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Roles of Self-Stigma, Social Support, and Positive and Negative Affects as Determinants of Depressive Symptoms Among HIV Infected Men who have Sex with Men in China

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Abstract Poor mental health was prevalent among HIV positive men who have sex with men (HIVMSM), and a tremendous burden extents on their families and society. The present study investigated the prevalence of depression and its relationship with social support, HIV self-stigma, positive affect and negative affect among 321 HIVMSM in Chengdu, China. The study was conducted during July 2013 through October 2013. Findings showed that 55.8 % of the participants had mild to severe depression. The results of structural equation modeling showed that social support and positive affect were negatively associated with depression, while HIV self-stigma and negative affect were positively associated with depression. Social support, positive affect, and negative affect mediated the association between HIV self-stigma and depression. The hypothesized model had a satisfactory fit. Interventions improving mental health among this population are warranted.

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Introduction

In China, the HIV epidemic among men who have sex with men (MSM) is worsening. A recent meta-analysis which included 84 studies reported that HIV prevalence among Chinese MSM was 6.5 % [1]. Some studies have reported HIV prevalence among MSM of about 20 % [2]. In addition to life-threatening physical illnesses, HIV positive men who have sex with men (HIVMSM) have to deal with severe stigma and numerous types of stressors, resulting in high prevalence of psychological problems, such as depression and anxiety. The prevalence of depression among HIVMSM ranges from 35 to 49 %, which is higher than that of people living with HIV (PLWH) in general and that of HIV negative MSM in the US and India [3–6], while a recent study conducted in China reported prevalence of mild to severe depression of 62 % among PLWH [7]. The burden of the mental health problems affects HIVMSM, their families, and the society tremendously. Poor mental health was also significantly associated with a number of HIV-related health outcomes and risk behaviors, such as low service utilization rate, poor adherence to antiretroviral therapy (ART), faster progression to AIDS and shorter survival [8–11], and practice of unsafe sex [12]. These consequences would further facilitate the transmission of HIV. In China, there is however, a lack of psychological support services and interventions targeting PLWH in general and HIVMSM in particular [13–15]. The World Health Organization has also reported the shortage of psychological support services to MSM [16].

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HIV-related stigma is one of the strongest determinants of psychological problems (e.g., depression) among MSM [17, 18] and PLWH in China [19]. High levels of stigma and discrimination experienced by PLWH has been well documented [20]. The situation among HIVMSM is likely to be much worse since they encounter multiple and layered sources of social stigma toward homosexuals and PLWH, in addition to their physical health problems. In particular, self-stigma is developed when individuals internalize prejudice, stereotypes, and discrimination toward themselves [21]. HIV-related self-stigma is strongly associated with depression and other health outcomes and behaviors, such as non-adherence to treatment among PLWH [22]. With effective interventions, however, it is possible to reduce self-stigma [23, 24].

Social support refers to the provision of psychological and material resources by people within one's social network [25]. It reduces depression among PLWH and is associated with a number of positive outcomes such as well-being [26], hope, and optimism [27]. Provision of advice and emotional support helps participants redefine their stressful situations and may lead to better mental health [25, 28]. One recent study suggested that participation in online support groups had positive impact on psychosocial outcomes among PLWH through an empowering processes which fostered social support and positive meanings [29].

To help the designing of effective interventions, it is important to understand the mechanisms, or mediators, that act between risk factors, such as self-stigma, and depression among HIVMSM. As HIV self-stigma is negatively associated with social support among PLWH [30–33], mediation effect may exist. Those who report self-stigma may isolate themselves and therefore, receive limited social support from others [34]. Many published studies supported that higher levels of self-stigma predicted lower levels of social support [31, 35, 36]. A prospective study found that social support mediated the effect of HIV self-stigma onto psychological distress [31]. In this longitudinal study, the authors found that among PLWH, self-stigma directly impacted psychological well-being 7 months later; self-stigma also indirectly impacted psychological well-being via dampened perceived social support [31].

Affect may also play a role in mediating the associations between self-stigma and depression as affect regulation is an important determinant of mental health problems [37, 38]. Positive affectivity is a trait that reflects stable individual differences in positive emotional experience [39], while negative affect reflects a general dimension of subjective distress and unpleasant engagement that subsumes a variety of aversive mood states, including anger, contempt, disgust, guilt, fear, and nervousness [40]. A number of studies have investigated associations between positive and negative affects and depression in various populations. The findings support the Tripartite Model which posits that depression is characterized by increased negative affect and reduced positive affect [41]. Positive affect is positively associated with better physical, social, and psychological well-being of PLWH [42–44] and negatively associated with depressive symptoms among undergraduate students [45]. Negative affect is positively associated with depression in general [46]. To our knowledge, there is no study investigating the relationship between positive and negative affects and depression among PLWH and HIVMSM.

It is important to recognize that positive affect and negative affect can be improved via interventions. For instance, the Three Good Things exercise, a positive psychological intervention which requests participants to write down three good things that they experience and feel grateful, was found to be effective in increasing positive affect [47]. Previous studies have shown that increase in positive affect facilitates better coping with stressors related to HIV, while reduction in negative affect facilitates performance of self-care behaviors [48].

Positive affect and negative affect are also positively and negatively associated with social support among PLWH [49]. Social support can increase positive affect through senses of stability, predictability, and control that it provides [50]. Availability of emotional support can help regulate emotion and hence strengthen positive affect and reduce negative affect [48]. Previous findings have suggested that positive affect and negative affect are important pathways through which social support influences illness management strategies among PLWH [48, 49]. However, the hypothesis that positive affect and negative affect mediate the association between social support and depression among PLWH has not been tested in literature.

As HIV self-stigma is associated with social support [31], it is possible that the association between HIV self-stigma and depression among HIVMSM may also be mediated by positive affect and negative affect. Qualitative studies have suggested that self-stigma is associated with various negative emotions such as stress, guilt, and shame [51, 52], which are risk factors of depression. We cannot locate studies reporting associations between HIV self-stigma and positive and negative affects among HIVMSM; the mediation hypothesis has hence not been tested. If such mediating effects exist, psychological interventions improving positive affect and/or negative affect may reduce the risk effect of HIV self-stigma in developing depressive symptoms.

The present study investigated the prevalence of probable depression among HIVMSM in China. We investigated further by using a structural equation modeling approach, the associations between social support, HIV

self-stigma, and positive/negative affects onto depressive symptoms. The hypothesized model is shown in Fig. 1. It includes the following components: (1) social support and positive affect are negatively associated with, and HIV self-stigma and negative affect are positively associated with, depressive symptoms; (2) HIV self-stigma is negatively associated with social support; (3) social support is positively associated with positive affect and negatively associated with negative affect, while the opposite is true for HIV self-stigma; and (4) HIV self-stigma has an indirect effect onto depression via social support and positive/negative affect. One more model was tested to examine whether the addition of direct path from HIV self-stigma to depression would improve goodness-of-fit. This model investigated the extent to which that the association between self-stigma and depression is mediated by social support, positive affect, and negative affect.

Methods

Study Population and Procedure

Inclusion criteria included: (1) Chinese men who have anal sex with at least one man in the last six months, (2) age 18 years old or above, and (3) having been diagnosed as being HIV positive for at least three months. Similar inclusion criteria has been used in a number of published studies [53, 54].

The cross-sectional study was conducted in Chengdu, China, from July 2013 to October 2013. Participants were recruited by four well-trained peer fieldworkers, who were staff of a local non-governmental organization (NGO). The NGO was one of the largest gay organizations in China. It publicized the study through posters displayed at the public area of the NGO and social media to their service users. The fieldworkers approached prospective participants,

briefed them about the study and logistics, and invited them to participate in the study after confirming their eligibility. Interested participants were invited to visit the office of the NGO and met with a research assistant there. It was confirmed that participants' refusal would not affect their right to use any services and they could quit the interview at any time without being questioned. After obtaining written informed consent, anonymous face-to-face interviews, using a pilot-tested and structured questionnaire, which took about 20 min to complete, were conducted in a private room. Upon completion of the interview, a monetary compensation of RMB 50 (about USD 6) was provided to the participants to compensate their time.

There were about 1000 HIVMSM identified in Chengdu [55, 56]. The NGO served about 600 of them at the time of the study and could potentially contact them by phone call and social media. Of these, 350 were successfully contacted by the peer fieldworkers, of whom 321 (91.7 %) completed the interview with written informed consent. Ethics approval was obtained from the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong.

Measures

Participants' Background Characteristics

Information was collected about participants' demographic characteristics including ethnicity (Han vs. other ethnicity), residence, age, education level (primary school or below, junior high school, senior high school, vs. university or above), marital status (i.e., single, married, cohabiting with girlfriend, cohabiting with boyfriend, divorced, widowed, vs. others), job, personal monthly income (in RMB), and sexual orientation (homosexual, heterosexual, bisexual, vs. not sure).

Fig. 1 Hypothesized structural model (model 1) in the study relating depression, self-stigma, positive affects, negative affects, and social support
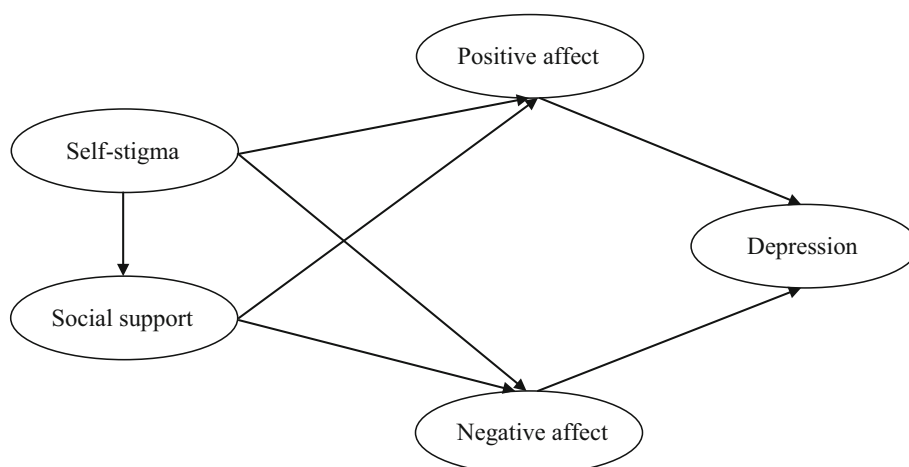
Social Support

Two items were constructed in this study to gauge the level of emotional and material social support participants received. Participants were asked: (1) "How much support can you obtain from family/friends/colleagues when you need to talk or to obtain emotional support?" and (2) "How much support can you obtain from family/friends/colleagues when you need material support (e.g., financial help)?" Responses were recorded on scales that ranged from 0 ('none') to 10 ('tremendous'). The Cronbach's alpha value of the scale formed by adding up the item responses of the two questions, was 0.68 in this study.

Self-Stigma

The level of self-stigma was assessed by using the 9-item Self-Stigma Scale-Short Form (SSS-S) [57]. Participants were asked to rate each item on a 4-point Likert scale that ranged from 1 'strongly disagree' to 4 'strongly agree', with higher scores indicating a stronger sense of self-stigma. Example items include "I fear that others would know that I am a PLWH", "I feel uncomfortable because I am a PLWH", and "I feel like I cannot do anything about my PLWH status". The SSS-S has three subscales, with 3 items in each subscale: (1) affective components, (2) cognitive components, and (3) behavioral components. Scores for each subscale range from 3 to 12. The Chinese version has been validated among people with mental illness in Hong Kong (Cronbach's alpha ranged from 0.84 to 0.91) [57]. In the present study, the Cronbach's alpha value was 0.90. The Cronbach's alpha values for the affective, cognitive, and behavioral subscales were 0.68, 0.74, and 0.86, respectively.

Positive Affect and Negative Affect

To assess positive affect and negative affect, the 20-item Positive and Negative Affect Schedule (PANAS) scale [40] was administered. As pointed out by Watson and Clark (1997), positive affect and negative affect are two distinct constructs rather than two extremes of the same dimension [58]. PANAS has been used in the Chinese population (Cronbach's alpha value was 0.85 for the Positive Affect Subscale and 0.83 for the Negative Affect Subscale) [59]. It consists of 20 items, in which 10 items reflect expectations for positive affect and 10 for negative affect. Participants were asked to rate to what extent they feel this way at the present moment on a 5-point Likert scale ('very slightly or not at all' to 'extremely'). Scores for each subscale range from 10 to 50, with higher scores representing higher levels of positive affect and negative affect. In this study, the Cronbach's alpha value was 0.86 for the

Positive Affect Subscale and 0.93 for the Negative Affect Subscale.

Depression Symptoms

The 20-item Center for Epidemiologic Studies Depression Scale (CES-D) [60] was used to assess the presence of depressive symptoms. The Chinese version of the CES-D was validated, showing good internal reliability [60–62]. The Cronbach's alpha value for CES-D ranged from 0.84 to 0.91 among PLWH [63–66] and from 0.85 to 0.92 among MSM [67–69]. Participants were asked to rate how often they have experienced the symptomatology in the past 7 days, on a 4-point Likert scale ['rarely or none of the time (less than 1 day)' to 'almost or all of the time (5–7 days)']. The total score ranges from 0 to 60, with higher score reflecting greater severity. The CES-D is composed of four dimensions: somatic symptoms (total score ranges from 0 to 21), depressed affect (total score ranges from 0 to 21), (lack of) positive affect (total score ranges from 0 to 12), and interpersonal problems (total score ranges from 0 to 6). Example items include "My sleep was restless", "I felt depressed", "I was happy", and "people were unfriendly". A score of 16 or more is suggestive of the presence of depressive symptoms (probable depression), and a score of 25 or more is highly associated with major depression. In this study, the Cronbach's alpha value was 0.92. The Cronbach's alpha values of the four dimensions were 0.86, 0.89, 0.76, and 0.77, respectively.

Statistical Analysis

First, zero-order correlations among all variables were examined, and multiple regression analyses were conducted to examine the contribution of demographic characteristics to the studied variables using SPSS 16.0 (SPSS Inc., Chicago, IL). Second, confirmatory factor analysis (CFA) was conducted to assess the goodness of fit of the measurement model [70]. CFA establishes convergent and divergent validity in the proposed model, which is requested by many SEM researchers as a required first step before undertaking structural analysis [70, 71]. Third, structural equation modeling (SEM) was performed by AMOS 17.0 to test the hypothesized model (Model 1). The maximum likelihood method was used. The maximum likelihood method is the most common method of estimating model parameters, which picks estimates with the greatest chance of reproducing covariance in the observed data [71]. The normality was also tested for all indicator variables. To evaluate the overall model fit, we used indices including χ^2/df ratio, comparative fit index (CFI), incremental fit index (IFI), and root-mean-square error of approximation (RMSEA). For each index, the following

criteria was applied: (1) χ^2/df ratio values less than 3 indicates a good model fit [70, 72]; (2) CFI and IFI values greater than 0.9 indicates a good model fit [73]; and (3) for RMSEA, a value between 0.05 and 0.08 indicates an acceptable model fit [74]. Fourth, one more model (Model 2) was fitted to test mediations of the associations between HIV self-stigma and depression. In Model 2, a direct path from self-stigma to depression was added to Model 1. Lastly, Model 3 was fitted to test the significance of the direct effect of social support to depression. The total, direct, and indirect effects of the final model were calculated by a bootstrap procedure [75]. As suggested by Shrout and Bolger [76], bias-corrected confidence intervals for each direct and indirect path were reported and calculated in the bootstrap analysis by AMOS 17.0, based on 5000 bootstrap samples. All statistical tests were two sided, and a p value <0.05 was considered statistically significant. Since a potential debate on using parcel items exists and the scales on Positive Affect and Negative Affect do not have subscales for parceling the items meaningfully, items were not parceled to avoid arbitrary decisions. We followed the widely used procedure [71] that correlations between the pairs of residuals of some items with the largest Modification Indices (MI) values would be added until the model reaches a satisfactory fit.

Results

Sample Characteristics

Among the 321 participants, 58.6 % were <30 years old; 10.3 % were currently married with a woman or cohabiting with a girlfriend; 59.8 % had attended university or above; 10.6 % had had monthly personal income of less than 1000 RMB (160 USD); 85.0 % indicated that they were homosexuals; and 33.0 % did not have a full-time job (Table 1).

The mean score of the overall self-stigma scale was 24.1 (SD = 5.51). The mean score for the three subscales of self-stigma was 8.6 (SD = 1.85), 8.2 (SD = 2.01), and 7.3 (SD = 2.29), respectively. The mean score of Positive Affect subscale and Negative Affect subscale was 27.1 (SD = 7.34) and 22.9 (SD = 8.68), respectively (Table 2).

Prevalence of Probable Depression

The prevalence of probable mild ($16 \le CESD < 20$), moderate ($20 \le CESD < 25$) and severe ($CESD \ge 25$) depression was 12.8, 11.2 and 31.8 %, respectively (mild to severe: 55.8 %). The mean CES-D score was 19.6 (SD = 11.39). The mean score for the four subscales of CES-D was 6.4 (SD = 4.47), 6.5 (SD = 4.75), 5.7 (SD = 3.06) and 1.0 (SD = 1.37), respectively.

Associations Between Background Characteristics and Studied Variables

Multiple regression results showed that demographic characteristics (i.e., ethnicity, residence, age, education level, marital status, job, personal monthly income, and sexual orientation) explained a small percentage of variance across the studied variables (probable depression, self-stigma, positive affect, negative affect, and social support). Adjusted R^2 only ranged from 0.02 to 0.03 (p value ranged from 0.015 to 0.064). Significant demographic variables (i.e., age, marital status, and sexual orientation) were hence adjusted in subsequent analyses although they had limited contribution to explaining variances of depressive symptom (adjusted $R^2 = 0.021$, $p = 0.064$), self-stigma (adjusted $R^2 = 0.034$, $p = 0.016$), social support (adjusted $R^2 = 0.028$, $p = 0.031$), positive affect (adjusted $R^2 = 0.034$, $p = 0.015$), and negative affect (adjusted $R^2 = 0.027$, $p = 0.035$).

Correlations Between Variables

Table 2 shows the means, standard deviations, and correlations for all variables in this study. Most variables in the model were correlated with each other in a way that supported the relationships suggested by the SEM model. Specifically, self-stigma showed significant positive correlations (r ranged from 0.56 to 0.59, $p < 0.001$, Table 2) with negative affect and depression, as well as negative correlations (r ranged from -0.19 to -0.25, $p < 0.01$, Table 2) with positive affect and social support. In addition, positive affect showed significant negative correlations (r = -0.36, $p < 0.001$, Table 2), whilst negative affect showed positive correlations (r = 0.80, $p < 0.001$, Table 2) with depression.

Measurement Model

Table 3 presents the factor loadings of the measurement model. The test of the measurement model resulted in the following statistical values: χ^2/df ratio = 3.39, CFI = 0.85, IFI = 0.85, RMSEA = 0.086 (90 % CI 0.081, 0.092), which were indicative of the need for some modifications. The following modifications were made: (1) the item of alert in positive affect was excluded from the final model due to its non-significant and limited contribution to positive affect (Unstandardized and standardized loading (positive affect to alert) is 0.003 and 0.002 respectively, Table 3); and (2) Based on the Modification Indices provided in the CFA results, three correlation paths between some positive affect items residuals (i.e., between strong and determined, between inspired and determined, and between determined and attentive) and five correlation

	Frequency (N = 321)	Percentage (%)
Demographic characteristics		
Ethnicity		
Han	315	98.1
Others	6	1.9
Residence (Hukou)		
Chengdu	174	54.2
Others	147	45.8
Age		
≤25	88	27.4
26–30	100	31.2
31–40	96	29.9
>40	37	11.5
Education level		
Junior high school or below	34	10.6
Senior high school	95	29.6
University or above	192	59.8
Marital status		
Single	203	63.2
Married/cohabiting with girlfriend	33	10.3
Cohabiting with boyfriend	63	19.6
Divorced/widow/others	22	6.9
Job		
Full-time	215	67.0
Part-time	20	6.2
Unemployed	26	8.1
Student	17	5.3
Individually owned business	29	9.0
Retired/others	14	4.4
Personal monthly income		
≤1000	34	10.6
1001–3000	142	44.2
3001–5000	97	30.2
5001–7000	26	8.1
>7000	22	6.9
Sexual orientation		
Homosexual	273	85.0
Bisexual	39	12.1
Heterosexual/not sure	9	2.8

Table 1 Demographic characteristics of HIVMSM

paths between some negative affect items residuals (i.e., between distressed and upset, between guilty and ashamed, between hostile and irritable, between nervous and afraid, and between jittery and afraid) with the largest MI values were added until the model reaches a satisfactory fit. This modification procedure has been widely used [71]. Results of the CFA showed that the overall modified measurement model yielded a satisfactory fit, χ^2/df ratio = 2.57, CFI = 0.91, IFI = 0.91, RMSEA = 0.07 (90 % CI 0.064, 0.076). Standardized factor loading of the modified measurement model ranged from 0.42 to 0.94 and were all statistically significant at the level of $p < 0.001$ (Table 3).

Structural Models

Results of the SEM showed that Model1 (Fig. 2) yielded a satisfactory fit [χ^2/df ratio = 2.46, CFI = 0.90, IFI =

Table 2 Mean, standard deviation of the variable and correlation between variables in the study

Variable	1	2	3	4	5
1. Self-stigma	–				
2. Social support	−.25***	–			
3. Positive affect	−.19**	.20***	–		
4. Negative affect	.56***	−.32***	−.15**	–	
5. Depression	.59***	−.36***	−.36***	.80***	–
Mean (SD)	24.06	12.70	27.11	22.95	19.59
Standard deviation	5.51	4.86	7.34	8.68	11.39

** $p < .01$; *** $p < .001$

Table 3 Unstandardized and standardized loading for measurement model

| Parameter estimate	Original measurement model		Modified measurement model	
	Unstandardized loading	Standardized loading	Unstandardized loading	Standardized loading
Positive affect → interested	1.00	0.71	1.00	0.73
Positive affect → excited	0.82 (0.072)***	0.68	0.81 (0.068)***	0.70
Positive affect → strong	0.92 (0.089)***	0.62	0.85 (0.085)***	0.59
Positive affect → enthusiastic	1.11 (0.091)***	0.73	1.06 (0.085)***	0.73
Positive affect → proud	1.12 (0.094)***	0.72	1.10 (0.088)***	0.73
Positive affect → alert	0.00 (0.090)	0.00	NA	NA
Positive affect → inspired	1.07 (0.092)***	0.69	1.01 (0.087)***	0.68
Positive affect → determined	0.90 (0.089)***	0.61	0.74 (0.084)***	0.52
Positive affect → attentive	1.03 (0.085)***	0.72	0.95 (0.080)***	0.69
Positive affect → active	1.09 (0.090)***	0.73	1.06 (0.085)***	0.73
Negative affect → distressed	1.00	0.83	1.00	0.82
Negative affect → upset	0.79 (0.054)***	0.73	0.79 (0.045)***	0.71
Negative affect → guilty	0.88 (0.068)***	0.66	0.87 (0.070)***	0.64
Negative affect → scared	1.04 (0.056)***	0.84	1.05 (0.058)***	0.84
Negative affect → hostile	0.73 (0.055)***	0.67	0.74 (0.056)***	0.68
Negative affect → irritable	0.82 (0.068)***	0.62	0.82 (0.070)***	0.61
Negative affect → ashamed	0.92 (0.066)***	0.69	0.92 (0.068)***	0.68
Negative affect → nervous	0.95 (0.057)***	0.79	0.95 (0.059)***	0.78
Negative affect → jittery	1.10 (0.060)***	0.84	1.10 (0.062)***	0.84
Negative affect → afraid	1.17 (0.063)***	0.84	1.16 (0.066)***	0.83
Self-stigma → affective	1.00	0.86	1.00	0.86
Self-stigma → cognitive	1.12 (0.059)***	0.89	1.12 (0.059)***	0.89
Self-stigma → behavioral	1.10 (0.069)***	0.77	1.11 (0.069)***	0.77
Social support → emotional	1.00	0.69	1.00	0.68
Social support → material	1.17 (0.189)***	0.76	1.17 (0.190)***	0.76
Depression → somatic complaints	1.00	0.90	1.00	0.90
Depression → depressed affect	1.12 (0.042)***	0.94	1.12 (0.042)***	0.94
Depression → lack of positive affect	0.32 (0.041)***	0.42	0.32 (0.041)***	0.42
Depression → interpersonal problems	0.25 (0.015)***	0.73	0.25 (0.015)***	0.73

Standard errors are in parentheses

*** $p < 0.001$

0.90, RMSEA = 0.068 (90 % CI 0.062, 0.073)]. In sum, self-stigma exerted its effect onto depression indirectly via social support, positive affect, and negative affect. The overall Model 1 explained 79.8 % of the variance in depressive symptoms. The standardized path coefficients of the structural Model 1 are presented in Fig. 2.

Fig. 2 Hypothesized structural model (model 1, 2 and 3) relating depression, self-stigma, positive affects, negative affects, and social support. Note: All path coefficients and factor loadings shown were standardized. *p < 0.05; **p < 0.01; ***p < 0.001
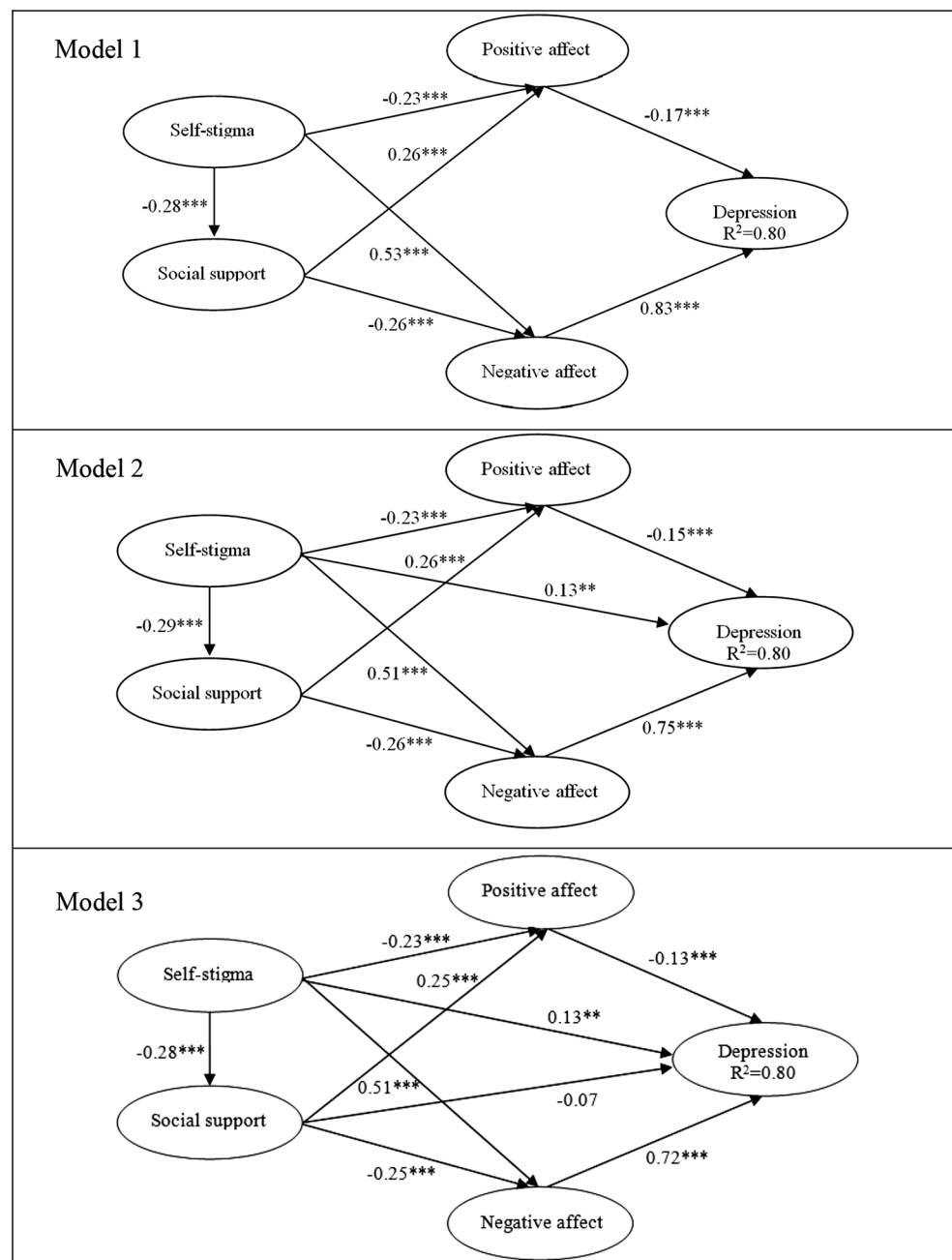
Testing Mediation Effects of the Associations Between Self-Stigma and Depression

Model 2 improved significantly as compared to Model 1 ($p = 0.005$, Table 4). The association between self-stigma and depressive symptoms was partially mediated by positive affect, negative affect, and social support (Fig. 2). Self-stigma also had significant direct effect on depressive symptoms (Fig. 2). Results of the SEM showed that Model 2 yielded a satisfactory fit [χ^2/df ratio = 2.46, CFI = 0.90, IFI = 0.90, RMSEA = 0.067 (90 % CI 0.062, 0.073)]; the overall Model 2 explained 80.0 % of the variance in

depressive symptoms. The standardized path coefficients of Model 2 are also presented in Fig. 2.

Model 3 did not improve significantly in terms of goodness-of-fit, as compare to Model 2 ($p = 0.119$, Table 4). Social support had no significant direct effect on depressive symptoms (Fig. 2). Results of the SEM showed that Model 3 yielded a satisfactory fit [χ^2/df ratio = 2.45, CFI = 0.90, IFI = 0.90, RMSEA = 0.067 (90 % CI 0.062, 0.073)]; the overall Model 3 explained 80.0 % of the variance in depressive symptoms. The standardized path coefficients of Model 3 are also presented in Fig. 2.

Table 4 Goodness-of-fit of hypothesized structural models (model 1, 2 and 3)

	CFI	IFI	RMSEA	χ^2/df	χ^2	df
Models						
Model 1	0.90	0.90	0.068	2.46	1022.62	415
Model 2	0.90	0.90	0.067	2.45	1014.78	414
Model 3	0.90	0.90	0.067	2.45	1012.35	413

	Changes in χ^2	Changes in df	p value
Comparisons			
Model 2 versus model 1	7.84	1	0.005
Model 3 versus model 2	2.43	1	0.119

Model 1: No direct path from self-stigma/social support to depression

Model 2: A direct path from self-stigma to depression was added to Model 1

Model 3: A direct path from social support to depression was added to Model 2

Table 4 compared the goodness-of-fit of Model 1 and 2. Model 2, by adding a direct path from self-stigma to depression, significantly improved goodness-of-fit as compared to Model 1; while Model 3, did not have significant improvement in the goodness-of-fit as compared to Model 2. Thus we chose Model 2 as the final model. Table 5 assessed the sizes of the total, direct, and indirect effects of the final model (Model 2) by bootstrapping procedures. The estimated mediation effect from self-stigma to depression via affects and social support was 0.48 (95 % CI 0.39, 0.58; $p < 0.001$; Table 5). The mediation effect via each specific path is shown in Table 5.

Discussion

The study examined effects of risk and protective factors (self-stigma and social support) on depressive symptoms among Chinese HIVMSM and tested the mediation roles of

positive affect and negative affect regarding such associations. The findings showed that social support was negatively associated with self-stigma. In addition, higher levels of self-stigma were associated with higher levels of depression, and such association was partially mediated by lower social support, lower positive affect, and higher negative affect.

This study confirmed the importance of social support to mental health status of HIVMSM. Our results support existing literature [26, 27] that social support is associated with better health among PLWH. However, many HIVMSM may have inadequate level of social support. This is partially because PLWH often feel isolated and seldom disclose their HIV status to others due to high levels of discrimination and stigmatization [77], contributing to unavailability of social support. In China, over 90 % of PLWH did not voluntarily disclose their HIV status to others [77]. Also, 27.2–38.8 % of their community members (e.g., neighbors, colleagues, family members, and medical staff) showed negative attitudes after discovering their HIV positive status [77]. Hence the support that they could seek from their family members and friends is very limited [78]. Effective programs enhancing perceived social support are greatly warranted.

We also found significant associations between social support and higher levels of positive affect and lower levels of negative affect. One possible explanation might be that those with higher levels of social support are more likely to receive more love and care, which may lead to higher levels of positive affect and lower levels of negative affect. Such better affect status would in turn result in better mental health.

Many studies reported a high level of self-stigma among PLWH. The present study highlighted the detrimental impact of self-stigma on mental health of PLWH. Such results were consistent with other studies [31, 79]. Findings also suggested that the positive association between self-stigma and depression is partially mediated by lower levels of positive affect, higher levels of negative affect, and lower levels of social support. This finding confirmed

Table 5 Bootstrap Analyses of total, direct, and indirect effects of the mediation model

Paths	Effect (95 % CI)[a]	p value
Direct effect		
Self-stigma → Depression	0.131 (0.031, 0.246)	0.009
Indirect effect	0.484 (0.389, 0.582)	<0.001
Self-stigma → Positive affect → Depression	0.034 (0.005, 0.086)	0.008
Self-stigma → Negative affect → Depression	0.382 (0.234, 0.518)	<0.001
Self-stigma → Social support → Positive affect → Depression	0.011 (0.001, 0.044)	0.031
Self-stigma → Social support → Negative affect → Depression	0.056 (0.009, 0.152)	0.006
Total effect	0.615 (0.508, 0.704)	<0.001

[a] Bias-corrected confidence intervals were presented based on 5000 bootstrap samples

previous findings from Mak and her colleagues' study that self-stigma indirectly impacts psychological well-being via dampened perceived social support [31]. One possible explanation may be that those who report self-stigma may isolate themselves and therefore, receive limited social support from others. Indeed, previous findings have reported that self-stigma is associated with fear of disclosure [80] and social distancing [34].

In the present study, higher level of negative affect and lower level of positive affect were found to be associated with depression, findings corroborating with those of the Tripartite Model [41]. The relatively weak correlation between positive affect and negative affect supported that the two constructs are separate constructs [58]. It is also found that the effect of negative affect is stronger than that of positive affect on depression. It may be due to the fact that the factors in the CESD (somatic complaints, depressed affect, lack of positive affect, interpersonal problems), which was used to measure depressive symptoms in this study, tended to capture better negative affect better compared to positive affect. Indeed, studies have suggested that the items on somatic complaints, depressed affect, and interpersonal problems were found reliable and valid in measuring depressive symptomatology, while items in the positive affect factor were only weakly related to other measures of psychological distress [81].

Findings of the present study have important implications on how to improve mental health among PLWH. First, the study highlights the importance of improving the social support of PLWH in reducing depression symptoms. PLWH tend to seek support from other PLWH, rather than close friends and family members due to the issue of disclosure and social acceptance [34]. Peer support groups were found effective in increasing social support [82]. It is also important to note that online support groups may offer some benefits for PLWH [29]. Therefore it is necessary to encourage PLWH to join peer/online support groups so they can receive support from peers. Secondly, this study also suggests that interventions should aim to reduce self-stigma among PLWH. Empirical data has suggested that self-stigma can be reduced through interventions, e.g. counseling, cognitive behavioral therapy, self-help, or support groups [23, 24]. Third, as we further found that the protective factor of social support is strongly and negatively associated with self-stigma, interventions preventing depression among HIVMSM should integrate components of self-stigma reduction and enhancement of social support. Fourth, the results suggest that self-stigma reduction programs should also integrate affect interventions, given the significant mediation effects of positive affect and negative affect. Positive psychology interventions (PPI) have been developed and tested among general populations, such as undergraduate students, and were found effective in enhancing positive affect [83]. A pilot positive affect intervention that incorporated eight skills (e.g., noticing positive events, gratitude, and personal strengths) has been applied to newly diagnosed PLWH and was found effective in increasing positive affect and reducing negative affect [84]. It has, however, never been applied to the population of HIVMSM. More studies are greatly warranted.

There were several limitations in the current study. First, we cannot derive any conclusive causal relationships as this study used a cross-sectional design. Although this study provided evidence that higher levels of self-stigma are associated with lower social support, lower positive affect and higher negative affect, which in turn increases depressive symptoms, longitudinal studies are warranted to further explicate the causalities between these variables. Second, the results may not be generalized to other cultures and populations. Third, reporting bias may exist due to the nature of self-reported data. Fourth, selection bias may exist as this study had a convenient sample which did not include all HIVMSM in Chengdu and there were noncontacts. Fifth, the measurement on social support was self-constructed for this study and has not been validated. It only included two items measuring emotional support and material support (a part of instrumental support), which may be less ideal to form a latent variable in SEM. The Cronbach's alpha for this self-constructed measurement was moderate. However, it is important to point out that the use of self-constructed items for social support was very commonly in the literature [85, 86]. Sixth, the sample size of 321 may not be enough for this study. Seventh, the values of the model fit indices were close to the lower boundary of the recommended range [73]. Eighth, depression was measured using self-reported instrument. Therefore misclassification errors might exist.

In sum, this study is among the first to examine the importance of positive and negative affects and social support as mechanisms though which self-stigma related to depressive symptoms among HIVMSM. Results suggested that there is a need to reduce HIV self-stigma and increase social support in improving mental health among PLWH. Affect interventions (e.g., positive psychological interventions) should be integrated in programs that aim to reduce self-stigma.

Compliance with Ethical Standards

Conflict of interests There is no conflict of interests of all authors.

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