epidemiological investigation work. (Participant 6)”

### The shortage of personal protective equipment

There was a lack of supplies in the early stages of the emergency response. ‘Owing to the insufficient personal protective equipment, we have to conduct an epidemiological investigation through video call (Participant 3)’; ‘There was personal protective equipment in the warehouse which was only enough for three days. (Participant 15)’ However, this problem was resolved when the government of Guangzhou took control of the overall management of emergency supplies.

### Outdated information technology

Automated or semiautomated information technology was insufficiently implemented at epidemiological investigation sites, and data recording and entry were inefficient.

“The information of epidemiological investigation is recorded on papers, and we can’t bring it out after the interview. This recording method is outdated. And I have to take a photo and then type the information onto the computer. (Participant 23)”

“After the interview, we used Word, Excel and other software for data statistics and information reporting, which was inefficient. (Participant 22)”

One of the participants said that this method of information collection and processing ‘may cause errors in the entry and sorting of information. (Participant 12)’

### Theme 3: respondent uncertainty

Patients should provide accurate and detailed information in the epidemiological investigation interview;

however, recall bias, non-cooperation and language barriers heavily obstructed interviews.

### Recall

Patient’s activity trajectory during the first 14 days before diagnosis helped determine the source of infection. However, recalling their 14-day activity trajectory before diagnosis in detail is a big challenge for most people.

“To be honest, if we are asked to recall our activity trajectory one week ago, it would surely take us a long time. Who did we eat with? How long has it been? Have you ever coughed? Or did the other person cough? Therefore, all we can do is be patient. (Participant 20)”

“The elderly usually don’t remember what they did on which day. (Participant 18)”

### Uncooperative respondents

Some patients concealed their illness and activity trajectory during the epidemiological investigation.

“There were some patients who concealed their activity trajectory, and even their family members helped them to do so. Also, more than 50% of foreign patients refused to answer, and we don’t know whether they didn’t want to report it or if they had forgotten. (Participant 21)”

“If the patient refuses to answer, it costs us a lot of time and energy, even with the help of the police. (Participant 14)”

### Language barrier with foreign cases

Most participants said there was a language barrier with foreign interviewees. ‘Some patients speak their local dialect, which makes the translation machine useless. (Participant 11)’ ‘Later, the Foreign Affairs Office arranged some translators to cooperate with us. But these were translators without a medical background. (Participant 8)’

### Theme 4: impact on work and social life

Since the pandemic on 25 January, the epidemiology workforce has been working intensively for months and must stay up late to work overtime, undoubtedly affecting their social lives.

### Poor physical and mental health

Most of the participants said they were stressed in the face of sudden acute infectious diseases threatening public health.

“I slept no more than 4 hours a day, and I was on call 24 hours. I endured great psychological stress. I could only go home once a week or ten days. (Participant 1)”

“I work under enormous pressure because I am always in direct contact with COVID-19 patients. Although I have worked until 4 or 5 o’clock past midnight, I have to continue working the next day. (Participant 9)”

The continued work also harmed their physical health.

“At that time, most of us were with poor psychological health and got obese or thin owing to overwork. (Participant 23)”

“Our results on physical examinations are worse than those in previous years. (Participant 11)”

#### Work–family conflict

There was work–family conflict for some public health workers. They worked overtime continuously during the pandemic and could not take care of their family.

“For some colleagues, there was no one to take care of their children and elders. Therefore, I hope the government can provide the basic needs of our families. (Participant 3)”

“As a medical worker, I couldn’t take care of my children well, so I had to send them to my parents. (Participant 9)”

#### Theme 5: inadequate early-stage joint prevention and control mechanism

The Joint Prevention and Control Mechanism was essential in the response to the COVID-19 pandemic, and the problems in practice should be considered.

#### Insufficient multidepartment collaboration

Without the full cooperation of other organisations, the CDC could not complete the epidemiological investigation perfectly. However, in the early stages of the pandemic, multiple departments did not efficiently collaborate. Some participants said,

“Though the Ministry of Public Security and the General Administration of Customs have participated in the epidemiological investigation, they provided lesser degrees of assistance to us. Later in about a month, because of the launch of a first-level (level I) response to the new coronavirus pneumonia epidemic, they provided more help in the epidemiological investigation. (Participant 20)”

It is difficult to precisely determine the infection source and close contacts without ample assistance; however, a cooperative working process was not established in the early stages of the pandemic.

“In the early stages, if you wanted to get detailed and complete flight information, you would need to make contact with relevant organizations many times but may get an incomplete record sometimes. (Participant 19)”

Now, a cooperative working process has been established, and epidemiological investigation work is much easier to conduct with the full support of various organisations.

#### Poor information sharing

Due to the issues revolving around information confidentiality and sharing, different teams were delayed in obtaining information.

“Information sharing between organizations is not timely, nor is it so between different teams within the same organization. Considering the confidentiality of the information, each team asked other organizations for the files they needed independently and couldn’t share. Each team in the CDC asked for the same files several times. It increased our workload, and we felt so tired. (Participant 5)”

At the same time, lagging information resulted in patients being repeatedly interviewed by various organisations and increased workload.

“After an epidemiological investigation of a patient is conducted by the CDC, the General Administration of Customs and the local District Office may inquire about the patient, which results in the patient providing the same information several times. (Participant 16)”

“This may be caused by the lag in information synthesis, which makes us perform many redundant duties. (Participant 17)”

#### DISCUSSION

Qualitative interviews were conducted with 24 members of the COVID-19 epidemiology workforce. This study’s focus was to summarise the challenges encountered by the epidemiology workforce in the epidemiological investigation of COVID-19. Furthermore, the study aimed to provide measures to improve the efficiency and quality of CDC personnel in epidemiological investigation work in China. We found several challenges experienced in the epidemiological investigation of COVID-19. These were high-intensity epidemiological investigation task, emergency management requiring improvement in the early stage, respondent uncertainty, impact on epidemiological workers’ lives and inadequate early-stage Joint Prevention and Control Mechanism.

Epidemiological investigations are urgently needed and cumbersome. The epidemiology workforce has been working around the clock since the commencement of the COVID-19 pandemic. Many countries have reported a shortage of health workers and intensive overtime during this unprecedented situation. High-frequency and intensity work creates occupational hazards and psychological stress for front-line healthcare workers, making them unable to handle family responsibilities. When we discussed the psychological stress of front-line health workers in the face of sudden acute infectious diseases threatening public health, we found that most of them experienced stress. This may be due to heavy workload, high risk of infection, limited experience and physical and mental exhaustion.<sup>6</sup> Some studies have shown that



medical workers experience stress, anxiety and depression.<sup>9,10</sup> Therefore, the epidemiology workforce's physical and mental health status should be considered, and timely interventions should be available to support them.<sup>11</sup>

The epidemiology workforce is essential during an emergency response. However, there were no clear duties existed for front-line workers in the early stages of the epidemic response until clear guidance was published. The epidemiologist's role may have been interpreted differently by health organisations and emergency response teams during the early stages of the pandemic.<sup>12</sup> This global challenge in the COVID-19 emergency response resulted in unclear task distribution and reduced team response effectiveness. We believe that clarifying duties and clear leadership should be emphasised and that communication skills must be strengthened. This could enable greater human resources use efficiency and ensure that the public health workforce can effectively manage health security.<sup>13</sup>

The personal protective equipment shortage problem is a common challenge worldwide. In Guangdong, the local government quickly resolved the issue by coordinating the provision of personal protective equipment for each CDC. Controlling the epidemic was another effective response to the shortage challenge. Emergency supplies should be coordinated by the country/provincial/city government, stored in emergency centres and used rationally during emergency response. However, the study also discovered other problems, including a shortage in the epidemiology workforce and outdated information technology.

By 2020, a rapid, global increase in the public health workforce and expertise in infectious disease control was required for the emergency response to the COVID-19 pandemic. Efforts to reduce substantial shortages in the epidemiology workforce have varied. Some have endeavoured to build a workforce by increasing the exposure of students and young professionals to applied public health experiences.<sup>14</sup> Findings show that a critical mentorship programme over a short period can be a helpful support measure for the emergency response workforce. It can successfully mitigate the inexperience of the rapidly expanding workforce. The mentorship support provided to the mentees in this programme improved their confidence and engagement in professional skills and knowledge upskilling.<sup>15</sup> However, temporary training is insufficient in the long term during a pandemic. A timely response is vital, and a sufficiently experienced epidemiology workforce is needed. Therefore, in the future, a high-quality, well-structured professional epidemiology workforce should be trained for long-term, organised and scientific approaches. Personnel in each CDC department should receive specific annual training, enabling each department to provide trained personnel to support the emergency response team. The Chinese government is hiring more public health workers and increasing investments in public health. In the long term, more epidemiologists with better training and

greater government investment are needed for future responses.<sup>16</sup>

In addition, the outdated information technology leads to low efficiency in epidemic prevention and control and increases the workload of healthcare workers. A series of studies have highlighted that healthcare workers must perform too many repetitive tasks (eg, filling out forms) while trying to combat COVID-19. These tasks consume a lot of time and energy and indicate insufficient information synthesis.<sup>17</sup> We can fully use big data, artificial intelligence and cloud computing, which play an integral role in epidemic monitoring and analysis, virus traceability, resource allocation, and virus prevention and control. In actuality, subjective and objective factors such as patients' recall deviation or concealment often interfere with scientific and rigorous epidemiological investigations. This poses a danger of misinterpretation. Many studies have shown that big data is essential in epidemiological investigations.<sup>18,19</sup> In Gansu province, the epidemiology workforce uses the public security system and big data to collect relevant data and compare epidemiological investigation information. They verified the activities and contacts of confirmed and suspected cases in detail, shortening the epidemiology workforce verification time and guaranteeing the accuracy of the investigation results. These investigations are undoubtedly more effective when leveraging the cases' activity trajectory and surveillance video analysis. Screening and comprehensive sorting of useful information provided by patients alongside big data can help obtain patient information more accurately and efficiently.<sup>20</sup> Big data is useful in emergency response, and the Chinese government attaches great importance to protecting privacy.<sup>21</sup> Using big data and surveillance requires written applications and authorisation accompanied by police supervision. The government asked the epidemiology workforce to sign confidentiality agreements, and individuals were held responsible for improper information disclosure.<sup>22</sup> Big data is beneficial in epidemiological investigations and personal privacy should be protected at the same time.<sup>23–25</sup>

Patients and potential contacts should provide accurate and detailed information during epidemiological interviews. However, we found that some patients could not cooperate with the investigation because of poor memory, poor physical health and poor hearing in older adults. Some patients concealed their illness and activity trajectories for privacy reasons. Several countries have also reported uncooperative cases.<sup>26–28</sup> A report from the Ministry of Justice of the People's Republic of China showed that more than 19 patients concealed their COVID-19-related information in the early stage of the pandemic.<sup>29</sup> This concealment obstructs epidemiological investigation and increases the workload. One patient in Weifang, Shandong province, concealed his travel and close contact history, resulting in 68 quarantined medical workers.<sup>29</sup> On 10 February 2020, the Opinions on Punishing Crimes against The Prevention and Control of Novel Coronavirus Pneumonia was issued in

accordance with the law. Administrative punishment may reduce concealment and other obstructions.

The language barrier is also a problem in epidemiological investigations of foreign regions. We found that some foreigners were uncooperative with the epidemiological investigation because of their poor understanding of China's strategy for epidemic control and the different prevention and control measures worldwide. China, Singapore and the Republic of Korea have attempted to stop the spread of COVID-19 by focusing on three key aspects: source of infection, route of transmission and vulnerable population. Other countries adopted only influenza-like prevention and control measures, arguing that the transmission rate could be reduced. They contended that transmission could not be stopped entirely but only slowed until the population achieved herd immunity.<sup>30</sup> Cooperation among countries is essential for fighting COVID-19. If a consensus can be reached on mask-wearing, patient isolation and source tracing, there will undoubtedly be significant progress in the global fight against COVID-19. The promotion of quarantine policies may be helpful. In addition, misinformation about COVID-19 negatively impacts epidemic prevention and control.<sup>31</sup>

Some problems in the early stages of joint prevention and control mechanisms are unavoidable in such an unprecedented situation. On the one hand, certain organisations provided less assistance. Some studies indicated that the CDC could not mobilise various resources in the early stages of the pandemic due to the complexity of the virus, leading to many measures being carried out ineffectively.<sup>32</sup> On the other hand, timely information sharing was not always possible due to conflicts with confidentiality. A unified information-sharing department or system that allows various authorised organisations to obtain patient information in real-time is needed. This can make the link between epidemic prevention, control and treatment more efficient. Therefore, the Central Committee and State Council established the Joint Prevention and Control Mechanism of the State Council. This committee comprises nine task forces covering 32 departments and is responsible for interagency, cross-sector coordination and communication for the COVID-19 response. The Joint Prevention and Control Mechanism of the State Council focuses on prevention and control, delivery of equipment and supplies, and more.<sup>33</sup> Its establishment solved the problems in the joint prevention and control mechanisms and effectively unified all departments in the fight against the epidemic.

Our study has several limitations. As with other qualitative studies, researchers' opinions and beliefs influence the study process.<sup>34</sup> However, researchers' diverse views promoted rigorous debate and data analysis so that the themes could be appropriately generalised and presented. The sample size was relatively small, but the interview content achieved saturation from the interviewees' answers. This meets the qualitative analysis needs of this study. The study took place in Guangdong Province, and

epidemiological workers' experiences in different provinces and cities may vary from those reported in Guangdong. While we feel that our findings are likely relevant to a province with similar management patterns in the epidemiology workforce, replication in other settings would be required to confirm this. Epidemiological investigations have involved many other organisations. To better respond to the COVID-19 pandemic and other infectious diseases, future studies should explore the challenges that other organisations might face when conducting similar epidemiological investigations.

In this study, we highlighted the current issues of epidemiological workers at the front line of the COVID-19 pandemic and provided insights to further address such problems. In subsequent work against COVID-19 and other pandemics, more attention should be paid to the five key themes.

## CONCLUSIONS

This study investigated the current epidemiological issues surrounding the COVID-19 pandemic and offered suggestions for the epidemiology workforce. In conclusion, we identified the following key challenges: high-intensity epidemiological investigation task, emergency management requiring improvement in the early stage, respondent uncertainty, impact on epidemiological workers' lives and inadequate early-stage Joint Prevention and Control Mechanism. These challenges are global and not just unique to China. Our findings share essential experiences and offer insights into the underlying issues encountered by COVID-19 epidemiological workers.

**Contributors** PZ, HZ and BH conceived and designed the study. PZ and BH carried out the interviews. PZ, CL and HZ analysed and interpreted the data. XD, XC, PZ, CL, HZ, BH, YZ, HF and DJ contributed substantially to conception and design, acquisition of data, and analysis and interpretation of data. PZ and CL drafted the manuscript. All authors read, edited and approved the final manuscript. All authors had full access to all of the data in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. PZ is responsible for the overall content of the manuscript, and serves as the guarantor.

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