

# The impact of COVID-19 pandemic on HIV care continuum in Jiangsu, China

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## Research Article

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## Abstract

## Background

The COVID-19 pandemic seriously threatens general public health services globally. This study aimed to evaluate the impact of the COVID-19 pandemic on HIV care continuum in Jiangsu province, China.

## Methods

Data for analysis was retrieved from the web-based Comprehensive Response Information Management System (CRIMS) for HIV/AIDS in China. We used time series model of seasonal autoregressive integrated moving average (SARIMA) and Exponential smoothing to predict the amount of HIV care services during the COVID-19 measures, and Chi-square were performed to assess subgroup differences.

## Results

Overall, the testing rate decreased 49.0% (919,938) decrease in the first three months during the COVID-19 measures, as compared with the estimated number. Although an estimated of 1555 confirmatory tests were expected in the first three months during the COVID-19 measures, only 48.7% (757) confirmed HIV/AIDS cases were actually recorded. In the actual data during the first period of COVID-19, 980 clients received confirmatory tests, only 71.4% (700) were reportedly linked to care. Only 49.5% (235) out of the expected 475 estimated number of clients received CD4 cell count test services. Meanwhile 91.23% (208) had initiated antiretroviral therapy (ART) which compared to 227 the estimated number of initiated ART. Compared with the same period during 2016 to 2019, PLWHIV who were less than 30, migrants were more likely to be influenced by the COVID-19 policies.

## Conclusions

The COVID-19 pandemic had a negative impact on the HIV healthcare systems in Jiangsu, China. Further measures that can encounter the impact of the pandemic are needed, in order to maintain HIV care continuum.

## Background

The SARS-CoV-2 virus which causes a severe acute respiratory syndrome (COVID-19) has become a global pandemic since it was first reported in December 2019[1–4]. As the world strives to scale up public health systems in responses to the pandemic, most countries have had to close borders or restrict international traffic to contain transmission rates [5]. The Chinese government as part of its response strategy initiated a level one public health emergency response (PHER) late January 2020, which restricted social contact in communities and shut down public transportation systems at the national level [1]. These COVID-19 measures are extremely important for COVID-19 control, but it also seriously impacted other public health services including services for HIV care continuum [6]. According to some modelling studies, HIV related deaths and new HIV infection will increase with the duration of pandemic COVID-19 because of the interruption of antiretroviral therapy (ART), compared with if there was no COVID-19 pandemic [7–8].

In order to achieve the UNAIDS “90-90-90” goal [9], the Chinese government initiated a “Five expend and six strengthen” program after the “Four free one care” policy to expend and strengthen the HIV related health care system. The government scaled up the network of HIV testing to all level two hospitals or health institutions and encouraged community-based HIV testing and self-testing. However, HIV care continuum services delivery was strongly hindered by the COVID-19 measures. For example, the measures will hamper or delay to routinely HIV care services [10–13]. Meanwhile, newly confirmed people living with HIV (PLWHIV) clients also faced barriers to early ART initiation as most hospital had shut down some medical services or repurposed focus of medical services to COVID-19 cases [14].

In addition, existing facility registered PLWHIV also faced the risk of interruption to their continued access to ART, mental health care, and/or treatment of other chronic conditions services [10–11, 14–16]. Key populations faced barriers to acquiring HIV related

knowledge, receiving pre-exposure or post-exposure prophylaxis, as well as obtaining sterile needles and syringes [16].

To evaluate the overall impact of the pandemic of COVID-19 measures in a province with around 100 million people, this study compared the predicted amount of HIV care services along the HIV care continuum with the actual numbers captured from the registration system in the first three months of the COVID-19 measures in Jiangsu province, China.

## Methods

This study compared the predicted data with the actual data captured from the registration system in Jiangsu China during the first three months of COVID-19 measures in Jiangsu, China.

### Data source

All actual data were extracted from the web-based Comprehensive Response Information Management System (CRIMS), which is a real-time case reporting system for HIV care services in China. All clients that received positive HIV confirmation test results are linked to the CRIMS and are entitled to free health care services such as physical and mental health care, referral care, CD4 testing, viral load testing once per year, ART services, amongst others. Epidemiological characteristics and clinical results of PLWHIVs collated by health care workers for reporting on CRIMS including patient name, identification card number, age, occupation, route of infection, screening sites, CD4 cell count, ART, and so on.

In total, 2,500 laboratories made up of 14 confirmatory laboratories, 699 screening laboratories, and 1787 screening sites, are designated for HIV testing services in Jiangsu, as at 2019. These facilities reported data on the number of screened or confirmed tests via a web-based system monthly and the testing data used in this study were retrieved from this system.

COVID-19 related case reports for Jiangsu on the other hand were retrieved from publicly available disease databases of Jiangsu provincial Health Committee (<http://wjw.jiangsu.gov.cn/>) and merged for analysis.

### Definition of characteristics

Migratory status was determined using patients' official household registration details. Participant's whose registration were not in Jiangsu, was categorized as immigrant [10]. Screening test sites were classified into four groups consisting of: clinical sites, key population sites, penitentiary sites, and others. Data on HIV testing services accessed by persons who sought facility-based healthcare services such as surgery, antenatal care, and sexual transmitted infection testing or medical examination were categorized as hospital sites data. Screening test data that reported from voluntary counseling and testing (VCT), pre-marital examination centers, HIV-positive sexual partners or children testing, physical examination entertainment venue employees, blood donors and conscription physical examination are categorized as key population sites data. Test reports that came from detention and prison centers were categorized as penitentiary sites data while testing results obtained via other means not stated were categorized as other site data.

### Prediction of the amount of services should be provided during the first three months of COVID-19 measures

The HIV/AIDS and COVID-19 epidemic curves were constructed using data from Jan 1<sup>st</sup>, 2020 to Mar 31<sup>st</sup>, 2020 (we define this as the first three months of the COVID-19 measures in China) and key dates relating to epidemic features and control policies were overlaid to aid interpretation (Supplement fig 1). Autoregressive integrated moving average (ARIMA) model was used for forecasting parameters from 2016 to 2020. The normal formular of ARIMA is written as  $ARIMA(p,d,q)(P,D,Q)_s$ . Four synergistic steps is to developed an ARIMA model, including time series stationary, model identification, parameter estimation and diagnostic checking[17]. First, we choose sequence diagram and white noise test to test whether the time series is stationary or not with log transformation, seasonal or non-seasonal difference. The augmented Dickey-Fuller (ADF) unit root test is carried out to verify the stability of the sequence. Secondly, autocorrelation function (ACF) and partial autocorrelation (PACF) graph were applied to determine the approximate value of p, q, P and Q. Thirdly, the actual ARIMA model was determined by the parametric test and residual test. Box' test was used to test whether parameters were statistical significance and whether the residual is white noise. Lastly, according to Akaike information criterion (AIC) and Bayesian information criterion (BIC) criteria, the model with the smallest AIC and BIC values is selected as the optimal model [18]. If the ARIMA model does not fit for the data, an alternative model of

exponential smoothing model was used for forecasting parameters. All the parameters in the ARIMA model were showed in the supplement materials (Supplement fig 3, Supplement table 1). The error rate is calculated to testified the accuracy of forecast model using data from 2016 to 2019(Supplement fig 4).

### **Statistical analysis**

All curves were forecasted using R packages in R software with version 3.6.3 in a time series model for Jan 2020 to Mar 2020 based on the monthly number of reported data from Jan 2016 to Dec 2019. Then we analysis the difference characteristics between the first quarter in 2020 and cumulative numbers in the first quarter for 2016 to 2019 using R software with version 3.6.3. All statistical significance level was set at  $\alpha=0.05$ .

### **Ethical statement**

Participants provided written informed consent prior to the interview and blood collection. Information on clients' personal identifying information such as name, ID number, phone number, and home address were eliminated prior to data analysis. The study process and contents were reviewed and approved by the Institutional Review Board of the National Center for AIDS/STD Control and Prevention (NCAIDS) and Center for Disease Control and Prevention (CDC) in China. The study was carried out in accordance with relevant guidelines.

## **Results**

Findings are reported following the structure of HIV care continuum from testing to ART initiation due to the short time period.

### **Testing**

From 2016 to 2019 the actual number of screening tests reported each year for Jiangsu province accelerated from 9,644,750 in 2016 to 11,326,388 in 2019. The number of screening tests in hospital sites accounted for the majority number of HIV/AIDS screening tests recorded, and the proportion accelerated through the years from 77.0 in 2016 to 79.6 in 2019. Compared with the real number of HIV/AIDS screening tests in the same period, the estimated curve of screening tests was quite similar to the real number of screening tests during 2016 to 2019 (Fig 1). During the first period of COVID-19, the predicted number of screening test of HIV was 2,280,488. The actual number of screening test of HIV was 1,875,685 at the same time. Overall, 49.05% (919,938) decrease in screening test was found during the first period of COVID-19.

During the first period of COVID-19, the actual number of HIV screening positive was 2401. Only 40.8% (980) received confirmation test marking a significant decrease the distribution ( $P<0.001$ ) when compared to 51.5% who received confirmation test at the same period during 2016 to 2019 (Supplement fig 2).

### **Linkage to care**

Based on the estimation model, the expected number of positive screening tests was 3789 during the pandemic of COVID-19. However, the real number of positive screening test was 2401 for the same time showing 36.6% (1388) decrease in screening test positivity rate for the study period. Compared to the expected number of confirmatory tests of 1555, 37.0% decreased confirmation test was recorded. Of 980 recorded confirmed cases, only 77.2% were reported on CRIMS while 71.4% were reported to be linked to HIV healthcare. About 28.57% new PLWHIV were lost to follow up. Of the 475 clients expected to receive CD4 cell count tests, only 49.5% were reported to have received CD4 cell count tests (Fig 2, Supplement fig 2).

### **ART initiation**

Compared with the actual number of PLWHIV 700, were linked to HIV health care system, 29.7% (208) initiated ART immediately. However, when considering of the predicted number of ART initiation 227,91.63% were reported to have initiated ART (Fig 2, supplement Fig 2).

### **Characteristics of PLWHIV during COVID-19**

The number of PLWHIVs who were less than 30 in the first quarter of 2020 decreased slightly by 6.01% compared to the proportion in the same period of 2016 to 2019, however the number who aged more than 50 increased by 6.31% during the same period ( $P<0.001$ ). The number of PLWHIVs who were migration decreased by 4.19% during the same period ( $P=0.032$ ). Meanwhile, the proportion of that received CD4 cell count decreased significantly by 10.65% compared to the same period during 2016 to 2019 ( $P<0.001$ ) (Table 1).

## Discussion

The COVID-19 outbreak has had a series of impacts on the continuum of HIV health care system in Jiangsu, China. The number of reported HIV screening tests decreased by 49.05% compared with the expected estimated data during the COVID-19 pandemic period. Almost 60% of people who tested positive during HIV screening tests within the period received confirmatory tests of which about 80% were registered into the healthcare system. However, most of the PLWHIV enrolled into the HIV related health care system did not receive timely health care services. Only an estimated one third of PLWHIV received CD4 cell count tests and less than 30% of them initiated ART during the period.

As the number of HIV screening laboratories increased rapidly in the hospital system as part of response to achieving the target of “90-90-90”, hospital related screening test was the major and dominant source of HIV screening and accounted for 79.86% of all reported screening tests in 2019 for Jiangsu. However, during the outbreak of COVID-19, majority of hospitals had to shut down clinical services or shifted majority of health care resources and staffs to compliment COVID-19 effects control efforts within the level one PHER phase [15,19]. These measures halted HIV related health service chain and decreased the chances of people who wanted to check their HIV status during the period especially among members of key populations. The CDC system which is another key HIV related health care system in terms of HIV services provision had to mobilize and relocate all health resource to cope with the COVID-19 outbreak. This delayed also led to cancellation of some scheduled HIV screening and confirmatory testing as well during the period under review. Even for institutions that could still provide HIV related health care, obtaining access to transport for some community settings during the period was impossible due to the implemented policies on quarantine and social distancing. Otherwise, people who lacked knowledge on the SARS-COV-2 feared facing COVID-19 related stigma and discrimination and hence shied away from getting routine HIV testing especially in the hospital during the period [20,21].

PLWHIVs who had already been diagnosed HIV positive could access free HIV related health care services such as face-to-face counseling and free ART initiation with the help of doctors, CDC staffs, or community based organization (CBO) staffs when requested in China. However, with only 14 confirmatory testing laboratories in Jiangsu, people who received positive results in the screening test phase faced a challenge in accessing confirmatory test due to the restrictions on public transportation or the costs [19]. This study's findings showed that about 29.1% of newly diagnosed PLWHIV became lost to follow up or failed to get enrolled into the health care system during the pandemic of COVID-19. In addition, the policy on quarantine challenged the timely initiation of ART as only about 20% of newly diagnosed PLWHIVs started their ART during the COVID-19 epidemic. Until 2019, only 40 hospitals could provide ART and meet the needs of more than 20,000 PLWHIVs in Jiangsu province. More than that, PLWHIV, who were already enrolled into health care systems also faced the challenge of discontinued ART due to the movement restriction policy. An online survey conducted during the period of the level one PHER showed that about 32.6% of PLWHIV were at risk of ART discontinuation in near future [4]. In addition, some PLWHIV also believed hospital centers to be the most dangerous sites for SARS-Cov-2 infection and hence resisted the urge to receive health care services at the facility during the outbreak period [20].

Based on findings from this study, it is evident that the COVID-19 pandemic affected the whole HIV health care system. How do we then maintain the HIV health care system during the COVID-19 pandemic was a major hindrance to achieving the “90-90-90” goal. Considering the discontinuation of public screening test systems, CBO are one option to bridging the gap between key populations and healthcare systems [22–23,24–25]. Another solution to expand the network of HIV testing is for authorities to encourage HIV self-testing among key populations [26–27]. HIV self-testing is an innovative approach to merging the gap between key population and public health facilities as well as providing access to HIV testing safely by maintaining social distancing. In addition, the convenience and privacy associated with HIV self-testing can help expand the coverage of HIV testing and reach those who are reluctant, or unable to access facility-based HIV testing [28,29]. Following the procedure for HIV testing in China, the duration between time of screening test and confirmatory testing can be reduced by use of “one-stop service” centers [30]. The adoption of one-stop service centers can also help improve the success of linkage to care rates. In response to the challenges of discontinued

ART delivery, the Chinese NCAIDS made a notice to guarantee free antiviral drugs in some selected treatment management agencies. PLWHIV could therefore refill antiviral drugs at the nearest selected locations or by post to continue ART.

Our study had some limitations. First, there might have been some delays in the entry of some of the retrieved data on the HIV healthcare system due to the COVID-19 outbreak and this could have affected our data. Secondly, as most cases self-reported on their high-risk behaviors, some may have misreported behaviors due to stigma or misunderstanding especially amongst patients who have had homosexual contacts. Despite these limitations, our study showed that the outbreak of COVID-19 and the policy on quarantine and lockdown had a negative effect on the HIV healthcare system.

## Conclusions

In conclusion, the outbreak of COVID-19 as well as the quarantine and lockdown policies had a negative impact on the continuum of HIV healthcare systems in Jiangsu. Therefore, HIV testing systems should be expanded by encouraging HIV self-testing or community-based testing, and a more flexible policy for ART initiation in face of new challenges should be developed.

## Abbreviations

Severe acute respiratory syndrome coronavirus 2	SARS-CoV-2
Coronavirus Disease 2019	COVID-19
Public health emergence response	PHER
Antiretroviral therapy	ART
People living with HIV	PLWHIV
Comprehensive Response Information Management System	CRIMS
Autoregressive integrated moving average	ARIMA
Augmented Dickey-Fuller	ADF
Autocorrelation function	ACF
Partial autocorrelation	PACF
Akaike information criterion	AIC
Bayesian information criterion	BIC
National Center for AIDS/STD Control and Prevention	NCAIDS
Center for Disease Control and Prevention	CDC
Community based organization	CBO

## Declarations

### Ethics approval and consent to participate

Participants provided written informed consent prior to the interview and blood collection. Information on clients’ personal identifying information such as name, ID number, phone number, and home address were eliminated prior to data analysis. The study process and contents were reviewed and approved by the Institutional Review Board of the National Center for AIDS/STD Control and Prevention (NCAIDS) and Center for Disease Control and Prevention (CDC) in China. The study was carried out in accordance with relevant guidelines.

### Consent for publication

Not applicable.

## Availability of data and materials

COVID-19 related case reports for Jiangsu were retrieved from publicly available disease databases of Jiangsu provincial Health Committee (<http://wjw.jiangsu.gov.cn/>) . The other datasets used in this study are available from the corresponding author on reasonable request.

## Competing interests

The authors declare that they have no competing interests.

## Funding

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## Authors' contributions

L S, W T and G F had the original idea; T Q, H H, X L, Y C and Y C collected the data; L S, G M and W T analyzed the data; L S wrote the main manuscript text; G M, Y C, W T and G F revised the manuscript.

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Tables

Table 1. Characteristics of reported HIV cases in the first quarters of 2016 to 2020

Characteristics	2016 -2019 Q1	2020 Q1	Chi square (P value)
Age group			
<30	1400(34.71)	215(28.70)	15.596 (0.000)
30-49	1526(37.83)	281(37.52)	
≥50	1108(27.47)	253(33.78)	
Gender			
Male	3518(87.21)	665(88.79)	1.291(0.256)
Female	516(12.79)	84(11.21)	
Education			
Primary and below	598(14.82)	162(21.63)	22.841(0.000)
Junior middle school	1318(32.67)	238(31.78)	
High school and above	2118(52.50)	349(46.60)	
Marital status			
Single	1554(38.52)	260(34.70)	4.569(0.102)
Married	1918(47.55)	370(49.40)	
Disvoted or widow	562(13.93)	119(15.89)	
Migration			
Yes	1677(41.57)	280(37.38)	4.413(0.036)
No	2357(58.43)	469(62.62)	
Routine of transmit			
Homosexual	2212(54.83)	392(52.34)	2.544(0.279)
Heterosexual	1700(42.14)	338(45.13)	
others	122(3.02)	19(2.54)	
CD4 test			
Yes	1733(42.96)	242(32.31)	29.119(0.000)
No	2301(57.04)	507(67.69)	
ART			
Yes	704(17.45)	208(21.03)	42.920(0.000)
No	3330(82.55)	541(78.97)	

Figures

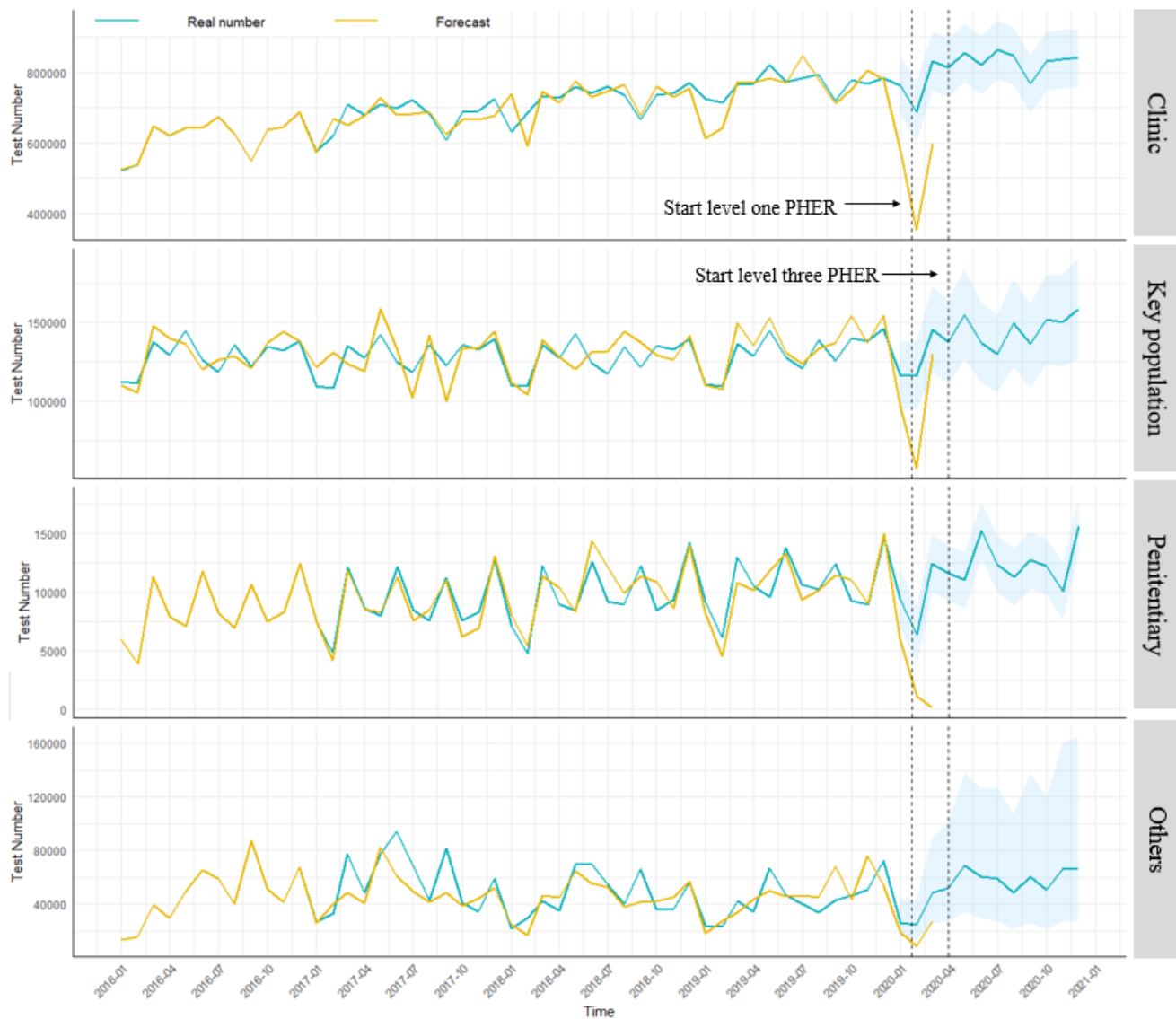
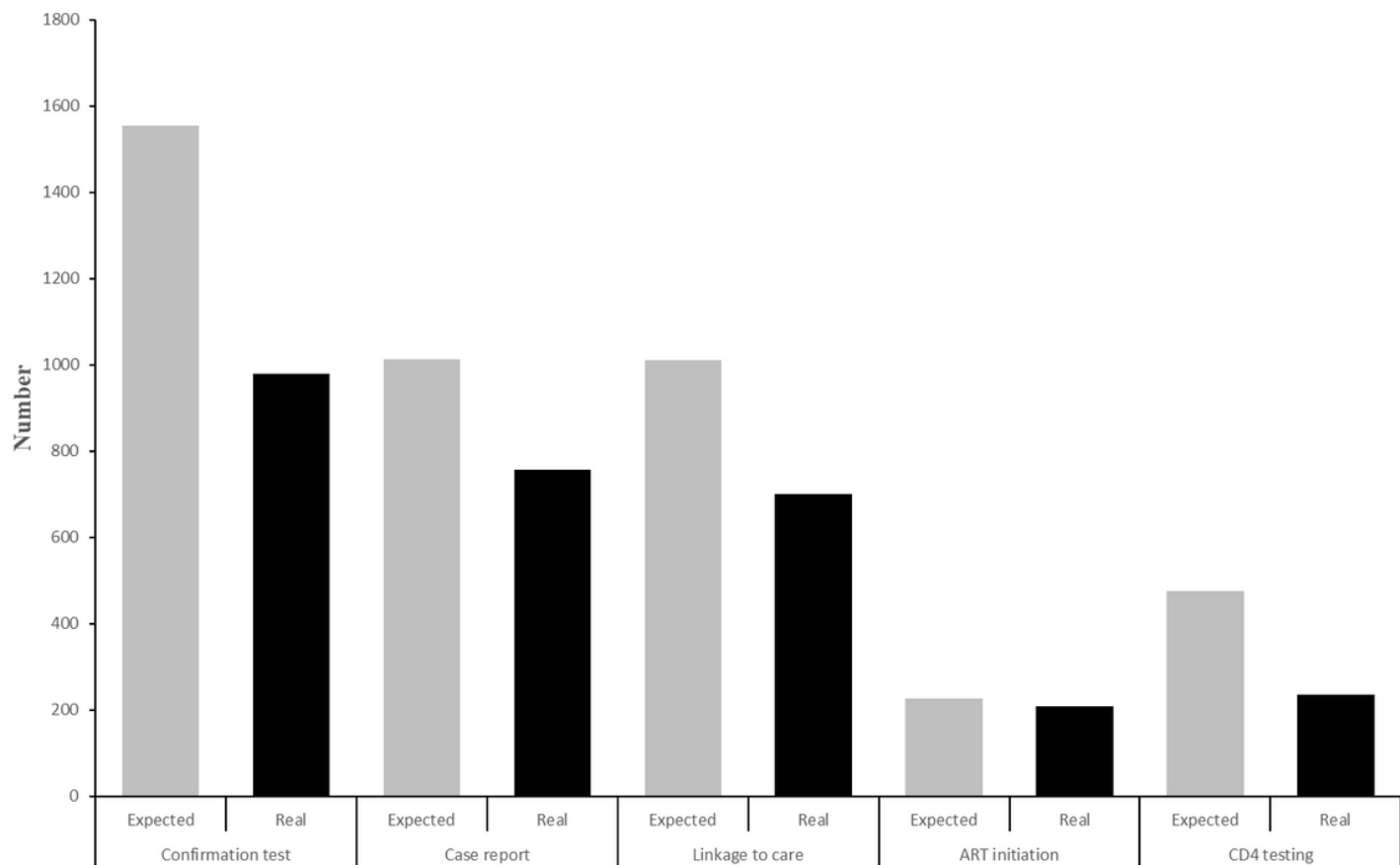


Figure 1

An estimation curve of HIV screening tests during 2016 to 2020



**Figure 2**

Cascade of linkage to healthcare success rates during COVID-19 era in Jiangsu, China, 2020

**Supplementary Files**

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