

The Role of Personality, Social Economic and Prevention Strategy Effects in Health-Related Quality of Life Among People Living with HIV/AIDS

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Research Article

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**The role of personality, social economic and prevention strategy
effects in health-related quality of life among people living with
HIV/AIDS**

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Abstract

Background

HIV/AIDS has transformed into a chronic controllable but not yet curable disease as other chronic diseases. The first-three 90% was an epidemic control, the addition of so-called fourth 90% that included the improved HRQoL for PLWHIV required solutions beyond ART and viral load suppression. To explore the effects of specific factors on HRQoL could help to appreciate the quality of health care they received and to support the policy making during the whole prevention process. Our study will explore the role of personality, social economic and prevention strategy effects in health-related quality of life among people living with HIV/AIDS.

Methods

A cross-sectional study was conducted among PLWHIV aged more than 16 years old in the 10 municipals in Yunnan province, China. Individual-level HRQoL data were measured by SF-12 and EQ-5D-5L. We assembled municipal-level data about social economic from the Yunnan Statistical Yearbook in 2020 carried out by Statistical Bureau of Yunnan Province. Another municipal-level data about prevention strategy was from the evaluation system for the quality of strategy implemented. We used the principal component analysis to build the social economic and strategy effect on each area respectively and used multi-level model (MLM) to explore the personality, social economic and strategy effects in health-related quality of life among PLWHIV.

Results

According to the principal component analysis, all the ten areas were classified into ten models by the social-economic level and four kinds by the prevention strategy practice level. About area effect, the significant difference of global HRQoL measured by EQ-5D-5L index score was found between strategy 1 and strategy 2 ($Z=2.14$, $P<0.05$). The significant difference of mental component of HRQoL measured by PCS-12 was found between strategy 1 and strategy 3 ($Z=-3.23$, $P<0.001$). About individual effect, the significant difference of global HRQoL measured by EQ-5D-5L

and also demonstrated in the variables of all have known HIV status and not clear whether to know compared to no one know the infectious status($Z=-4.89$, $P<0.001$, $Z=-2.65$, $P<0.01$). The significant difference was found in the physical component of HRQoL measured by PCS-12 between partial have known HIV status, all have known HIV status and not clear whether to know compared to no one know the infectious status($Z=-2.29$, $P<0.01$, $Z=-3.49$, $P<0.001$, $Z=-2.58$, $P<0.05$). We also found the significant difference between the all have known HIV status and no one know the infectious status ($Z=-3.160$, $P<0.01$). The significant difference also existed in the variables of anxiety score and depression score ($Z=-7.84$, $P<0.001$, $Z=-2.58$, $P<0.05$). These significant differences were also found in the physical component and mental component of the HRQoL measured by PCS-12 and MCS-12 ($Z=-7.07$, $P<0.001$, $Z=-2.98$, $P<0.05$; $Z=-16.81$, $P<0.001$, $Z=-11.25$, $P<0.05$). Otherwise the social support score contributed positively to predict the PCS-12 and the MCS-12 ($Z=3.34$, $P<0.001$, $Z=8.14$, $P<0.001$). The interaction effect demonstrated between the individual-level variable of anxiety and the area-level variable of strategy practice whatever in global HRQoL or PCS-12 and MCS-12($Z=3.3.32$, $P<0.001$; $Z=3.28$, $P<0.001$; $Z=3.27$, $P<0.001$). It demonstrated that the effects of individual-level predictors of others know HIV status, transmission model, recent CD4 counts, social support, anxiety and depression on HRQoL were different among different areas.

Discussion

Our study identified the possible strategy determinant of individual HRQoL of PLWHIV and we also found the area effect on the HRQoL. In our study, we considered the social-economic model to explain the area effect. The area-level predictors explained a proportion of the between-area variation of the HRQoL scores, whatever the physical component and the mental component. Our study demonstrated the impact of the stigma, social support, anxiety, depression and social economic status on the HRQoL in the individual-level. This study also showed the evidence of initial casual heterogeneity on the effects of HRQoL. The impact of the individual-level factors on a respondent's HRQoL may be modified by the area-level

characteristics to some extents. Finally our study demonstrated a model combined of area-level social-economic and prevention strategy practice and individual effect on the HRQoL, which could be a valuable resource for evaluating the overall health of the areas and help improve local decision making.

Key words: Health-related quality of life, HIV/AIDS, Multi-level model, Personality factors, social economic, prevention strategy

Background

With advanced access to antiretroviral therapy (ART) and effective ART delivering of sustained virological suppression, the health outcomes of people living with HIV/AIDS (PLWHIV) have been significantly enhanced. HIV/AIDS has transformed into a chronic controllable but not yet curable disease as other chronic diseases [1,2]. Health-related quality of life (HRQoL) was a pivotal aspect for both clinical and research in chronic diseases, which often required the complex and life-long management and therapies [3]. Otherwise, we could not consider HRQoL as a unitary construct, which included several domains of psychological, social, occupational and physical to cope with the complicated progressions of chronic diseases [4]. The UNAIDS 90-90-90 targets (that by 2020, 90% of all people living with HIV will know their status, 90% of people diagnosed with HIV infection will receive sustained ART, and 90% of those receiving ART will virally suppressed) [1] are increasingly being achieved in the future. The first-three 90% was an epidemic control, the addition of so-called fourth 90% that included the improved HRQoL for PLWHIV required solutions beyond ART and viral load suppression [5]. Suitable HRQoL could become equal significance to the first-three. Therefore, to explore the effects of specific factors on HRQoL could help to appreciate the quality of health care they received and to support the policy making during the whole prevention process.

Previous studies have shown the determinants of HRQoL among PLWHIV [6-9]. Most of them have emphasized on the positive role of ART to improve the HRQoL of PLWHIV. Some social-demographic factors, such as education level, family economic status and employment status could also contribute to the good global HRQoL. Published reviews and meta analyses have shown insufficient social support, stigma and discrimination, week adherence to ART, Low CD4+T cell count and advancing HIV stage were linked with poor HRQoL. These factors could consider as the indicators of the strategies and interventions which implemented in the contexts. Some researchers have hypothesized that the individual's HRQoL was not only defined by their personal-level characteristics, but also was socially determined by

both physical and social environmental characteristics [10]. So we could summarize the predictors of HRQoL for PLWHIV as the three categories: personality, social economic and strategies. For the PLWHIV on ART, the effect of ART was strongly associated with the adherence to ART, HIV care clinics and specialized HIV services, which often defined by the local strategy inclination and professional technology level. We could consider the effect of ART on the HRQoL to be a cluster at the strategy level. Otherwise, education level, family economics and employment status could generate another cluster at the area-specific social economic level. These factors could also generate the effect on the HRQoL of PLWHIV on the individual level. One study has explored the area deprivation that was an independent effect isolated with the individual effect on adult depressive symptoms in China [11]. One study revealed the family level factors which influence the adolescents' global physical self-concept. The same result was also found in a research to determine the family clustering of depressive symptoms [12]. For the CD4 cell count, a research adopted the same analyses train of thought and demonstrated that the variation existed between patients occupied 63% and within patients occupied 37% [13]. One study calculated the proportion of between-county variation in HRQoL that was explained by country-level contextual variables. All these research have explored the determinants from different levels to predict the dependent variables and found the casual heterogeneity of level-1 factors on dependent variables modified by level-two factors.

HRQoL of PLWHIV was an indicator that had multi-dimensions [14], the effects from predictors associated with HRQoL were always complicated. To guide public health policy, it would be informative to examine the variation of HRQoL among geographic areas and strategy differences. Few study was conducted to explore the effects on HRQoL of PLWHIV from different levels, especially on the strategy and area level, which is critical for the policy making to accomplish the fourth 90. Our study will explore the role of personality, social economic and prevention strategy effects in health-related quality of life among people living with HIV/AIDS and the causal heterogeneity modified by level-two factors on level-one factors to predict dependent

variables.

Methods

Study design and study population

A cross-sectional study was conducted among PLWHIV aged more than 16 years old in the 10 municipals in Yunnan province from October, 2019 to May, 2020. A convinced sampling method was used to include 1,997 participants. All the investigators from local CDCs and social organizations were trained strictly to implement the investigation face to face.

Data collection

Health-related quality of life

Individual-level HRQoL data were measured by SF-12 and EQ-5D-5L. SF-12(12-item Short Form Health Survey), which is the shortened version of SF-36 (36-item Short Form Health Survey) and could explain at least 90% accuracy of SF-36^[15]. The SF-12 consists of eight domains to generate finally two separate summary scores, physical functional scores (PCS) and mental functional scores (MCS) ranging from 0 to 100. Higher scores indicated the better HRQoL. We also used EQ-5D-5L to measure the HRQoL simultaneously. The EQ-5D-5L could define the 3,125 possible health states by the different combinations. We adept the Chinese population-based preference trade-off time (TTO) to transform the measures into UI (Table 1), thereby producing a single preference-based index ranging from -0.391 to 1.000, where 0 was equal to death and -0.391 meant worse than death. For example, when we calculated a combination of “21145”, the UI equaled to $1-0.066-0-0-0.252-0.258=0.424$ ^[16].

Demographic and HIV diagnosis variables

All the demographic data, including age, race/ethnicity, education level, marital status, household income per year, whether infection status known to others or not and so on, and HIV diagnosis variables, including initial infection status, transmission model,

duration of ART and the most recent CD4 counts were obtained by self-designed questionnaires.

Social support, depression and anxiety

We used the Social Support Rating Scale (SSRS) established by Xiao Shuiyuan in 1986 primarily for the Chinese population [17]. It comprised ten items and three dimensions. A respondent's social support was measured on three scales: objective social support, subjective social support and support utilization. The final social support was obtained by averaging all items scores from three dimensions. A higher total score demonstrated a higher level of perceived social support. Anxiety and depression were measured by the Chinese version of the Hospital Anxiety and Depression Scale (HADS) [18], which was a short scale with 14 items designed for anxiety and depression diagnose in non-psychiatric patients. Anxiety and depression were assessed by seven items respectively. Higher scores demonstrated more serious depression or anxiety symptoms.

Area-level data collection

We assembled municipal-level data about social economic from the Yunnan Statistical Yearbook in 2020 carried out by Statistical Bureau of Yunnan Province [19]. We used the data of GDP per capital, employment rate, birth rate, mortality rate and natural growth rate to calculate the municipal-level social economic effect, which was encouraged to measure the social economic status of the areas. Another municipal-level data about prevention strategy was from the evaluation system for the quality of strategy implemented designed by Yunnan Center for Disease Control and Prevention, which included epidemic surveillance, the high-risk behavior intervention, PLWHIV management and follow-up and experimental management to construct the prevention strategy.

Data statistical analysis

Our study used the five indicators (GDP per capital, employment rate, birth rate, mortality rate and natural growth rate) to demonstrate the social economic effect. The

epidemic surveillance score, the comprehensive score of female sex workers intervention, the comprehensive score of men has sex with men intervention, the comprehensive score of PLWHIV management and follow-up and the score of HIV laboratory testing quality. All the six indicators demonstrated the strategy implemented effect of each area. We used the principal component analysis to build the social economic and strategy effect of each area respectively. In view of the sensitivity to the dimensions for principal component analysis, all the calculated indicators were adjusted between 0 to 1 by min-max standardization to eliminate the influential of dimension inconformity [11]. The standardization equation has shown as flowing.

$$S_{ij} = \frac{x_{ij} - x_{ij(\min)}}{x_{ij(\max)} - x_{ij(\min)}}$$

S_{ij} demonstrated the transferred i indicator of j area, x_{ij} demonstrated the original i indicator of j area, $x_{ij(\min)}$ and $x_{ij(\max)}$ demonstrated the max and the min i indicator in all the areas.

We defined the first and the second principal component as the social economic effect and strategy effect respectively.

Our study used multi-level model (MLM) to explore the personality, social economic and strategy effects in health-related quality of life among PLWHIV [12,20]. We set individual-level as the level-1 and area-level as the level-2. We adapted random coefficient model to fit. Let y_{ij} be the score of HRQoL for individual i from area j. We use one individual-level and one area-level predictor respectively to keep the notation simple and without loss of generality, indicated by x_{ij} and z_j . We listed the traditional single-level model $y_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + \varepsilon_{ij}$.

The casual heterogeneity was expressed by adding an interaction term, $\beta_3 x_{ij} z_j$, to the model.

For the MLM, the individual-level model includes only individual-level predictors

and its regression coefficients were not fixed but varied across areas and fitted into area-level model.

Individual-level model: $y_{ij} = \beta_{0j} + \beta_{1j} x_{ij} + \varepsilon_{ij}$

Area-level intercept model: $\beta_{0j} = \beta_{00} + \beta_{01} z_j + \mu_{0j}$

Area-level slope model: $\beta_{1j} = \beta_{10} + \beta_{11} z_j + \mu_{1j}$

The area-level errors $(\mu_{0j}, \mu_{1j}) \sim N(0, \sum = \begin{bmatrix} \tau_{00} & \tau_{01} \\ \tau_{01} & \tau_{11} \end{bmatrix})$ and were assumed to be

independent from the individual-level errors $\varepsilon_{ij} \sim N(0, \sigma^2)$. Both the intercept and slope of the individual-level model were determined by the area-level variable. The main effect of area-level variables and the causal heterogeneity were determined by examining the intercept and slope of the individual-level model respectively.

The MLM divided the total variance of HRQoL into between-country (i.e., \sum) and within-country (i.e., σ^2) variance.

We also could include the multiple independent variables to the full MLM like the multivariate models. In our study, the individual level independent variables would be age, race/ethnicity, education level, household income per year, recent CD4+T counts, transmission model, duration of ART, social support, anxiety and depression. The area-level predictors in the study were social economic effect and strategy effect.

Results

Research field and subjects

A total number of 1,997 respondents were enrolled in our study, with a mean age of 45.1 ± 11.8 , ranging from 16 to 82. 66.4% respondents were Han nationality and others were from minority ethnic groups, e.g. Yi minority, Zhuang minority, Dai minority, Bai minority and so on. 58.5% respondents reported themselves divorced, unmarried and separated. 71.1% respondents have accepted the education less than

nine years. 40.3% of respondents worked as the farmers. The average income per capital of their households was 11,600 yuan in 2020. For their HIV-related characteristics, 70.5% of respondents were in HIV stage, 28.2% of respondents were in AIDS stage when they were firstly diagnosed. 70.2% of the samples were those patients with heterosexual transmission, 18.2% of respondents reported that they had the history of Intravenous Drug Use (IDU). 98.8% of respondents have kept in ART, among those, 58.9% have been treated more than four years. 71.3% of respondents had a high CD4 cell counts (≥ 350 cells/ μl), 50.0% of respondents had more than 500 cells/ μl of CD4 cell counts. The more details have shown in Table 2.

Health related quality of life

The global score of quality of life measured by EQ-5D-5L was range from -0.391 to 1.000, with a mean score(SD) estimated of 0.901 ± 0.146 . The median was 0.951 and the IQR was 0.107. The HRQoL score measured by PCS-12 was range from 22.63 to 62.31, with a mean score (SD) estimated of 46.62 ± 8.55 . The median was 48.22 and the IQR was 12.80. And by MCS-12 was range from 9.70 to 62.66, with a mean score (SD) estimated of 47.80 ± 9.71 . The median was 48.19 and the IQR was 13.76. The significant difference of EQ-5D-5L index score, PCS-12 and MCS-12 were found between the age groups($P < 0.001$), race/ethnicity groups($P < 0.05$), occupation groups($P < 0.001$), household income per year groups($P < 0.001$), Others know HIV status groups($P < 0.001$), initial infectious status groups($P < 0.05$), transmission model groups($P < 0.001$) and duration of ART groups($P < 0.001$). Significant difference of EQ-5D-5L index scores and PCS-12 were found between the most recent CD4 counts ($P < 0.001$). The more details have shown in Table 3.

The social economic and strategy effect construction

For the social economic effect, the component analysis showed the result that the initial eigenvalue of the first and second component were 2.43 and 1.73 respectively, which totally explained 83.34% of variance. The first and second component scores were calculated as following:

The first component score= $-0.170 \times \text{GDP per capital} - 0.229 \times \text{employment rate} + 0.387 \times \text{birth rate} + 0.222 \times \text{mortality rate} + 0.362 \times \text{natural growth rate}$

The second component score= $0.488 \times \text{GDP per capital} + 0.434 \times \text{employment rate} + 0.183 \times \text{birth rate} + 0.322 \times \text{mortality rate} + 0.112 \times \text{natural growth rate}$

By the standardization, we constructed the social economic effect as showing in Figure 1. We could consider that the ten areas formed the ten kinds of social economic models.

For the strategy practice effect, the component analysis showed the result that the initial eigenvalue of the first and second component were 2.38 and 1.41 respectively, which totally explained 75.76% of variance. The first and second component scores were calculated as following:

The first component score= $0.127 \times \text{epidemic surveillance score} + 0.343 \times \text{the comprehensive score of female sex workers intervention} + 0.372 \times \text{the comprehensive score of men has sex with men intervention} + 0.379 \times \text{the comprehensive score of PLWHIV management and follow-up} + 0.062 \times \text{the score of HIV laboratory testing quality}$

The second component score= $0.428 \times \text{epidemic surveillance score} - 0.324 \times \text{the comprehensive score of female sex workers intervention} + 0.033 \times \text{the comprehensive score of men has sex with men intervention} + 0.011 \times \text{the comprehensive score of PLWHIV management and follow-up} + 0.648 \times \text{the score of HIV laboratory testing quality}$

By the standardization, we constructed the strategy effect as showing in Figure 2. We could consider that the ten areas formed four kinds of strategy practice models.

The effect of area level exploring

Based on the nesting of individual scores into the areas, we began our MLM analyses with construction of the zero two-level model (area-individual) for HRQoL index score, PCS-12 and MCS-12 to investigate the variance among different areas. We

found that the variance for HRQoL index score, PCS-12 and MCS-12 on the area level has demonstrated the normal distribution (0, 0.003), (0, 12.69) and (0, 15.12). The variance for all the three scores on the area level has shown the significant differences ($P<0.001$). The variance partition coefficient (VPC) of HRQoL index score, PCS-12 and MCS-12 was 13.6%, 17.2% and 15.8% respectively. Table 4 showed the partition of variance based on the MLM.

Social economic effect, strategy effect and individual effect associated with HRQoL

Table 5 to Table 7 showed the details of the predictors from the area-level and individual-level associated with the HRQoL, PCS-12 and MCS-12. Based on the social economic models and the strategy practice models by component analyses, we mainly examined the strategy effect as the area-level variables to predict the HRQoL. With age, race/ethnicity, marital status, education level, occupation, household income per year, others know HIV status, initial infectious status, transmission model, duration of ART, the most recent CD4 counts, social support score, anxiety score and depression score as individual-level variables to predict the HRQoL. About area effect, the significant difference of global HRQoL measured by EQ-5D-5L index score was found between strategy 1 and strategy 2 ($Z=2.14$, $P<0.05$). The significant difference of mental component of HRQoL measured by PCS-12 was found between strategy 1 and strategy 3 ($Z=-3.23$, $P<0.001$). About individual effect, the significant difference of global HRQoL measured by EQ-5D-5L and also demonstrated in the variables of all have known HIV status and not clear whether to know compared to no one know the infectious status($Z=-4.89$, $P<0.001$, $Z=-2.65$, $P<0.01$). The significant difference was found in the physical component of HRQoL measured by PCS-12 between partial have known HIV status, all have known HIV status and not clear whether to know compared to no one know the infectious status($Z=-2.29$, $P<0.01$, $Z=-3.49$, $P<0.001$, $Z=-2.58$, $P<0.05$). We also found the significant difference between the all have known HIV status and no one know the infectious status ($Z=-3.160$, $P<0.01$). The significant difference also existed in the variables of anxiety score and depression

score ($Z=-7.84$, $P<0.001$, $Z=-2.58$, $P<0.05$). It demonstrated that the global HRQoL scores increased to 0.010 by the decreasing of anxiety scores to 1 and that the global HRQoL scores increased to 0.003 by the decreasing of depression scores to 1. These significant differences were also found in the physical component and mental component of the HRQoL measured by PCS-12 and MCS-12 ($Z=-7.07$, $P<0.001$, $Z=-2.98$, $P<0.05$; $Z=-16.81$, $P<0.001$, $Z=-11.25$, $P<0.05$). Otherwise the social support score contributed positively to predict the PCS-12 and the MCS-12 ($Z=3.34$, $P<0.001$, $Z=8.14$, $P<0.001$). Both the physical component and the mental component of the HRQoL measured by PCS-12 and MCS-12 were significantly lower for the group of Intravenous Drug User than the group of heterosexual transmission ($Z=-3.86$, $P<0.001$, $Z=-2.96$, $P<0.05$). The physical component of the HRQoL measured by PCS-12 was significantly lower for the group with less than 200 cell/ μ l CD4 counts recently than the group with more than 500 cell/ μ l CD4 counts recently ($Z=-3.09$, $P<0.05$).

The interaction effect on HRQoL by area-level and individual-level

We calculated the interaction coefficients of area-level predictor and selected individual-level predictors. Table 7 showed the analyses results. The interaction effect demonstrated between the individual-level variable of anxiety and the area-level variable of strategy practice whatever in global HRQoL or PCS-12 and MCS-12 ($Z=3.32$, $P<0.001$; $Z=3.28$, $P<0.001$; $Z=3.27$, $P<0.001$). We also considered the plots to visualize the effects of HRQoL, PCS-12 and MCS-12 scores from selected individual-level predictors modified by area-level effect. Figure 3 to Figure 5 indicated that the variability within and among areas existed in the selected area-level predictor of strategy and in the selected individual-level predictors of others know HIV status, transmission model, recent CD4 counts, social support, anxiety and depression. It demonstrated that the effects of these variables on HRQoL were different among different areas.

Discussion

Nowadays the HRQoL of PLWHIV has approached to a high level with the mean index score more than 0.9 measured by EQ-5D-5L in Yunnan province. However it's still necessary to explore the predictors associated with the HRQoL based on the diversity within and among areas and individuals. Our study applied MLM as an advanced statistical analytical tool to qualify the effect of area-level social economic and prevention strategy and the effect of individual-level variables on the HRQoL of PLWHIV in the era of the fourth 90 for HIV/AIDS. Firstly, we applied component analyses to classify the social economic model and prevention strategy model for the ten municipals in Yunnan province. Finally, ten kinds of social economic models were formed based on the GDP per capital, employment rate, birth rate, mortality rate and natural growth rate. By the MLM, we found the area-level effect in ten municipals on the HRQoL, which was considered that the social economic development status might inform the independent effect on the HRQoL, especially on the psychological component of the HRQoL. These results were accordance with one study carried out in China to explore the effect of area deprivation on adult depressive symptoms, which has found that the area deprivation has an independent contextual effect. Otherwise, the area-level of prevention strategy also configured four kinds of models based on the indicators of the epidemic surveillance score, the comprehensive score of female sex workers intervention, the comprehensive score of men has sex with men intervention, the comprehensive score of PLWHIV management and follow-up and the score of HIV laboratory testing quality. We considered that Kunming, Yuxi and Honghe municipal informed a strategy that had a good quality to practice the prevention strategy. Dehong municipal still kept a strategy practice model of demonstrative plot [21]. Other two kinds of strategy practice model consisted of Zhaotong, Lijiang, Puer and Wenshan, Lincang, Dali respectively could be considered as a general strategy model. In our study, we found that the effect of the second and the third strategy model (Zhaotong, Lijiang, Puer strategy model and Wenshan, Lincang, Dali strategy model) on HRQoL and the psychological component of HRQoL decreased compared to the first strategy model(Kunming, Yuxi and Honghe model). The prevention strategy generally contained the early testing and counseling,

supplying the timely and free ART and humanistic care. A good quality of strategy practice could form a good quality of prevention system.

Stigma was a traditional predictor in the HIV/AIDS prevention field [22], which could negatively influence happiness, self-esteem, sexual and social relationship and the sense of purpose in PLWHIV [1]. Our study found that whether the HIV infectious status known by others or not has a main individual-level effect on the HRQoL and whatever the physical component and the mental component. The infectious status known by partial or all of the friends and relatives could more or less lead to the stigma and discrimination so that the group when their HIV infectious status were open to others demonstrated the worse HRQoL. Previous research has shown that the HIV-related stigma and discrimination were strongly associated with self-assessed overall HRQoL and especially mental wellbeing [2]. It could also be an obstacle inhabited in the factors to prevent health seeking behavior and timely diagnosis. So one study has been conducted to assess the effect of stigma on HRQoL so as to develop the stigma reduction interventions for PLWHIV^[1]. One study implemented in the children living with HIV/AIDS found that the disclosure concerns would be a relevant target for interventions to decrease stigma and improve the HRQoL [23].

It's considered that the social support, anxiety and depression were the social-psychological characteristics associated with HRQoL^[24,25]. In our study, social support was an individual effect that was positively correlated with the physical and psychological components of the HRQoL. Many previous studies have proved the mediation effect to predict the HRQoL of PLWHIV [26, 27]. A good social support has been shown a protective resource for improved HRQoL, which was associated with better health outcomes in PLWHIV. Anxiety and depression were the two main mental health metrics, which were coexist with chronic disease [28]. Our study also showed the negative correlation between the depression and anxiety as the individual-level effects with the HRQoL. The individual with the more serious depression and anxiety symptoms often indicated a worse HRQoL. HRQoL was suggested that at least two factors were required^[4], one factor assessed physical and functional limitations to be

considered as the measure of physical QoL and the other reflected the impact of health on psychological state to be thought of a measure of psychological QoL. Generally, psychological influences on HRQoL was considered to be long and powerful when people reported how they felt. Otherwise the mediation effect among the depression, anxiety, social support and the HRQoL make it necessary to advance the humanistic care and poverty relief for PLWHIV.

Others the individuals with a higher household income per year contribute to improved physical and mental component of the HRQoL, which was consistent with some of the previous studies [2]. It's not surprising that PLWHIV who had a low income often reported a low HRQoL. It could be have relationship between the income and the social-economic status, which could facilitate the social integration for a better opportunity for health protection and promotion. Our study demonstrated that a low recent CD4 counts predicted a poor physical component of HRQoL ,the same result as other study^[29]. It emphasized on the importance of the timely ART and effective ART.

The MLM analysis had a greatest advantage to have the ability to fit both area and individual level, accord to the structure of the data measurement. The main objective of our study was to identify the social-economic and strategy effect form the area-level with impact on individual HRQoL and quantify the impact. Although predicting the HRQoL has some difficulties to get the stable perceived measurements, the results of our analysis with MLM demonstrate a goodness-of-fit, which was that a proportion of between area variation explained by the country-level predictors. Our study found that the effect of the predictors on the HRQoL has changed by the different areas. So another advantage of MLMs was to allow different individual-models in different areas. We could examine the initial casual heterogeneity by the relationship between slopes of individual-level effects and area-level variables directly. So we could determine whether the impact of an individual-level factors on a respondent's HRQoL was modified by some area-level characteristics.

Several limitations were noted in our study. First, the adequate area-level variables were hard to acquire and therefore, there was some difficulties to configure the accurate models for social economic and prevention strategy. Second, the effects inhabited in the variables to predict the HRQoL were complicated, such as the direct, indirect and mediated effects. Our study did not clarify these relationships. Third, our study did not emphasized more on the variance explanation for the different levels, which was considered to be an advantage of the MLM analysis. Fourth, our study didn't use the professional measurement scale to define the stigma for PLWHIV.

Conclusion

Our study identified the possible strategy determinant of individual HRQoL of PLWHIV and we also found the area effect on the HRQoL. In our study, we considered the social-economic model to explain the area effect. The area-level predictors explained a proportion of the between-area variation of the HRQoL scores, whatever the physical component and the mental component. Our study demonstrated the impact of the stigma, social support, anxiety, depression and social economic status on the HRQoL in the individual- level. This study also showed the evidence of initial casual heterogeneity on the effects of HRQoL. The impact of the individual-level factors on a respondent's HRQoL may be modified by the area-level characteristics to some extents. Finally our study demonstrated a model combined of area-level social-economic and prevention strategy practice and individual effect on the HRQoL, which could be a valuable resource for evaluating the overall health of the areas and help improve local decision making.

Abbreviation

ART Antiretroviral Therapy

PLWHIV People Living with HIV/AIDS

HRQoL Health-related Quality of Life

SF-12 12-item Short Form Health Survey

PCS physical functional scores

MCS mental functional scores

SSRS Social Support Rating Scale

HADS Hospital Anxiety and Depression Scale

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Availability of data and materials

We used STATA version 14.0(StataCorp LLC, College Station, TX) to perform statistical analysis. The data will not be shared because the raw data included the individual's information, and the information of people living with HIV/AIDS must be kept confidential.

Author's contribution

All authors were involved in the study's conception and design, as well as data collection, sorting, analysis and interpretation. All authors critically reviewed the report for important intellectual and practical content.WX did the study design, statistical analysis and manuscript writing. LH, YEN, DW, LJ, LF, QS, GQ, HL, ZJ, XM, ZZ, NJ, FL, LX and SL did the field investigation organization. SZ supervised the study.

Ethics approval and consent to participate

All patients were informed about the study objective, and they were assured of confidentiality. They were asked to indicate their agreement and understanding with a signed informed consent

form before the investigation. The study was approved by the ethics research committee of Yunnan Centers for Disease Control and Prevention, China (No. YNCDC/QR-KJB-2021-003).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interest.

Reference

- [1] Galit ZA, Maria R, Lars EE, et al. Stigma reduction interventions in people living with HIV to improve health-related quality of life [J]. *Lancet HIV* 2019; 19:30343-1.
- [2] Abdulnaser A, Diala A, Fatima-AL T. Health-related quality of life among persons living with HIV/AIDS in Jordon: an exploratory study [J]. *HIV/AIDS-research and palliative* 2020; 12:897-907.
- [3] Murri R, Fantoni M, Del Borgo C, et al. Determinants of health-related quality of life in HIV-infected patients [J]. *AIDS care* 2003;15:581-590.
- [4] Burgess AP, Carretero M, Elkington A, et al. The role of personality, coping style and social support in health-related quality of life in HIV infection [J]. *Quality of Life Research* 2000; 9:423-437.
- [5] UNAIDS survey aligns with so-called fourth 90 for HIV/AIDS [J]. *The lancet* 2019; 393:2188.
- [6] Issifou Y, Lihanimo D, Akouda AP, et al. Health-related quality of life among people living with HIV/AIDS in Togo: individuals and contextual effects [J]. *BMC Research Notes* 2019; 12:140.
- [7] Bello SI, Bello IK. Quality of life of HIV/AIDS patients in a secondary health care facility, Ilorin, Nigeria [J]. *Proc BayI Univ Med Cent* 2013; 26:116-119.
- [8] Degroote S, Vogelaers D, Vandijck DM. What determinants health-related quality of life among people living with HIV: an updated review of the literature [J]. *Arch Public Health* 2014; 72:1-10.

- [9] Ghiasvand H, Higgs P, Noroozi M, et al. Social and demographical determinants of quality of life in people who live with HIV/AIDS infection: evidence from a meta-analysis [J]. *Biodemography Soc Biol* 2020; 65:57-72.
- [10] Haomiao Jia, David GM, Norma K. Country-level social environment determinants of health related quality of life among US adults: a multilevel analysis [J]. *Journal of Community Health* 2009; 34:430-439.
- [11] Zhicheng Wang, Yan G. Study on the effect of area deprivation on adult depressive symptoms in China [J]. *Chinese journal of Health Education*; 2021:37:3-7.
- [12] Rao C, Tianpei M, Qiaoyu H, et al. Multilevel modeling on the prevalence and determinants of depressive symptoms in middle and old-aged rural-to-urban immigrants in Chengdu [J]. *Sichuan Univ(Med Sci Edi)* 2019; 50:229-233.
- [13] Kindu K. Multilevel model on longitudinal data analysis in determinants of CD4 cell count among antiretroviral therapy attendant of HIV infected adults follow up in Gondar Teaching Referral Hospital, Gonder, Ethiopia [J]. *AIDS Research and Therapy* 2021;18:5.
- [14] Kastien HT, Rosenkranz B, Bennett B, et al. How to evaluate health-related quality of life and its associated with medication adherence in pulmonary tuberculosis-designing a prospective observational study in South Africa [J]. *Front Pharmacol* 2016; 7:1-11.
- [15] Wang XW, Guo GP, Zhou L, et al. Health-related quality of life in pregnant women living with HIV: a comparison of EQ-5D and SF-12 [J]. *Health and Quality of Life Outcomes* 2019;15:158.
- [16] Luo N, Liu G, Li MH, et al. Estimating an EQ-5D-5L value set for China [J]. *Value in Health* 2017; 20:662-669.
- [17] Yu Y, Yang JP, Shui CS, et al. Psychometric testing of the Chinese version of the medical outcomes study social support survey among people living with HIV/AIDS in China [J]. *Applied Nursing Research* 2015; 28:328-333.
- [18] Reda AA. Reliability and validity of the Ethiopian version of the hospital anxiety and depression scale. (HADS) in HIV infected patients [J]. *Plos One* 2011; 6:e16049.

- [19] Statistical Bureau of Yunnan Province. Yunnan Statistical Yearbook [M]. Beijing: China Statistics Press, 2020.
- [20] Yang M, Li XS. The multi-level model applied in medical and public health [M]. Beijing: Peking University Press, 2007.
- [21] m.people.cn. Yunnan has transformed to the demonstration plot for HIV/AIDS prevention [DB/OL]. <http://m.people.cn/n4/2018/0519/c1420-11007157.html?from=timeline>. 2018-05-19/2021-04-16.
- [22] Nelson VD, Irma SG, Jose TA. AIDS-related stigma and social interaction: Puerto Ricans living with HIV/AIDS [J]. Qualitative Health Research 2005;15:169-187.
- [23] Rydstrom LL, Wikalander M, Naver L, et al. HIV-related stigma and health-related quality of life among children living with HIV in Sweden [J]. AIDS care 2016; 7:665-671.
- [24] Robert B, Rebecca R. Social support and quality of life over time among adults with HIV in the HAART era [J]. Social Science & Medicine 2004; 58:1353-1366.
- [25] Monica NB, Liliane L, Irismar RO, et al. Quality of life, anxiety and depression in patients with HIV/AIDS who present poor adherence to antiretroviral therapy: a cross-sectional study in Salvador, Brazil [J]. The Brazilian Journal of Infectious Diseases 2017; 21:507-514.
- [26] Wang XW, Guo GP, Zhou L, et al. Depression and anxiety mediated perceived social support to predict health-related quality of life in pregnant women living with HIV[J]. AIDS care 2018; 30:1147-1155.
- [27] Bekele T, Rourke SB, Tucker R, et al. Direct and indirect effects of perceived social support on health-related quality of life in persons living with HIV/AIDS [J]. AIDS care 2012; 25:337-346.
- [28] Liu L, Pang R, Sun W, et al. Functional social support, psychological capital, and depressive and anxiety symptoms among people living with HIV/AIDS employed full-time [J]. BMC Psychiatry 2013; 13:324-333.
- [29] Murri R, Fantoni C, Del Borgo R, et al. Determinants of health-related quality of life in

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Figure legends

Figure 1 the standardization component score of social economic effect

Figure 2 the standardization component score of strategy practice effect

Figure 3 the effect pattern on HRQoL (a: strategy, b: others know HIV status, c: transmission model, d:anxiety, e: depression)

Figure4 the effect pattern on PCS-12 (a: others know HIV status, b: transmission model, c: recent CD4 counts, d:social support, e:anxiety, f: depression)

Figure 5 the effect pattern on MCS-12 (a: strategy, b: others know HIV status, c: transmission model, d: social support, e:anxiety, f: depression)

Table legends

Table 1 Chinese value set for EQ-5D-5L health status

Table 2 Study sample characteristics

Table3 HRQoL of different groups

Table4 the partition of variance of HRQoL

Table5 Predictors associated with HRQoL

Table6 Predictors associated with PCS-12

Table7 Predictors associated with MCS-12

Table 8 the interaction of selected individual-level predictors and area-level strategy practice

Figures

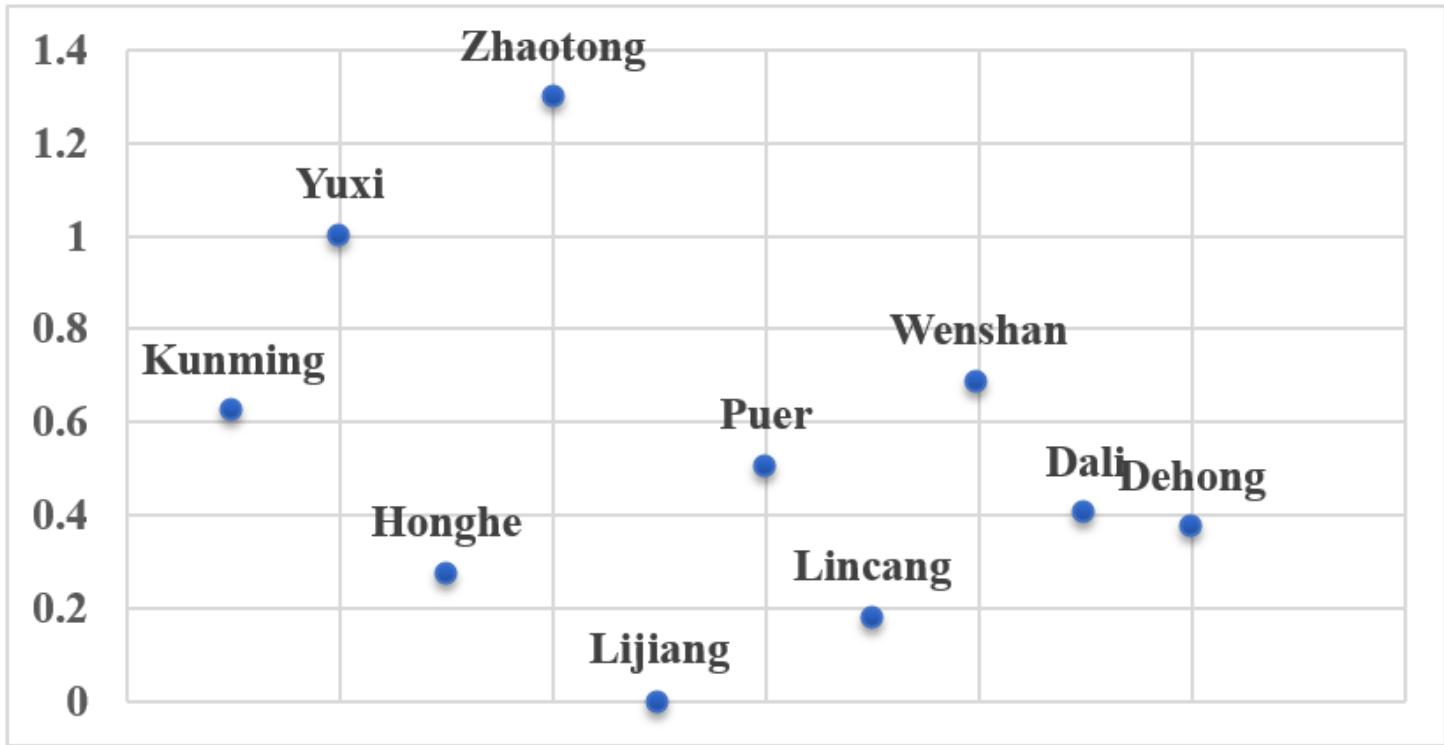


Figure 1

the standardization component score of social economic effect

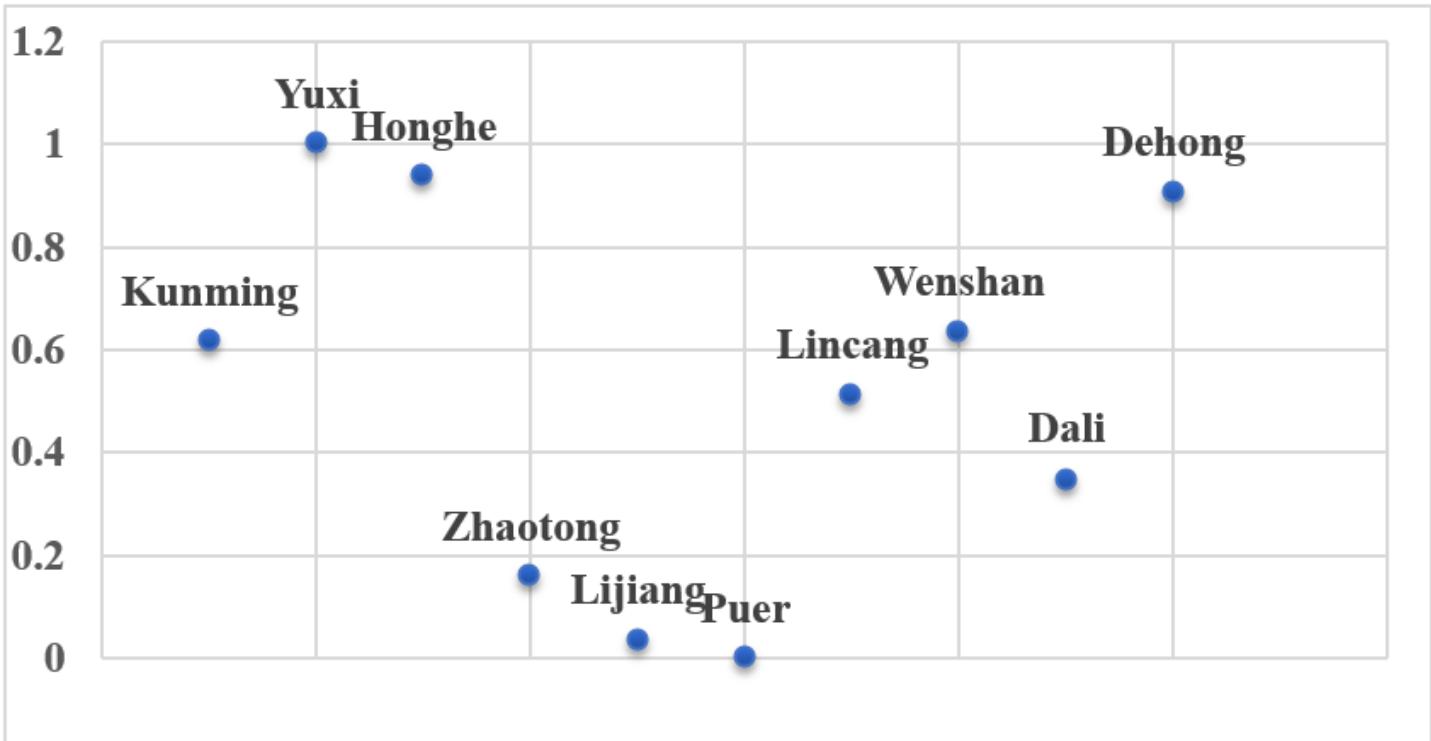
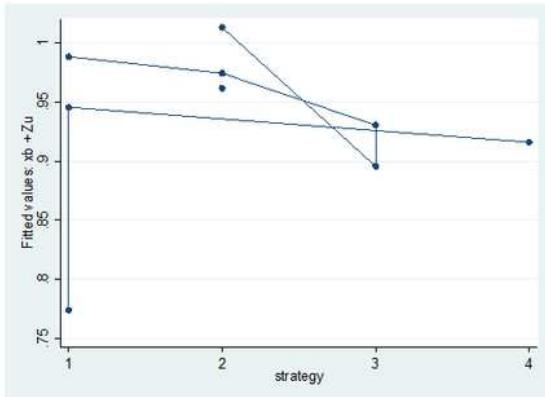
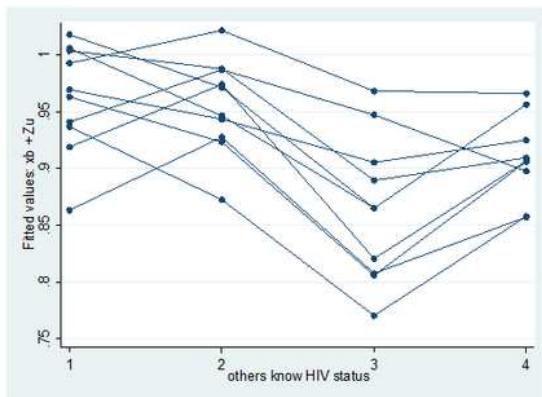


Figure 2

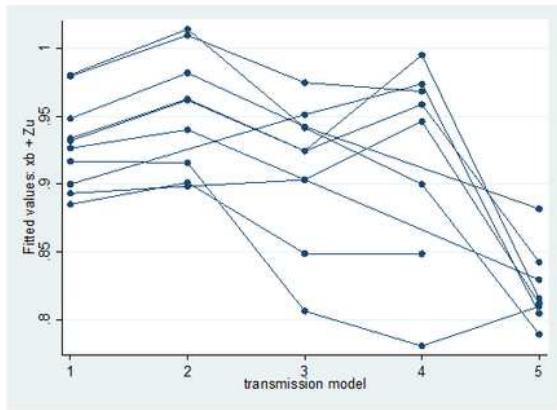
the standardization component score of strategy practice effect



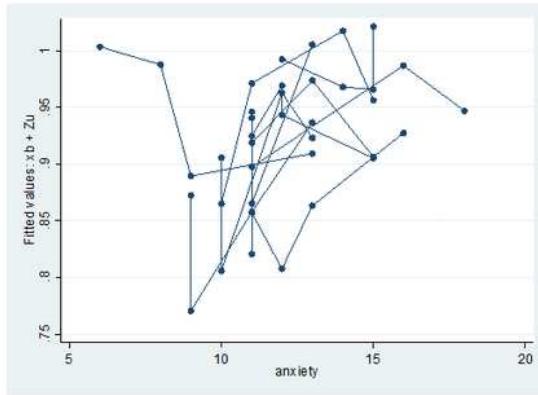
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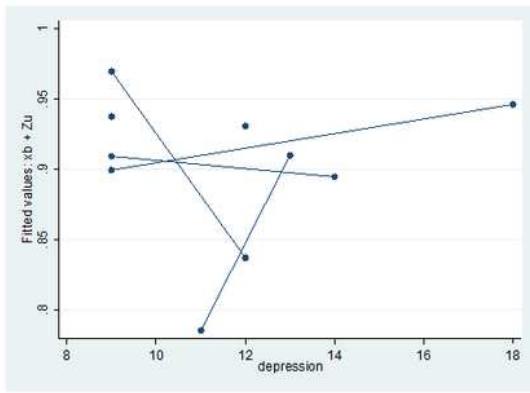
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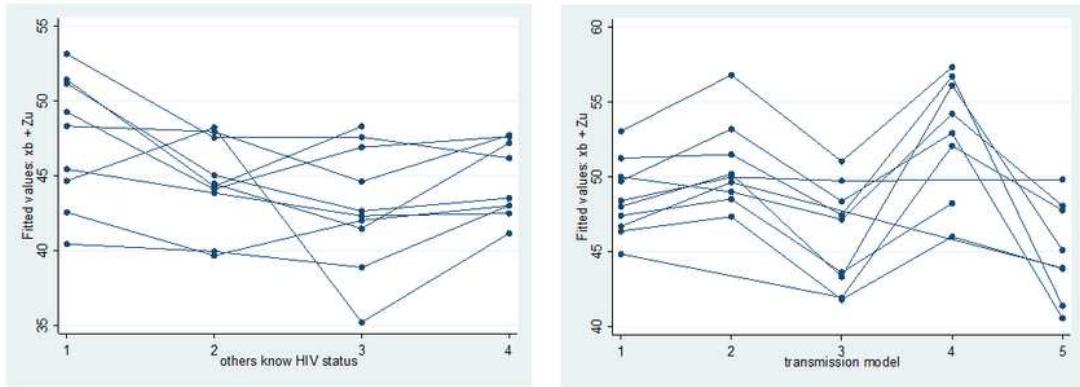
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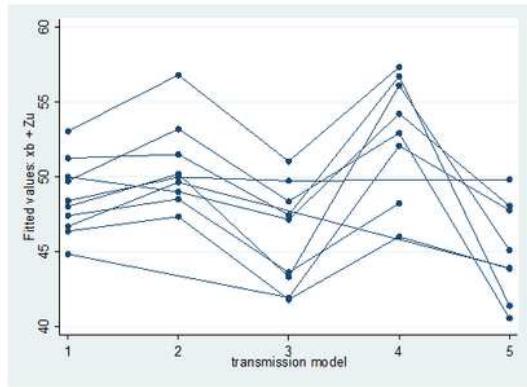
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Figure 3

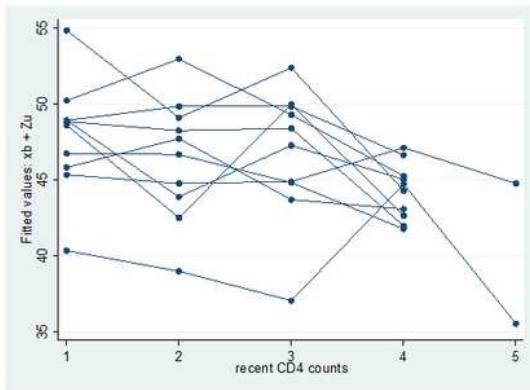
the effect pattern on HRQoL (a: strategy, b: others know HIV status, c: transmission model, d:anxiety, e: depression)



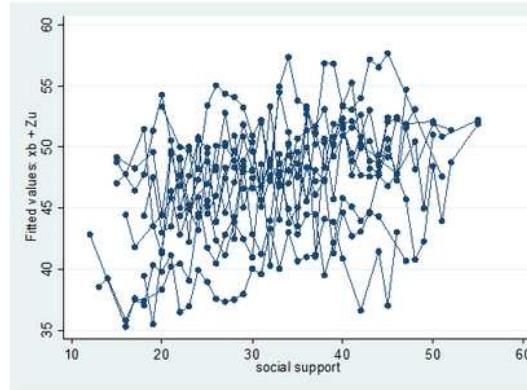
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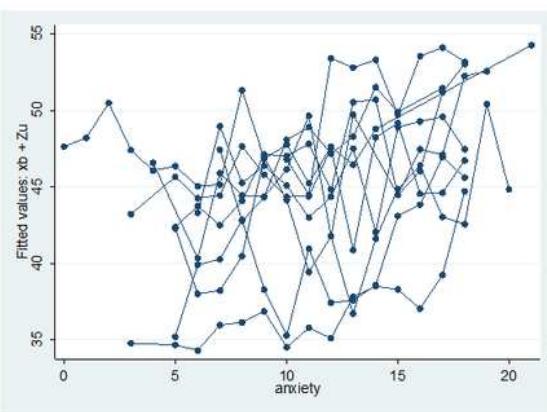
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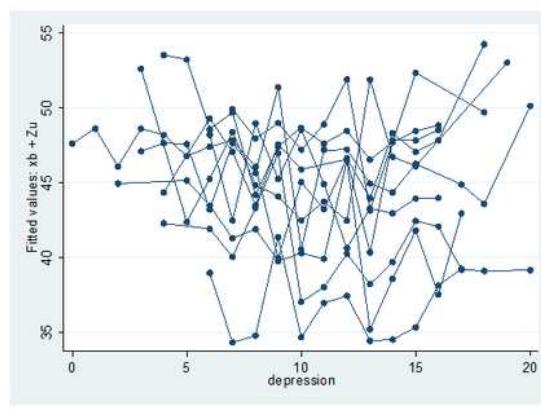
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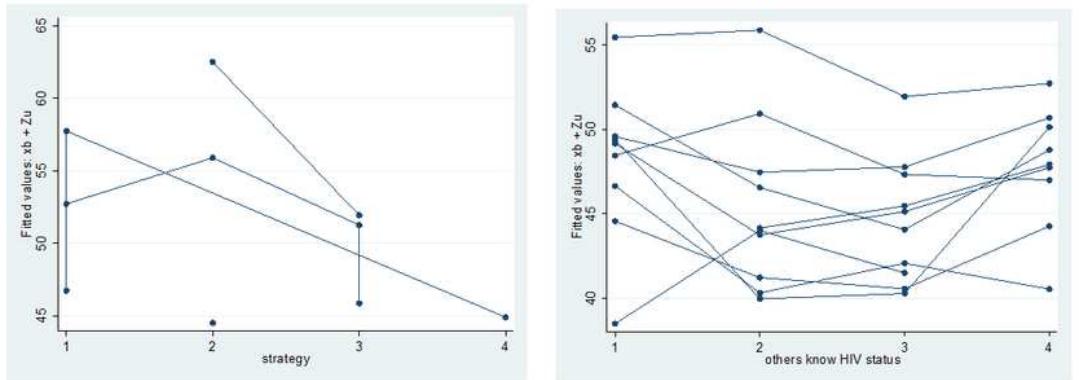
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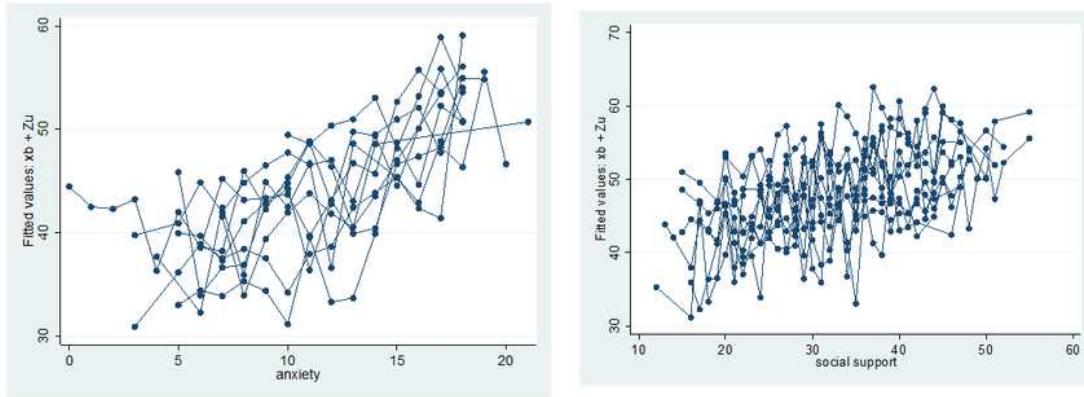
Figure 4

the effect pattern on PCS-12 (a: others know HIV status, b: transmission model, c: recent CD4 counts, d:social support, e:anxiety, f: depression)



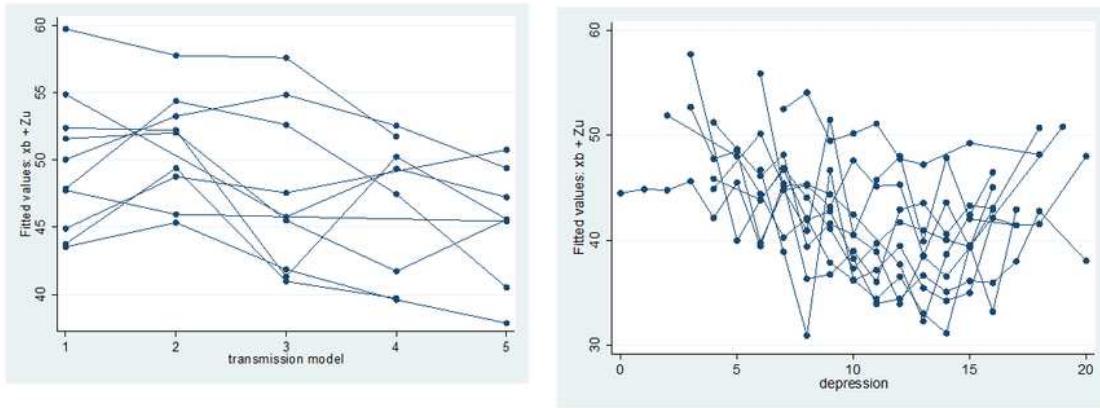
a

b



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Figure 5

the effect pattern on MCS-12 (a: strategy, b: others know HIV status, c: transmission model, d: social support, e:anxiety, f: depression)