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Stigma toward people living with HIV among healthcare providers in midwifery hospitals in Shenzhen, China from 2020 to 2023

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Shenzhen, a leading city in China's Elimination of Mother-to-Child Transmission (EMTCT) Programme, implemented effective practices to reduce HIV-related stigma and officially launched a comprehensive work plan in 2021. This study assessed the trend of HIV-related stigma in Shenzhen's midwifery hospitals by comparing two surveys of healthcare providers (HCPs) conducted in 2020 and 2023. The study included 2705 HCPs and used an adapted 15-item HIV-related stigma scale. The results showed a significant decrease in stigma, with the mean stigma score dropping from 2.01 in 2020 to 1.89 in 2023. While most items showed improvement, one item related to prejudice and stereotypes showed a slight increase in stigma. In two items on attitudes toward women living with HIV, HCPs were more supportive of their reproductive rights, but less so toward allowing women living with HIV with children to have more. Training was found to be a factor associated with reducing stigma. HCPs who did not receive training, were older, worked as nurses, or had no HIV patient service experience exhibited higher levels of stigma. In general, our findings suggest that the EMTCT programme may contribute to reducing HIV-related stigma, highlighting the importance of continued training and programme optimization to address persistent stigma.

Abbreviations

HCPs	Healthcare Providers
AIDS	Acquired Immune Deficiency Syndrome
HIV	Human Immunodeficiency Virus
PLHIV	People Living with HIV
UNAIDS	Joint United Nations Programme on HIV/AIDS
PMTCT	Prevention of Mother-to-Child Transmission
EMTCT	Elimination of Mother-to-Child Transmission
Coef.	Coefficients
Adj. Coef.	Adjusted Coefficients
SMDs	Standardized Mean Differences
CIs	Confidence Intervals
IPW	Inverse Probability Weights

Worldwide, people living with HIV (PLHIV) face persistent stigma and discrimination, which significantly impact their access to prevention and healthcare services[1]. Despite remarkable medical advancements and global efforts to end AIDS, the Joint United Nations Programme on HIV/AIDS (UNAIDS) reported that approximately 9.2 million PLHIV globally did not receive antiretroviral therapy, and about 630,000 died from preventable AIDS-related causes in 2023[2]. Stigma, the labeling of a person or group with disfavored by society that lower their status in society, commonly results in experiences of discrimination[3]. Stigma occurs at multiple levels of society[3,4], from individuals who internalize fears about their HIV status, to communities where gossip and

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discrimination persist, and at the policy level, where the rights of PLHIV often lack adequate protection. The UNAIDS PLHIV Stigma Index[3] has revealed that healthcare settings are one of the key areas where significant stigma impedes access to and continuation of healthcare. Furthermore, stigma specifically hinders prevention of mother-to-child transmission (PMTCT) services[5,6]. Studies in South Africa have shown that 35–51% of new HIV infections among newborns were attributed to HIV-related stigma, compared to only 8% from treatment failure[7,8].

In China, efforts to combat HIV/AIDS have included legal protections and prevention programmes since 2006[9]. However, a meta-analysis revealed that 37.59% of healthcare providers (HCPs) in China exhibited some level of stigma toward PLHIV[10]. Taking a proactive stance, China has adopted the global Elimination of Mother-to-Child Transmission (EMTCT) programme[11], where stigma reduction is an important component. Shenzhen, designated as a pilot city for EMTCT since 2018, officially launched a comprehensive work plan in early 2021, signifying the full-scale implementation of the programme. In accordance with the work plan, Shenzhen has taken a series of measures to reduce HIV-related stigma and discrimination in midwifery hospitals. These measures included conducting a baseline survey of stigma among HCPs, routine monitoring of stigma levels, training HCPs in anti-stigma practices, organizing awareness activities on specific days, producing anti-stigma brochures, incorporating specific anti-stigma content into institutional policies, and establishing channels for patient complaints and feedback.

In 2023, Shenzhen was validated as the pioneer city in China to achieve the goal of elimination mother-to-child HIV transmission. The city has developed standardized tools[12] that are tailored to its context for monitoring stigma levels among HCPs in midwifery hospitals. Although a baseline measurement was established in 2020[13], the trends in HIV-related stigma among HCPs before and after the implementation of this EMTCT work plan remain uncertain.

Consequently, this study aims to assess the trends in HIV-related stigma among HCPs in Shenzhen's midwifery hospitals between 2020 and 2023, assess the impact of stigma reduction measures implemented during this period, and explore the factors associated with stigma to improve the quality of the PMTCT service and optimize the implementation of the broader programme.

Results

Demographic, work-related, and training characteristics of respondents

Demographic, work-related and training characteristics of the survey respondents are presented in Table 1. We included 2705 HCPs from midwifery hospitals in this study, with 84.40% being female. Participants were categorized by age, with the plurality (37.49%) aged between 30 and 39 years old. Additionally, 25.21% were aged 40–49, 24.14% were under 30, and 12.57% were 50 or older. The professional types included 37.15% clinical doctors, 33.27% nurses, 15.75% medical technicians, 13.64% administrative and others. Moreover, 7.50% participants have ever worked in HIV specialized units and 16.52% had served HIV patients in the last 12 months. A total of 57.08% of participants had ever received training on stigma and discrimination, with 44.92% receiving it in 2020 and 65.96% in 2023.

Statistically significant differences were observed between the two survey rounds in demographic and work-related characteristics of HCPs in the unadjusted sample, such as age, gender, professional type, ever worked in HIV-specialized units and HIV patient service experience (Supplementary Table S1). However, after applying IPW, these differences in covariates were balanced in the weighted sample (Supplementary Table S2).

Responses of HCPs to the 15-item HIV-related stigma scale

The mean scores on the 15-item scale for HCPs decreased from 2.01 in 2020 to 1.89 in 2023, with an overall average of 1.94. The detailed distribution of HCPs' responses is shown in Fig. 1. In the Fear of Infection section, there was a reduction in the proportions of HCPs reporting being "worried" to "very worried" about contracting HIV while drawing blood from PLHIV, from 38.99% in 2020 to 18.23% in 2023, and while dressing wounds from PLHIV, from 43.24% in 2020 to 18.43% in 2023. For the Secondary Stigma section, all three items showed low levels of secondary stigma, with proportions under 10%, though a slight increase was observed in 2023.

In the section on Attitude toward Women Living with HIV, the item "Women living with HIV should be allowed to have babies if they wish" received increasingly positive responses. The proportion of those opposing this view decreased from 20.76% in 2020 to 14.01% in 2023. Additionally, the proportion of respondents holding the negative attitude that "Women living with HIV should not get pregnant if they already have children" decreased from 51.40 to 36.08%.

Regarding the unwillingness to provide services to key populations, there was a slight decline in negative attitudes across all three groups. Among participation, the proportion unwilling to serve sex workers decreased from 14.71 to 13.50%; for men who have sex with men (MSM), it dropped from 16.38 to 12.73%; and for those who inject illegal drugs, the figure fell from 25.04 to 20.92%.

In the Stereotypes and Prejudice section, four out of five items showed slight improvements. However, one item, "Most people living with HIV do not care if they infect other people" saw a 0.22% increase in negative attitude, with 37.88% of respondents still holding this view in 2023.

Multivariate regression analysis

As shown in Table 2, the multivariate regression model, based on inverse probability weighting and adjusted for gender, age, professional type, HIV patient service experience, ever worked in HIV-specialized units, indicated a significant decrease in HIV-related stigma among HCPs in Shenzhen from 2020 to 2023 (Model 1: Adj. Coef. = −0.11, 95% CI: −0.13, −0.08, $p < 0.001$). This trend persisted when training was included as an additional covariate (Model 2: Adj. Coef. = −0.08, 95% CI: −0.11, −0.05, $p < 0.001$).

Variables n (%)	Total (n = 2705)	2020 (n = 1142)	2023 (n = 1563)
Gender			
Female	2283 (84.40)	984 (86.16)	1299 (83.11)
Male	422 (15.60)	158 (13.84)	264 (16.89)
Age Group			
< 30	653 (24.14)	339 (29.68)	314 (20.09)
30–39	1014 (37.49)	433 (37.92)	581 (37.17)
40–49	682 (25.21)	237 (20.75)	445 (28.47)
≥ 50	340 (12.57)	120 (10.51)	220 (14.08)
Missing	16 (0.59)	13 (1.14)	3 (0.19)
Professional Type			
Clinical Doctor	1005 (37.15)	422 (36.95)	583 (37.30)
Nurse	900 (33.27)	436 (38.18)	464 (29.69)
Medical Technician	426 (15.75)	132 (11.56)	294 (18.81)
Administrative and Others	369 (13.64)	147 (12.87)	222 (14.20)
Missing	5 (0.18)	5 (0.44)	-
Work Experience (Years)			
< 10	1004 (37.12)	485 (42.47)	519 (33.21)
10–19	927 (34.27)	371 (32.49)	556 (35.57)
≥ 20	772 (28.54)	285 (24.96)	487 (31.16)
Missing	2 (0.07)	1 (0.09)	1 (0.06)
Ever Worked in HIV-Specialized Units			
No	2502 (92.50)	1089 (95.36)	1413 (90.40)
Yes	203 (7.50)	53 (4.64)	150 (9.60)
HIV Patient Service Experience (Last 12 Months)			
None	2173 (80.33)	1006 (88.09)	1167 (74.66)
Some	447 (16.52)	128 (11.21)	319 (20.41)
Missing	85 (3.14)	8 (0.70)	77 (4.93)
Training on Stigma and Discrimination			
No	1161 (42.92)	629 (55.08)	532 (34.04)
Yes	1544 (57.08)	513 (44.92)	1031 (65.96)

Table 1. Demographic, Work-related, and training characteristics of respondents.

Furthermore, the factors associated with the HIV-related stigma were investigated. HCPs who had received training in stigma and discrimination reported significantly less stigma (Adj. Coef.=−0.14, 95% CI: −0.17,−0.11, $p < 0.001$). In both models, older HCPs ($p < 0.001$), and those without served HIV patients in the last 12 months ($p < 0.05$) were more likely to display higher levels of stigma. Nurses exhibited higher levels of stigma toward PLHIV ($p < 0.001$) compared to clinical doctors, while administrative staff and others ($p < 0.05$) showed lower levels of stigma. Experience working in HIV-specialized units was significantly associated with stigma ($p < 0.01$), but this association was no longer significant after adjusting for the training factor in Model 2 ($p > 0.05$).

Discussion

HIV-related stigma in healthcare settings can disrupt access to medical care[3,7]. The EMTCT Programme places great emphasis on addressing this issue and has taken measures to reduce stigma[4,14]. Shenzhen, a city at the forefront of the EMTCT Programme in China, has been conducting effective practices and officially launched a comprehensive work plan in 2021. Our surveys, with the first round conducted in 2020 before the work plan's launch and the second in 2023, aimed to evaluate the trends in HIV-related stigma among HCPs in Shenzhen's midwifery hospitals. This study has been instrumental in evaluating the effectiveness of the programme in improving PMTCT service quality and optimizing the broader initiative.

Our findings show a significant reduction in HIV-related stigma among HCPs in Shenzhen's midwifery hospitals from 2020 to 2023. In detail, concerning the fear of infection, the percentage of respondents who reported being "worried" and "very worried" decreased by more than 20%, resulting in a proportion lower than that observed in other regions[15,16]. The reduction in the fear of infection could be attributed to the increasingly well-protected medical environment[17,18], which was also emphasized in Shenzhen's EMTCT Programme. By ensuring that universal precaution supplies and post-exposure prophylaxis are consistently available, the programme helps alleviate HCPs' concerns about occupational exposure to HIV, thereby reducing avoidance behaviors toward PLHIV.

Regarding gender equality and reproductive rights, which are key priorities of the EMTCT programme[14], our study observed some improvement in the attitudes of HCPs toward women living with HIV. This was reflected
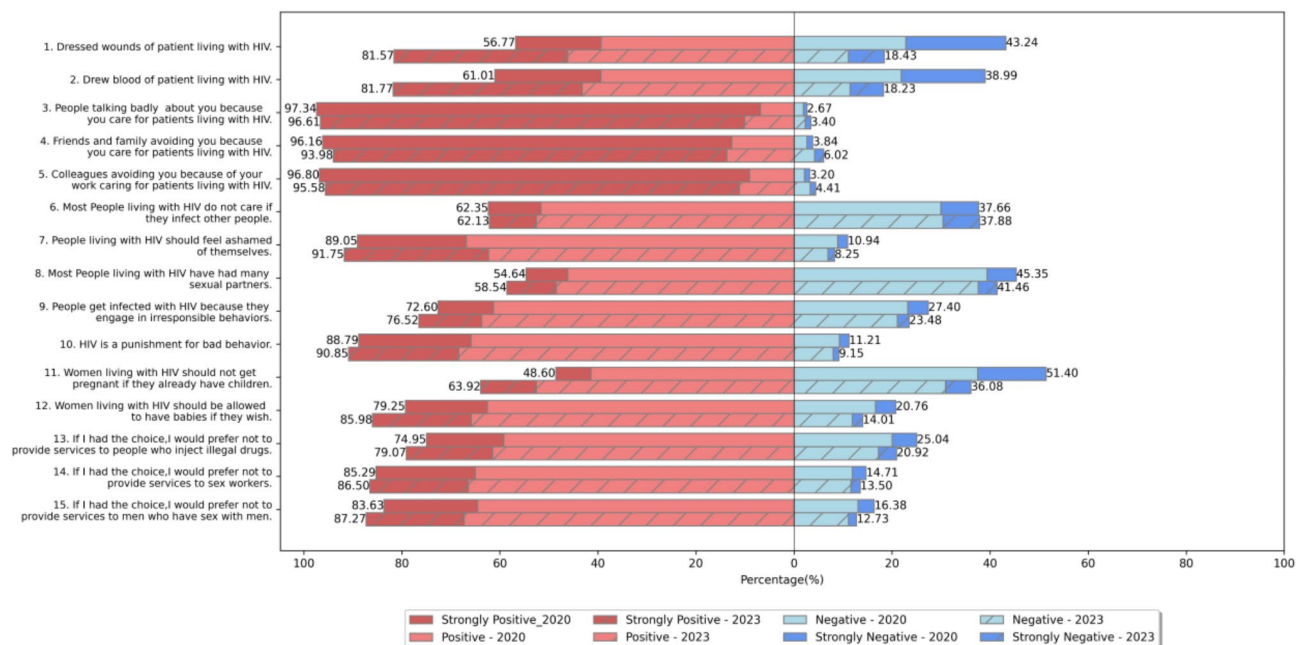
Fig. 1. Responses of HCPs to the 15-item HIV-related Stigma Scale in 2020 and 2023. Note: The bars are color-coded: solid for 2020, striped for 2023. Red shades represent positive responses, and blue shades represent negative responses. Percentages on the left are for positive responses (strongly positive/positive), and on the right for negative responses (strongly negative/negative). The order of the items follows their categories.

in a decrease in negative responses to two specific questions, likely attributable to improvements in the medical environment and treatment services. However, attitudes toward the item, "Women living with HIV should not get pregnant if they already have children" remained relatively conservative, with 36.08% still expressing agreement in 2023. This highlights a contradiction in HCPs' attitudes toward women living with HIV. While HCPs acknowledged their right to have children, they held restrictive views for those who already have children. This suggests potential stigma, indicating that HCPs may not fully support their reproductive autonomy of women living with HIV. Although implicit, this stigma is revealed in their differing attitudes toward these women's reproductive choices and may stem from concerns about HIV transmission or doubts regarding their parenting abilities. Such stigma within healthcare institutions would discourage women living with HIV from pursuing pregnancy and restrict their access to reproductive services, highlighting the need for ongoing efforts to reduce stigma and promote reproductive equality[19,20]. The observed contradiction in attitudes and the limited existing research on this topic underscore the importance of our findings and the need for further investigation into the stigma surrounding reproductive choices for women living with HIV.

Attitudes toward key populations also showed slight improvement[21], with more than 85% of respondents expressing positive attitudes toward MSM and sex workers, However, willingness to serve those who inject drugs remains low, not reaching 80%. Our findings echo another study conducted in Laos, which also observed higher service willingness toward sex workers and MSM within healthcare institutions providing PMTCT services[22]. In contrast, a study from Iran reported a greater willingness to provide services to injection drug users across unclassified healthcare facilities[21]. The extent to which regional or healthcare facility factors contribute to this disparity is not yet clear. Stigmatization of these groups can exacerbate risky behavior[23–25], and further research is needed to explore the underlying reasons for these attitudes and to ensure equitable service provision across all populations.

Although most items have shown low levels of stigma or have improved, the reduction in stereotypes and prejudice has still been insufficient, consistent with many research findings[21,22,26]. In particular, over 35% of respondents still held negative views regarding statements like 'Most PLHIV have had many sexual partners' and 'Most PLHIV do not care if they infect others.' These figures have shown little to no change over the past years. This level of stereotypes and prejudice is higher compared to reports from other countries and regions[16]. This suggests that efforts within healthcare settings have been insufficient to address these deep-seated stigma. Since stereotyping and prejudice act as both driving factors and manifestations, fueling and being reinforced by the process of stigmatization, specific measures should be taken in future healthcare interventions. For example, UNAIDS has recommended integrating contact with PLHIV groups into training and incorporating HIV sensitization, stigma reduction, and human rights approaches into medical and nursing curricula[18]. On the other hand, despite a slight increase in secondary stigma, an impressive more than 90% of respondents still expressed a little to no worry, a figure that higher than in other regions[15,16]. This could be attributed to Shenzhen's low HIV prevalence and limited patient exposure[9,16].

The factors associated with HIV-related stigma among HCPs vary across countries and regions. The factors identified in this study include training, professional type, age, and HIV patient service experience. We found

Variables	Model 1		Model 2	
	Adj. Coef. (95% CI)	P-Value	Adj. Coef. (95% CI)	P-Value
Gender				
Female	ref.	ref.	ref.	ref.
Male	0.01 (−0.03, 0.05)	0.633	0.00 (−0.04, 0.04)	0.990
Age Group				
< 30	ref.	ref.	ref.	ref.
30–39	0.10 (0.06, 0.14)	< 0.001	0.11 (0.07, 0.14)	< 0.001
40–49	0.11 (0.07, 0.16)	< 0.001	0.12 (0.08, 0.16)	< 0.001
≥ 50	0.14 (0.08, 0.19)	< 0.001	0.14 (0.09, 0.20)	< 0.001
Professional Type				
Clinical Doctor	ref.	ref.	ref.	ref.
Nurse	0.14 (0.10, 0.17)	< 0.001	0.13 (0.09, 0.16)	< 0.001
Medical Technician	−0.03 (−0.08, 0.01)	0.178	−0.03 (−0.07, 0.02)	0.242
Administrative and Others	−0.07 (−0.11, −0.02)	0.006	−0.05 (−0.10, −0.01)	0.027
HIV Patient Service Experience (Last 12 Months)				
None	ref.	ref.	ref.	ref.
Some	−0.06 (−0.10, −0.03)	0.001	−0.05 (−0.09, −0.01)	0.014
Ever Worked in HIV-Specialized Units				
No	ref.	ref.	ref.	ref.
Yes	−0.08 (−0.13, −0.02)	0.006	−0.05 (−0.10, 0.01)	0.099
Training in Stigma and Discrimination				
No	-	-	ref.	ref.
Yes	-	-	−0.14 (−0.17, −0.11)	< 0.001
Survey Year				
2020	ref.	ref.	ref.	ref.
2023	−0.11 (−0.13, −0.08)	< 0.001	−0.08 (−0.11, −0.05)	< 0.001

Table 2. Multivariate regression model of HIV-related stigma among HCPs in Shenzhen midwifery hospitals. Note: The results were performed by multivariate regression model base on inverse probability weighting. Data showed in this table were adjusted coefficients and 95% confidence intervals.

that training was indeed associated with reducing HIV-related stigma, aligning with other studies[22,27–30]. Furthermore, the increase in HCPs receiving training on HIV-related stigma from 2020 to 2023 reflects the process effectiveness of the EMTCT programme. After statistical adjustment for training effects, the temporal dimension of the implementation of the EMTCT programme work plan retained its statistical significance. This may reflect a combination of programme-related measures, the passage of time, broader societal shifts, and other external factors such as the COVID-19 pandemic. The COVID-19 pandemic, particularly in its first wave in 2020, may have had an unobserved impact on the attitudes and responses of HCPs, given the heightened stress and healthcare disruptions during that period.

Our research found that nurses exhibited higher levels of stigma compared to clinical doctors. A similar finding from Nigeria[31] reported that nurses, particularly midwives, hold negative attitudes toward HIV patients, likely due to fear of infection. In this study, midwives—categorized as part of the nursing profession—potentially confront a higher risk of infection and experience greater fear owing to their increased exposure to bodily fluids in midwifery settings. In contrast, administrative staff showed more positive attitudes. A UNAIDS report suggests that involving HCPs in designing stigma and discrimination training can improve their understanding and application of these concepts[32], an area where administrative staff are often engaged. Additionally, older HCPs, and those with no experience of contact with PLHIV displayed higher level of stigma, a trend that aligns with many findings[22,26,30].

One of the strengths of this study is its pioneering methodology to examining the evolution of HIV-related stigma among HCPs in China, specifically before and after the implementation of the EMTCT programme. This research offers a novel perspective on assessing the effectiveness and sustainability of such programs, providing valuable insights that can inform the development or refinement of local EMTCT strategies. Furthermore, by focusing on the stigma surrounding women's reproductive rights, this study uniquely explores attitudes and their changes over time. Additionally, it helps to uncover potentially overlooked social and ethical issues, provides a more comprehensive understanding of the current state and trends of HIV-related stigma among HCPs.

The study has several limitations. Firstly, as a single-region study, its generalizability is limited. However, tailoring the HIV-related stigma scale, it provides a reference that could be significant for other cities in China. Secondly, it is a cross-sectional study design, describing only the changes in stigma among HCPs without establishing causal pathways for stigma changes toward PLHIV. Despite this, IPW methods were used in this study to more accurately capture the trend[33,34]. Thirdly, while we used IPW with propensity scores to adjust for potential confounders, the method relies on accurately measuring all relevant variables. Our study may

not have included all factors, which could limit the generalizability of our findings and introduce unobserved confounding, potentially biasing the results.

This study contributes to the growing evidence that systematic, large-scale, long-term programme may have a lasting impact on reducing HIV-related stigma, providing a more sustained perspective and practical implications than short-term interventions. Firstly, attitudes toward women's reproductive rights may conceal hidden stigma, which requires further exploration. Qualitative research is recommended to uncover underlying factors and inform targeted interventions in this area. Secondly, prejudice and stereotypes are deeply ingrained and challenging to change. Tackling these issues require further improvement of the programme. Thirdly, training is associated with reducing stigma and should be implemented continuously to ensure sustained progress in this area. Fourthly, future research such as randomized controlled trials and longitudinal studies should explore specific interventions tailored for high-stigma subgroups and assess how these programme can be adapted and scaled across different healthcare contexts. Finally, given that this study was conducted in a single region, future research should evaluate the applicability and scalability of these findings in diverse settings.

The study reveals a significant reduction in HIV-related stigma among HCPs from 2020 to 2023, likely attributed to the positive impact of the EMTCT programme. However, certain aspects, particularly stereotypes and prejudice, as well as attitudes toward reproductive rights, still require additional intervention. Targeted efforts, especially for older HCPs, nurses, and those with limited experience with PLHIV, are essential for further reducing stigma. Nevertheless, to effectively address persistent HIV-related stigma, ongoing optimization of strategies is necessary.

Methods
Study design and participants
This study was conducted with a cross-sectional design, with data collected over two years: 2020 and 2023. The study aimed to assess trends in HIV-related stigma among HCPs in Shenzhen's midwifery hospitals. The first survey round was completed in December 2020, and the second in May 2023. Stratified, multistage random sampling was performed to recruit participants from midwifery hospitals across all 10 administrative districts of Shenzhen. We stratified the selection by the 10 administrative districts and randomly selected 30% of the midwifery hospitals from each district, ensuring representation from every district. In cases where the calculated number was less than one, at least one hospital from that district was included in the sample. All HCPs were eligible if they consented. The survey was anonymous to encourage participation and frankness. Consistency in sampling methods ensured homogeneity between the two survey rounds. All procedures were carried out in accordance with the ethical standards of the institutional and national research committees.

Questionnaire
Data were collected using a questionnaire adapted and refined from the *Brief Questionnaire for Measuring HIV Stigma and Discrimination Among Health Facility Staff*, originally developed and validated by the USAID[16,35]. This global questionnaire was created through a multi-step process and reviewed by experts in global stigma measurement. It has been field-tested in multiple countries, including China, and is adaptable to various HIV prevalence areas, languages, and healthcare settings. The questionnaire includes a comprehensive set of tools, such as a manual and guide[36–38], and demonstrates robust psychometric qualities, including content and structural validity, internal consistency, and hypothesis-testing capabilities. Additionally, it features a specialized section for PMTCT. This questionnaire has been modified and refined in the context of diverse regions[21,22,39].

In the first round of baseline data collection in 2020[13], we used the global questionnaire in Chinese[40], refining it based on pre-testing and consultative meetings to adapt it for the Shenzhen context. The Cronbach´s α of this initial version was 0.711, and included basic information and an HIV-related stigma scale with 43 items,

In the second round in 2023, based on the results of baseline surveys and field testing, we engaged in consultative meetings and psychometric analysis. This process led to the refinement and updating of the questionnaire to a more concise version, better tailored for HCPs in midwifery hospitals. The updated version demonstrated a significant improvement in content and structural validity with a Cronbach's α of 0.817[12]. It was incorporated as a routine monitoring instrument in Shenzhen's midwifery hospitals and included a 15-item HIV-related stigma scale and a basic information section. The shorter questionnaire only reduced the number of items without altering their descriptions.

For our analysis, we selected the basic information and the 15 overlapping questions on the HIV-related stigma scale from both 2020 and 2023 (Table 3). An English version of the questionnaire is provided in the Supplementary File 1. The basic information section of the questionnaire including age, gender, professional type, ever worked in HIV specialized units, working experience, HIV patient service experience in last 12 months and training on stigma and discrimination. Training was collected as part of the EMTCT programme. For the training question, selecting either of two options, "HIV stigma and discrimination" or "Key population stigma and discrimination", was categorized as a "yes" response.

Data collection
The study was conducted via electronic survey, utilizing self-report questionnaires. Data for two surveys were collected via the Chinese online survey platform "Questionnaire Star" (https://www.wjx.cn/). Participants could access the electronic questionnaire either by scanning a provided Quick Response (QR) code or clicking on a link generated by the platform. The survey was launched by the municipal health administrative department using official channels. Project leaders for the EMTCT programme in each administrative district and at each midwifery hospital were responsible for its implementation, specifically distributing the electronic questionnaires through their internal work groups.

No.	Items	Categories
1	Dressed wounds of patient living with HIV.	Fear of Infection
2	Drew blood of patient living with HIV.	
3	People talking badly about you because you care for patients living with HIV.	Secondary Stigma
4	Friends and family avoiding you because you care for patients living with HIV.	
5	Colleagues avoiding you because of your work caring for patients living with HIV.	
6	Most People living with HIV do not care if they infect other people.	Attitudes Toward PLHIV (Stereotypes and Prejudice)
7	People living with HIV should feel ashamed of themselves.	
8	Most People living with HIV have had many sexual partners.	
9	People get infected with HIV because they engage in irresponsible behaviors.	
10	HIV is a punishment for bad behavior.	
11	Women living with HIV should be allowed to have babies if they wish.	Attitudes Toward Women Living with HIV
12	Women living with HIV should not get pregnant if they already have children.	
13	If I had the choice, I would prefer not to provide services to people who inject illegal drugs.	Attitudes Toward Key Populations
14	If I had the choice, I would prefer not to provide services to sex workers.	
15	If I had the choice, I would prefer not to provide services to men who have sex with men.	

Table 3. The 15-item scale for assessing HIV-related stigma of HCPs toward PLHIV.

Measurements

Dependent variables: HIV-related Stigma

HIV-related stigma was quantified by calculating the mean score of the 15-item scale for each participant, with higher scores indicating a higher level of stigma among HCPs toward PLHIV. Each item on the scale was scored on a 4-point scale, with items 1–5 scored as follows: 4 = very worried, 3 = worried, 2 = a little worried, 1 = not worried. Items 6–15 were scored as: 4 = strongly agree, 3 = agree, 2 = disagree, 1 = strongly disagree. An exception was the item "Women living with HIV should be allowed to have babies if they wish." which was reverse-scored to maintain consistency in the interpretation of stigma scores: 1 = strongly agree, 2 = agree, 3 = disagree, 4 = strongly disagree. According to the user guide[36], individual averages exclude "not applicable" responses, with the final score calculated from the applicable responses.

The 15-item scale for assessing HIV-related stigma, shown in Table 3, was divided into 5 categories: Fear of Infection (Items 1–2), Secondary Stigma (Items 3–5), Attitudes Toward PLHIV (Stereotypes and Prejudice) (Items 6–10), Attitudes Toward Women Living with HIV (Items 11–12), Attitudes Toward Key Populations (Items 13–15).

Since the responses include both "worried" and "agreement" answers, we standardized the answer categorization when displaying the distribution of responses for the items. "Very Positive" corresponds to "strongly disagree" and "not worried"; "Positive" corresponds to "disagree" and "a little worried"; "Negative" corresponds to "agree" and "worried"; "Very Negative" corresponds to "strongly agree" and "very worried". The exception is the item "Women living with HIV should be allowed to have babies if they wish," where "strongly agree" and "agree" are corresponds to positive, and "disagree" and "strongly disagree" are considered negative. The order of the items follows that in Table 3. Responses marked as 'not applicable' were excluded from the presentation.

Independent variable: Implementation of the Shenzhen EMTCT Programme Work Plan (Before/After)

We categorized the data from the 2020 survey round as before the work plan implementation (before), and data from the 2023 survey round as after the work plan implementation (after).

Covariates

We included five variables as covariates: age, gender, professional type, ever worked in HIV specialized units, HIV patient service experience in last 12 months. These covariates were chosen based on prior research indicating their potential association with HIV-related stigma[16,21,22].

Statistical analysis

In this study, the basic information of the survey participants was presented as frequencies and proportions. variables were compared across surveys using chi-square tests. To facilitate comparisons between the two surveys, we used inverse probability weights (IPW) based on propensity score ($\widehat{e_i}$) to simulate responses to each survey by a population with a balanced distribution of covariates[34]. The IPW model included five covariates: age, gender, professional type, ever worked in HIV-specialized units, HIV patient service experience in the last 12 months. For participants interviewed in 2020 and 2023, the IPW was defined as $w = 1/(1 - \widehat{e_i})$ and $w = 1/\widehat{e_i}$, respectively[41–43]. Missing covariate data were minimal and addressed collectively within the IPW model. We removed all participants with estimated propensity scores outside the range of [0.1, 0.9], which accounted for 6.2% of the total study sample. Standardized Mean Differences (SMDs)[44] were used to evaluate the balance in covariates in the propensity-score weighted sample, with an absolute value of less than 0.1 indicating balanced

distributions. The SMDs in covariates before and after inverse probability weighting are shown in Supplementary Table S1.

We established two multiple regression models to evaluate the trend in HIV-related stigma among HCPs from 2020 to 2023, as the assessment of the impact of the implementation of the Shenzhen EMTCT Programme work plan during this period. Since training was a crucial component of the work plan, and we collected information on whether HCPs received training a potential factor associated with stigma[22], we included it as a variable in our analysis. Model 1 was established without considering training as a covariate, allowing us to assess the overall impact of the work plan. Model 2 included training as a covariate to analyze the association between training and stigma change. We calculated the adjusted coefficients (Adj. Coef.) and their 95% confidence intervals (CIs) for both models to provide a comprehensive understanding of the change of the stigma between 2020 and 2023. Statistical significance was set at a two-sided $p\text{-}value < 0.05$. The analyses were performed using Python 3.7.

Data availability
The datasets generated and/or analysed during the current study are not publicly available due to privacy concerns but are available from the corresponding author on reasonable request.

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Declarations

Ethics approval and consent to participate

The research protocol has been ethically reviewed and approved by the Shenzhen Maternity and Child Healthcare Hospital Ethics Committee (Ethics Review Approval No.: SFYLS (2021) 057). Informed consent was obtained from all subjects involved in the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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