Integrated universal HIV testing with public health care program: an exploratory study of 1.1 million people from Eastern China

Tiansheng Xie (tianshengxie@zust.edu.cn)
Zhejiang University of Science and Technology https://orcid.org/0000-0001-5323-6082
Fumin Liu
The First Affiliated Hospital of Zhejiang University, School of Medicine, Zhejiang University
Nanping Wu
The First Affiliated Hospital of Zhejiang University, School of Medicine, Zhejiang University

Research

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Abstract

Objective

By investigating the large-scale HIV antibody screening of more than 1 million people, we explored weather the strategy of integrated universal HIV testing in a public health care program was useful.

Methods

We used a multi-stage stratified random cluster sampling method in a community-based investigation of 30 sample points within 9 counties in the Zhejiang province. The HIV antibody was detected, and demographic information was collected.

Results

Of the 1 113 030 people screened for HIV, 310 tested positive (adjusted HIV prevalence, 3.45/10000; 95% confidence interval [CI], 3.41–3.48). The HIV prevalence was higher in men(5.62/10000) than in women(1.17/10000) of all ages; those in the 25–34 and 35–44 age groups were highest (compared with the < 15 age group, the adjusted odds ratios were 25.69 and 18.48, respectively). The HIV prevalence at the medium gross domestic product (GDP) level (adjusted HIV prevalence, 5.28/10000; 95% CI, 4.53–6.04) was significantly higher than those at high and low GDP levels Especially in the male 25–34 and 35–44 age groups. Compared with the native HIV positive population, the migrants were younger, did not have a stable sexual partner, and had a lower level of education.

Conclusion

By using universal HIV testing integrated into a public health care program was feasible and (perhaps) effective in finding new HIV cases. We should pay more attention to the 25–44 age male population, as well as migrants in our HIV/AIDS control strategies, especial in industrial activity district.

Introduction

The debate regarding the screening of human immunodeficiency virus (HIV), has persisted for more than 25 years. In 2012, the United States Preventive Services Task Force (USPSTF) recommended that clinicians screen adolescents and adults for the HIV infection [1]. HIV screenings and the earlier initiation of antiretroviral therapy (ART) combined with modifications of risky sexual behavior, reduced new infections by up to 65% [2]. Through increases in the availability and coverage of ART, the implementation of a "treatment as prevention" strategy became one of the most important achievements in efforts focused on acquired immunodeficiency syndrome (AIDS) [3, 4, 5]; however, a large proportion of HIV-positive individuals have not yet been identified. The results of a 17-country survey indicated that a median 11% of women and 10% of men had never received HIV tests and results [6]. The individual's awareness of their HIV status is important for the HIV care [7, 8]. At the end of 2012, Chinese authorities reported 383,285 confirmed cases of HIV [9]. The estimated number of PLWH in China was 780,000 in 2011 [10], and approximately 50% of those with HIV infection did not know their serostatus. Studies have indicated that those uninformed individuals in a population were sources of the HIV infection [11]. Community-based interventions have been successfully conducted to increase HIV testing in other countries [12, 13, 14, 15], however, routine HIV testing of all adults is not yet a primary goal in China [16, 17].

In our study, to identify a greater number of PLWH, we conducted a community-based epidemiological investigation of HIV infection among 1 113 030 individuals in the general populations that was integrated into a public health care program in the Zhejiang province.

Methods

Study setting and background

Zhejiang province is one of the most densely populated provinces in China, with approximately 33.5 million urban residents and 20.9 million rural residents. 11 357 HIV infections at the end of 2012 have been reported. The health exam plan (HEP) was first implemented by Zhejiang province in 2005 and has been provided free of charge to all residents every 2 years since then. The plan includes a physical examination (e.g., interrogation, auscultation, measuring blood pressure) as well as routine laboratory testing (e.g., blood glucose and blood lipid levels). With the support of the Mega-Project for National Science and Technology Development for the “11th Five-Year Plan of China” and the Bureau of Health of Zhejiang Province, the HIV antibody test was added to the HEP in the 9 counties. A cross-sectional study was conducted, and the data were mainly collected from the HEP.

Study design

Sample

The population survey and testing were conducted in 9 counties. These counties were selected among the 90 counties in the Zhejiang province because of their representative prevalence rate of HIV and HIV epidemic influencing factors (e.g., geographic location, population density, economic development). To be eligible for the study participants had to meet the following requirements: be a resident of the town or have lived there for >6 months; and provide consent to participate in the study.

Using a multi-stage stratified random cluster sampling method according to gross domestic product level (GDP; high [GDP-H], medium [GDP-M], or low [GDP-L]) [18], a total of 9 counties covering a population of 3 million were chosen from among 90 counties, the selected 9 counties were divided into GDP-H, GDP-M, and GDP-L levels, and each GDP level (about 1 million population per level) was assessed using 10 sampling points (approximately 400 000 people per point) (Fig. 1).

Data collection

The Prevention and Treatment Working Group of HIV/AIDS in Zhejiang Major Infectious District conducted the field investigation. After receiving appropriate training offered by the leading researchers in this study, the physicians of each participating hospital conducted medical examinations, interviews, and laboratory tests on subjects who volunteered for the free medical and health examinations. All residents and migrant workers who had lived in the area for >6 months qualified for inclusion. Collected information consisted of demographics (sex, age) and laboratory tests (HIV). For those who were HIV positive, information such as residence status, occupation, highest level of education, and marital status were recorded additional.

Ethics

The study was approved by the Ethics Committee of The First Affiliated Hospital at the School of Medicine of Zhejiang University(ID:2009-scientific research-7). Written informed consent was obtained from each participant or from the next of kin on behalf of minor/child participants. The registration number is ChiCTR-EOC-16009254.

Blood test

Blood samples were screened for HIV associated antibodies using an enzyme-linked immunosorbent assay technique (bioMerieux, The Netherlands) according to the manufacturer's instructions. If the result was positive, two additional assays (the original assay plus a second confirmatory assay) were conducted in parallel. If both results were positive or the results were discordant, a confirmatory test was performed by a western blot assay (HIV BLOT 2.2; Genelabs Diagnostics Pte. Ltd., Singapore).

Data analysis

All data collected by paper-and-pencil surveys were input manually into a custom-designed database and analyzed using SPSS for Windows Version 16.0. Descriptive statistics were generated for each of the general characteristics variables. We used Chi-square tests to compare the prevalence differences among the different demographic groups. Logistic regression analysis was performed to test the risk factors associated with HIV; in addition, adjusted odds ratios (AOR) were calculated by first building logistic models that adjusted for the factors found to be significant in the univariate analysis ($p < 0.05$) and subsequently limiting final multivariate models to those risk factors or confounders that were statistically significant. All statistical tests were two-sided with a significance level of $p < 0.05$. The participants were divided into the following age groups: <15, 15–24, 25–34, 35–44, 45–54, 55–64, and ≥65 years. The HIV prevalence rate was standardized by age and sex according to the year 2000 Chinese population structure [19].

Results

Demographic characteristics

Based on our sampling strategy, 1 113 030 residents were included in the study, 30 sample locations were registered according to the degree of economic development (GDP-H, GDP-M, and GDP-L levels, which had 10 points each and contained 390 782, 357 902, and 364 346 residents, respectively). All 1 113 030 subjects were submitted for HIV antibody testing; 406 649 (36.50%) of whom were male, of whom the mean age was 47.29 ± 18.11, 140 397 (12.61%) were ≤24 years of age, 550 465 (49.46%) were 25–54 years of age, and 422 159 (37.93%) were ≥55 years of age (Fig. 1, Table 1).

HIV prevalence by demographics

Of the 1 113 030 people screened for HIV, 310 (2.79/10000) were positive, with a standardized (adjusted for sex and age) rate of 3.45/10000 (95% confidence interval [CI], 3.41–3.48) (Table 1).

Among the male subjects, the crude rate was 5.56/10000, and the standardized rate (adjusted for age) was 5.62/10000 (95% CI, 5.54–5.69). Among the female subjects, the crude rate was 1.20/10000, and the standardized rate (adjusted for age) was 1.17/10000 (95% CI, 1.15–1.20). The HIV prevalence was higher among men than women in all age groups. Compared with male subjects, the risk of HIV infection for females was lower (OR = 0.22, AOR = 0.16; $p < 0.05$) (Table 2).

As expected, we found significant differences in HIV prevalence by age (Table 1, Fig. 2). The HIV prevalence was significantly lower in subjects < 15 years of age than in older subjects: the crude rate was 0.41/10000, while the standardized rate (adjusted for sex) was 0.42/10000 (95% CI, 0.34–0.5). The HIV prevalence was highest for the 25–34 age group: the crude rate was 5.07/10000, while the standardized rate (adjusted for sex) was 9.30/10000 (95% CI, 9.16–9.44). Compared with the subjects in the <15 age group, those in other groups had a higher risk of HIV infection (AOR range, 2.49–25.69) and those of the 25–34 and 35–44 age groups were extraordinarily high (OR = 12.33, AOR = 25.69, $p < 0.05$; OR = 11.71, AOR = 18.48, $p < 0.05$, respectively) (Table 2).

The HIV prevalence was also different at different GDP levels: the GDP-M level was the highest, with a crude rate of 3.38/10000 and a standardized rate (adjusted for sex and age) of 5.28/10000 (95% CI, 4.53–6.04); and the GDP-H level was the lowest, with a crude rate of 2.30/10000 and a standardized rate (adjusted for sex and age) of 2.75/10000 (95% CI, 2.28–3.27). Compared with the GDP-H level, the risk of HIV infection at the GDP-M level was higher (OR = 1.49, AOR = 1.72, 95% CI, 1.30–2.26, $p < 0.05$); no difference in HIV infection risk was seen between the GDP-H and GDP-L levels ($p > 0.05$).

To determine the reason for the variation in HIV prevalence at different GDP levels, we further analyzed the HIV prevalence distribution by gender and age and found that the HIV prevalence differences among levels specifically manifested themselves in the male population ($p < 0.05$). In contrast, no significant differences were seen in the female population (Fig. 3A). We simultaneously found that the HIV prevalence of the 25–34 and 35–44 age groups in the GDP-M level population were significantly higher than those in the GDP-H and GDP-L levels and that there was no difference between the GDP-H and GDP-L levels at any age group (Fig. 3B).

HIV positive population character analysis

All 310 HIV-positive cases were divided into a native group and a migrant group. The average patient age in the native group (163 cases; 52.58%) was 47.28 ± 13.25 years, while that of the migrant group (147 cases; 47.42%) was 34.27 ± 8.56 years. The migrant group was an average of 10 years younger; most of these individuals were in their sexually active periods. Compared with the native group, the migrant group had the following characteristics: more were unmarried (33.98% vs. 12.63%, $p < 0.05$), less educated (91.3% completed junior high school or less) and worked in migrant positions. We believe that being unmarried, less educated, and a migrant worker may be an important influencing factors for HIV transmission in Zhejiang province.

Discussion

Controversy has recently surrounded the idea of screening efforts, specifically whether they should be targeted at the highest risk groups or be routine elements of clinical practice [20]. While the proportion of PLWH who are aware of their status is approximately 80% in the U.S. [21, 22], the majority of those infected with HIV in Africa are unaware of their status [23, 24]; this percentage in China is approximately 40%. Individuals who are unaware of their serostatus can be a significant source of the infection. To identify all HIV-positive individuals, an expanding population-based test for HIV infection is thus recommended. There are several factors that prevent effective HIV testing and, the development of related programs and policies, which include HIV stigma and fear as well as practical obstacles such as transportation and cost [25, 26, 27, 28].

In this study, the HIV-antibody test was performed in the general population in 9 counties, which involved approximately 1 113 030 subjects. This was done in an attempt to understand the true HIV prevalence in the Zhejiang province. This large-scale population test was the first implementation of the USPSTF's universal HIV testing guideline in a developing country. We found that the crude HIV rate was 2.79/10000 and the standardized rate was 3.45/10000 (95% CI, 3.41–3.48), almost the same as the estimated rate of the Zhejiang province, which was calculated using the workshop model. However, it was much higher (nearly three times) than the reported rate in the general population in Zhejiang (0.01%) [29].

We can understand from this finding that universal HIV testing in the general population can be an effective strategy to identify PLWH and to identify the actual HIV prevalence. Similarly, testing participation increased from 10–37% in Uganda when individuals were made aware of their HIV test results at home instead of at a counseling site [30]. District-wide door-to-door HIV testing reached 63% of total households in the Bushenyi District, Uganda. This increased the proportion of people tested for HIV (20% vs. 63%; $p < 0.001$) and disclosed their serostatus (72% vs. 81%; $p = 0.04$) [31]. Improved coverage for HIV testing and reductions in the number of uninsured people should help the state and local health departments to expand of HIV screening [32]. The current study was integrated into the routine public health care of the Zhejiang province since we acknowledged that the government plays an important role in such efforts.

The current results also show that the HIV prevalence was much higher among males (5.62/10000) compared to females (1.17/10000). This finding is consistent with those of other studies [33, 34] concluding that, compared with women, men have a greater risk of contracting the HIV infection. This may be due to unprotected casual sexual behavior [35]. We also found significant differences by age in HIV prevalence: compared with the < 15 age group, the AOR of the other groups for HIV was 2.49–25.69. The HIV prevalence of the 25–34 age group was the highest, with a standardized rate of 9.30/10000 (95% CI, 9.16–9.44).

It was interesting to find that the HIV prevalence was also related to the economic development level; specifically that the HIV prevalence was GDP-M > GDP-L > GDP-H, and further analysis revealed that the male 25–34 and 35–44 age groups at the GDP-M level had a significantly higher risk than those at other levels. This may be because at the GDP-M level, the industrial structure includes more migrant workers and most of the work force consists of young men whose behaviors can put them at a higher risk of contracting infectious diseases. Some studies have suggested that rural migrant workers play an important role in HIV transmission in China [36, 37]. The HIV prevalence differences at various GDP levels may also be due to sanitary conditions as well as the interconnection of biological, social, ecological, and technological processes. Further studies should be performed to confirm our results.

A total of 47.42% of the entire HIV-positive population consisted of migrant workers. This finding means that nearly half of the HIV-positive subjects were not native; rather, they were migrant. Compared with the native HIV-positive subjects, the migrants were younger, more likely to not have a fixed sexual partner and are less educated. Limited education, constant mobility, hazardous working conditions, low wages, chronic underemployment, and substandard housing are also factors that can compromise the health of rural migrant laborers and make them more vulnerable to contracting HIV [28, 38]. Hence, migrants may serve as a “bridge” population that transmits HIV/STDs from high-risk groups to the general population. We suggest that more attention should be paid to reducing the migration of PLWH.

In conclusion, our study demonstrates a successful application of universal HIV testing by the integration of its principles into routine public health care in China. Our findings show that universal HIV testing is an effective way to identify PLWH. We believe that the calculated prevalence of 3.45/10000 is representative of the real HIV prevalence in the Zhejiang province. We suggest that the government should pay more attention to reducing harm inflicted by the sexually active male population. “Testing as prevention” (universal HIV testing in the general population; the early detection of PLWH) should be the foundation of the “treatment as prevention” strategy.

Declarations

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Author Contributions: Conceived and designed the experiments: NPW TSX. Performed the experiments: Prevention and Treatment Working Group of HIV/AIDS in Zhejiang Major Infectious District. Analyzed the data: TSX FML. Wrote the paper: NPW TSX.

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Tables

Table1. HIV prevalence in the study population

	No. of Subjects	HIV(+)	Crude Rate (/10000)	Standardized Rate (/10000)	95% CI (/10000)	P value of the Chi-square tests
Total*	1113030	310	2.79	3.45	3.41–3.48	
Age**						P < 0.01
<15	24313	1	0.41	0.42	0.34–0.50	
15–24	116084	24	2.07	3.18	3.08–3.28	
25–34	167746	85	5.07	9.30	9.16–9.44	
35–44	172462	83	4.81	6.54	6.42–6.65	
45–54	210257	60	2.85	3.53	3.45–3.61	
55–64	218657	40	1.83	2.04	1.98–2.10	
≥65	203502	17	0.84	0.78	0.74–0.81	
Gender***						P < 0.01
Male	406649	226	5.56	5.62	5.54–5.69	
Female	702543	64	1.20	1.17	1.15–1.20	
GDP level*						P < 0.01
GDP-H	390782	90	2.30	2.75	2.28–3.27	
GDP-M	357902	121	3.38	5.28	4.53–6.04	
GDP-L	364346	99	2.72	2.80	2.26–3.34	

Note: *Standardized by age and gender

**Standardized by gender

*** Standardized by age

Table 2. HIV infection risk factors according to logistic regression analysis

	OR	AOR	95% CI	P value
Age				
<15	1.00	1.00		
15–24	5.03	8.94	1.21–66.20	0.03
25–34	12.33	25.69	3.57–185.01	0.00
35–44	11.71	18.48	2.57–133.02	0.00
45–54	6.94	10.19	1.41–73.62	0.02
55–64	4.45	6.06	0.83–44.16	0.08
≥65	2.03	2.49	0.33–18.73	0.38
Gender				
Male	1.00	1.00		
Female	0.22	0.16	0.13–0.21	0
GDP level				
GDP-H	1.00	1.00		
GDP-M	1.49	1.72	1.30–2.26	0.00
GDP-L	1.18	1.15	0.86–1.53	0.35

OR, odds ratio; AOR, adjusted odds ratio; CI, confidence interval; GDP-H, high gross domestic product; GDP-M, medium gross domestic product; GDP-L, low gross domestic product

Figures

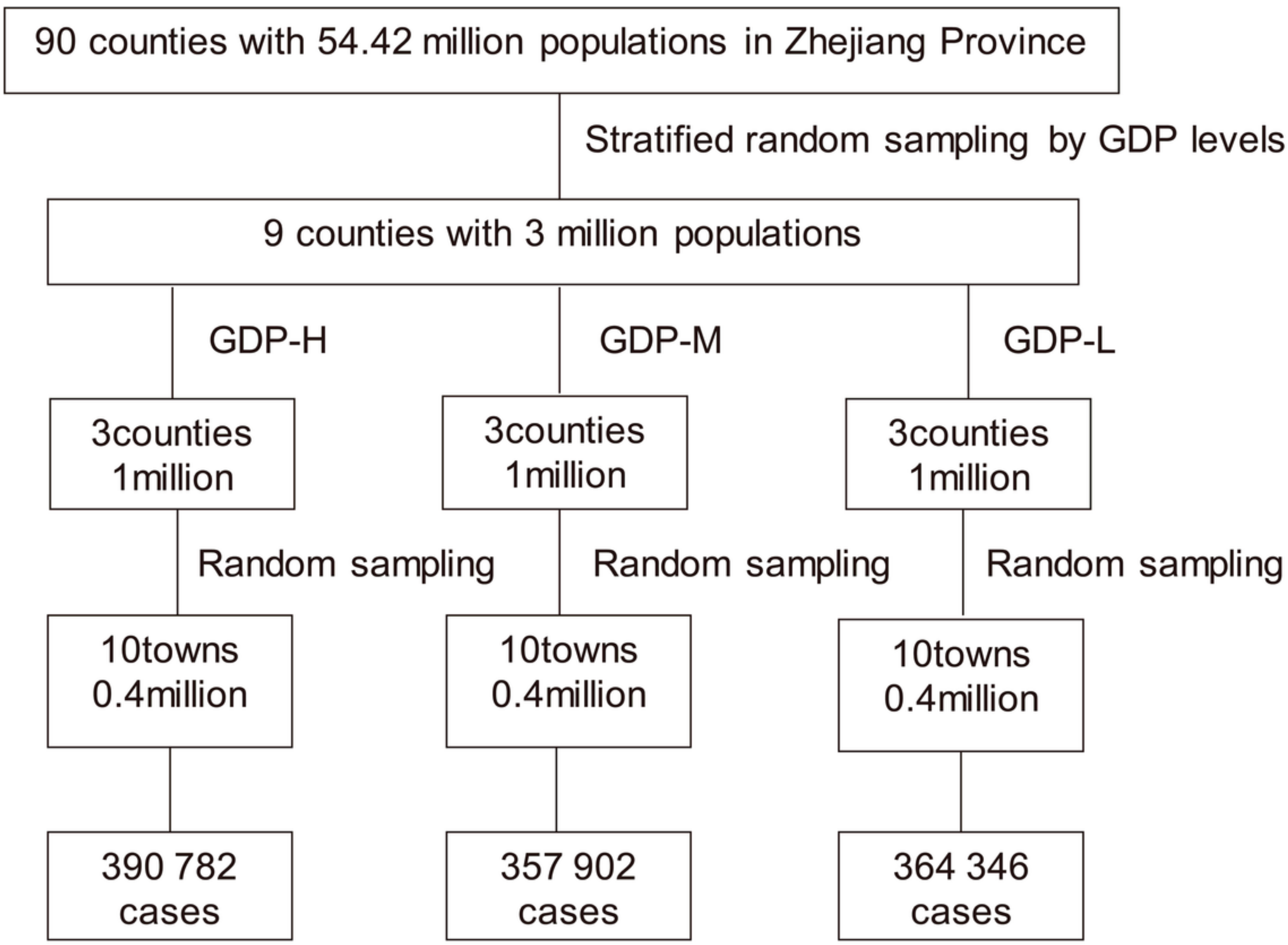

Figure 1

Sample collecting chart. Using a multi-stage stratified random cluster sampling method, a total of 9 counties covering a population of 3 million were chosen from 90 counties in Zhejiang Province, according to the level of GDP, the selected 9 counties were divided into GDP-H,GDP-M,GDP-L levels, each level have about 1 million population, and then in each GDP level chose 10 sampling points by random sampling method, finally GDP-H,GDP-M and GDP-L contained 390 782,357 902,364 346 subjects, respectively.

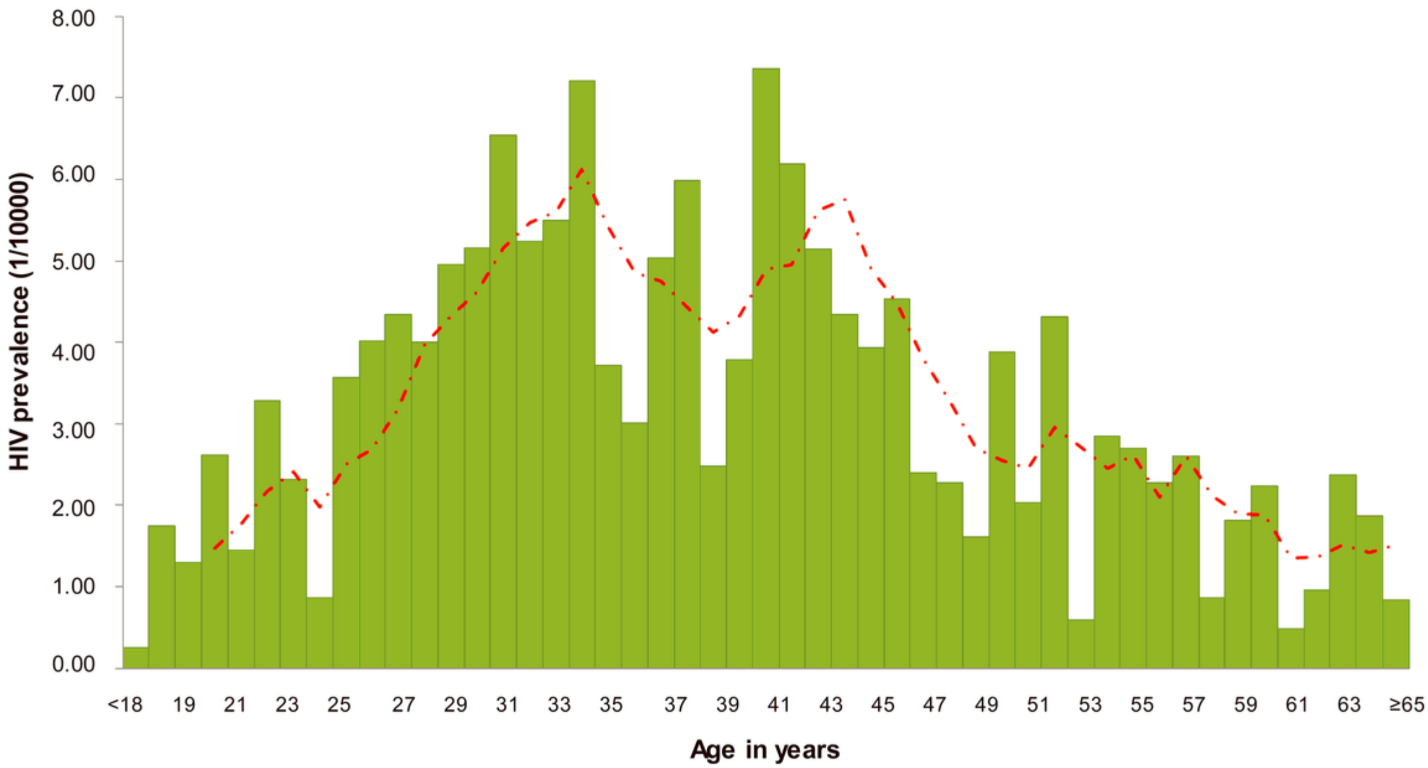

Figure 2

Distribution of HIV crude rate by age. Each column represents the HIV prevalence of corresponding age, HIV prevalence significant differences by age, and presents a double-peak. As can be seen from the red trend line, HIV prevalence of 25-34, 35-44 age group seems higher than that of other age group. Among the subjects <18 years and older than 60 years, the HIV prevalence were relative low.

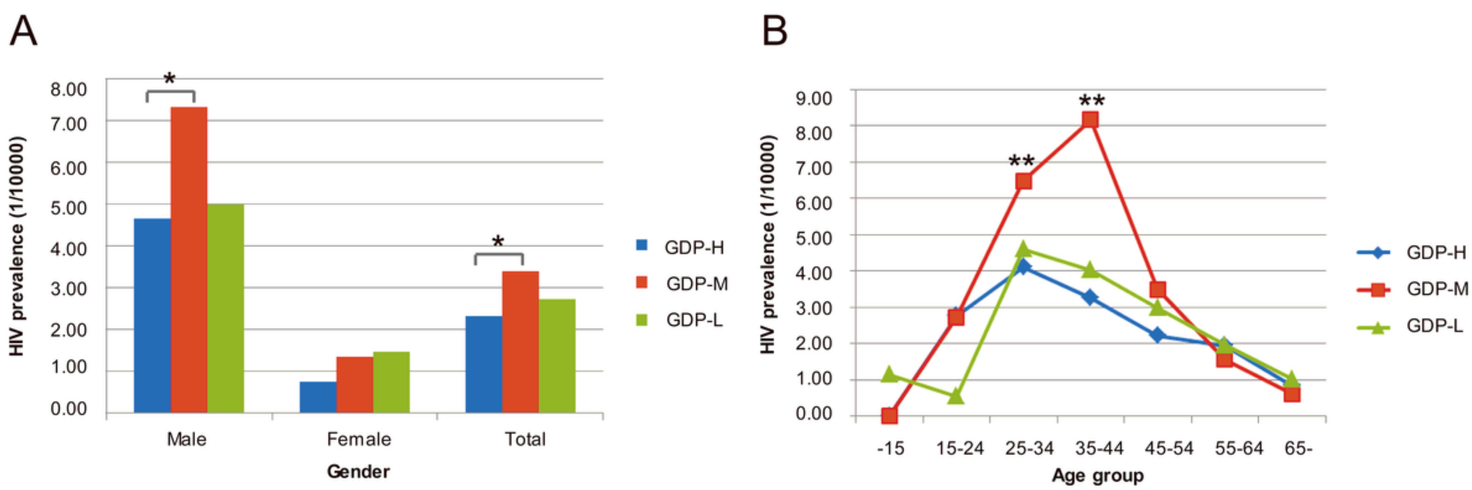

Figure 3

Subgroup analysis of HIV prevalence by GDP level. (A) Analyzed the HIV prevalence distribution by gender, between different GDP levels the HIV prevalence difference specifically manifested itself in the male population, compared with GDP-H, the HIV prevalence in GDP-M was significantly high in the male and total population($P<0.05$, labeled with *). There were no significant differences in the female population. (B) Analyzed the HIV prevalence distribution by age,25-34,35-44 age groups' HIV prevalence in the GDP-M level population was significantly higher than that in the GDP-H level ($P<0.05$, labeled with **), and there was no difference in all age groups between the GDP-H and GDP-L level.