

# Sexual difficulties in men who have sex with men living with HIV: their mental health and health-related quality of life

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## Abstract

**Background:** Health-related quality of life (HRQoL) is gaining significance for people living with human immunodeficiency virus (HIV), with sexual difficulties being a crucial yet frequently neglected component of HRQoL, especially in HIV-positive men who have sex with men (MSM).

**Aim:** The study sought to assess the levels of sexual difficulties and explore the associations between sexual difficulties, mental health, and HRQoL in HIV-positive MSM.

**Methods:** A cohort of 475 HIV-positive MSM was studied from January 2017 to December 2021. Sociodemographic, clinical, and lifestyle data were collected. Participants were divided based on Arizona Sexual Experience Scale (ASEX) scores into 2 groups: those with sexual difficulties and a control group without difficulties.

**Outcomes** Psychological symptoms were evaluated by the Symptom Checklist-90 (SCL-90), HRQoL was accessed via 36-item Short Form Health Survey, and sexual function was assessed using the ASEX. We also employed path analysis to unveil latent mechanisms, alongside multivariate analysis to identify independent factors, and aimed to elucidate the interplay among sexual function, HRQoL, and mental health in HIV-positive MSM.

**Results:** A total of 391 HIV-positive MSM were enrolled in the control group and 84 in the sexual difficulties group. The control group had significantly higher physical HRQoL ( $P = .004$ ) and mental HRQoL ( $P = .045$ ). In addition, SCL-90 scores were higher in the sexual difficulties group ( $P = .001$ ). Multivariate analyses that indicated regular exercise (odds ratio, 0.553;  $P = .024$ ) and alcohol consumption (odds ratio, 1.780;  $P = .033$ ) were independent factors associated with sexual difficulties. The proportion of alcohol consumption in the sexual difficulties group was significantly higher ( $P = .003$ ). ASEX scores increased gradually with increasing frequency of alcohol consumption ( $P = .031$ ). Results from structural equation model showed a negative association between HRQoL and ASEX scores ( $\beta = -0.13$ ,  $P < .001$ ) and SCL-90 scores ( $\beta = -0.40$ ,  $P < .001$ ).

**Clinical Implications:** HIV-positive MSM experiencing sexual difficulties exhibited lower HRQoL and worse mental health, with independent associations identified for regular exercise and alcohol consumption in relation to sexual difficulties.

**Strengths and Limitations:** Our research has pioneered in demonstrating that HRQoL mediates the relationship between sexual difficulties and psychological symptoms among HIV-positive MSM undergoing highly active antiretroviral therapy. We found the protective factor associated with sexual difficulties was regular exercise while the risk factor was alcohol consumption. However, the data were collected only from China, and it is still unclear how HRQoL changes after intervention.

**Conclusion** Routine follow-up for people living with HIV should encompass an investigation into sexual function, emphasizing the need for timely assessment and intervention, particularly in HIV-positive MSM with identified risk factors.

**Keywords:** HIV/AIDS; health-related quality of life; sexual difficulties; psychological symptom; alcohol consumption.

## Background

Advances in highly active antiretroviral therapy (HAART) have changed human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS) from a terminal illness to a chronic disease.<sup>1</sup> Health-related quality of life (HRQoL) and long-term outcomes are becoming increasingly important

for people living with HIV (PLWHIV) with an increasing life expectancy. HRQoL encompasses various dimensions, including physical, psychological, and social functioning, as well as overall health status.<sup>2</sup> Despite improvements in life expectancy, the HRQoL of PLWHIV is inferior to that observed in the general population.<sup>3</sup> The adverse effects of

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lifelong highly active antiretroviral therapy (HARRT) have also been shown to affect HRQoL.<sup>4</sup> Several other factors such as age,<sup>5</sup> gender,<sup>6</sup> HIV viral load,<sup>7</sup> CD4+ T cell counts,<sup>8</sup> mental health,<sup>9</sup> and behavioral factors,<sup>10</sup> have been reported to affect HRQoL in PLWHIV. The 36-Item Short Form Health Survey (SF-36) is a generic instrument to evaluate HRQoL as the extent to which physical health impacts functional ability and perceived well-being in mental, physical, and social aspects of life.<sup>11</sup> However, for the HIV-positive men who have sex with men (MSM) population, the levels of HRQoL and related factors remain unclear. A cross-sectional study in Chongqing, China, focusing on HIV-related behaviors, social support, and HRQoL among MSM and women revealed that HRQoL is influenced by a complex interplay of personal, environmental, and social factors.<sup>12</sup> Additionally, another study identified depression status, social stigma, and family support as significant influencers of life quality in MSM. Notably, depression emerged as a pivotal factor, markedly elevating the risk of diminished life quality among HIV-positive MSM.<sup>13</sup>

Sexual difficulties are an important but often overlooked aspect of quality of life. HIV infection has an especially negative impact not only on general HRQoL, but also on sexual difficulties. The rate of sexual difficulties in PLWHIV, especially MSM, has been reported to exceed incidence in the general population.<sup>14,15</sup> Sexual difficulties have an impact on HRQoL<sup>16</sup> and frequently lead to poor adherence to and all-cause hospitalization for HARRT in PLWHIV.<sup>17,18</sup> Few studies have reported that sexual difficulties may be associated with the use of HARRT and especially protease inhibitors.<sup>19,20</sup> Although a well-established rating questionnaire, the Arizona Sexual Experience Scale (ASEX), has been applied widely for the evaluation of sexual difficulties,<sup>21</sup> the issue of sexual difficulties in HIV-positive MSM has received little attention.

Aside from HRQoL and physical health, sexual difficulties are associated with psychological health as well.<sup>22</sup> The Symptom Checklist-90-Revised (SCL-90-R) reflects broad psychological symptom status in a wide range of individuals. Research on sexual difficulties in HIV-positive MSM is scarce. It is noted that HIV infection, including AIDS, is linked to increased instances of erectile dysfunction in MSM.<sup>23</sup> Mental health issues, depression, and associated medications significantly impact sexual function, particularly in relation to erectile dysfunction. Psychological factors like fear of HIV transmission and stigma are found to more profoundly affect erectile function than traditional risk factors, such as infection duration, HAART regimen, and sexual orientation.<sup>24</sup> Consequently, these studies predominantly concentrate on erectile dysfunction, shedding light on how HIV status, various medications (including HAART, recreational drugs, and antidepressants), and mental health contribute to sexual difficulties, with a specific emphasis on erectile dysfunction. In the realm of medical literature, particularly concerning HIV-positive MSM, there appears to be a scarcity of research exploring the tripartite relationship between HRQoL, a broad spectrum of sexual difficulties, and psychological health.

HRQoL encompasses patient reports of functioning and well-being across physical, mental, and social domains.<sup>25</sup> HRQoL covers various aspects of daily life, including physical self-care, work-related activities, and social interactions.<sup>25</sup> The biopsychosocial model, which views health outcomes as a complex interplay of biological, psychological, and social

factors, provides a theoretical framework supporting the role of HRQoL as a mediator. Sexual function, a physical function yet often neglected component of HRQoL, is directly linked to these domains.<sup>26,27</sup> Moreover, research on sexual dysfunction in the elderly has shown a strong correlation between sexual dysfunction and poorer quality-of-life scores, with no significant link to depression scores.<sup>28</sup> This finding suggests that sexual function may be more directly related to HRQoL, highlighting its importance in assessing HRQoL first in those patients.

The relationship between HRQoL and mental health is profound and complex. One study examined the relationship between mental health and HRQoL among Indonesian female migrant workers in Taiwan, revealing that coping strategies, including substance use, partially mediated the relationship between mental health problems and HRQoL.<sup>29</sup> A cross-sectional study investigating sexual minority populations in China found that depression and anxiety significantly mediated the relationship between sexual identity and HRQoL.<sup>30</sup> Additionally, HRQoL can impact psychological issues in return. A study involving 990 Iranian hospital nurses found that HRQoL can also have an effect on mental health both in direct and indirect way.<sup>31</sup> Liu et al<sup>32</sup> employed a systematic approach to examine various variables and found that HRQoL moderated the relationships between physical exercise, psychological resilience, and mental health. This aligns with studies suggesting HRQoL as an intermediary variable linking physical function with psychological well-being. Although intervention studies are ideal for confirming causal pathways, they are challenging to conduct such a study due to the multifaceted nature of HRQoL. While many existing studies are cross-sectional and do not fully establish causality, they provide valuable insights into HRQoL's mediating role. Current evidence, though primarily cross-sectional, consistently supports HRQoL's role as a meaningful mediator between physical function and mental health. This perspective is crucial for enhancing the well-being of individuals living with health challenges. However, no studies have yet reported on the relationship between HRQoL and mental health in people living with HIV, specifically regarding the role of sexual function in HRQoL and mental health for this population.

Hence, it is pertinent to inquire about the relationship between alterations in sexual function, quality of life, and psychological status among HIV-positive MSM. What is the relationship between those 3 measurements? And what are the respective independent factors for each of these domains? Understanding the potential mediating mechanisms of HRQoL between sexual difficulties and psychological health in HIV-positive MSM receiving HAART is crucial for preserving their physical and mental health. Additionally, to refine our intervention strategies for MSM experiencing sexual difficulties within our HIV-positive cohort, we have undertaken a concurrent analysis of sociodemographic factors, such as age, marital status, body mass index, education level, and income, as well as lifestyle habits including exercise frequency, sleep duration, circadian rhythm disruptions, tobacco smoking, and alcohol consumption. The findings are poised to offer valuable medical insights into the sexual difficulties, decreased HRQoL, and deteriorated mental health status within the HIV-positive MSM population, thereby potentially enhancing treatment adherence in this group.

## Methods

### Study participants

The patients were from a perspective cohort study regularly followed up from January 2017 to December 2021. The inclusion criteria were (1) MSM diagnosed with HIV infection and (2) patients without other severe diseases. The exclusion criteria were patients who had (1) incomplete information, (2) severe underlying diseases, and (3) psychological symptoms before HIV infection. Patients were subsequently categorized into 2 groups according the ASEX: one group with sexual difficulties and a control group without sexual difficulties. The study protocol received approval from the Institutional Review Board of Nanfang Hospital, in accordance with the principles outlined in the Declaration of Helsinki (approval number: NFEC-2021-178). We obtained written informed consent from all patients.

Participants were interviewed using a structured questionnaire to gather demographic data and information about lifestyle habits. Clinical data for these patients were accessible from our case management records. Public health professionals, specifically trained for data collection in this study, conducted the questionnaire administration. The education levels of participants were categorized as either fewer or more than 12 years. Income levels were defined as high if they exceeded 240 000 RMB/year and regular if they were <240 000 RMB/year. The frequency of regular exercise was classified as <1 time/wk, 1 time/wk, or more than 1 time/wk, with the stipulation that a session must last at least 30 minutes to be considered a single instance of exercise. Sleep duration was classified as >8 h/d, 6 to 8 h/d, or <6 h/d. Circadian disruption was categorized as stay up late occurring 1 time/wk, 1 to 3 times/wk, or more than 3 times/wk. Alcohol consumption was categorized as barely, 1 time/wk, 1 to 3 times/wk, or more than 3 times/wk. An occasion of alcohol consumption was only counted if the amount of alcohol exceeded 40 g per drinking session, a threshold consistent with criteria used in the assessment of alcoholic liver disease.<sup>33</sup>

### Questionnaires

#### *Symptom Checklist-90-Revised*

Psychopathology was measured by the SCL-90-R, a reliable, valid and accepted tool for psychological evaluation.<sup>34</sup> Each of the 90 questionnaire items is rated on a 5-point scale (0-4) and corresponds to 9 primary symptom domains of psychological distress. These include somatization (SOM), obsessive-compulsive (OS), interpersonal sensitivity (IS), depression (DEP), anxiety (ANX), hostility (HOS), phobic anxiety (PHO), paranoid ideation (PAR), and psychoticism (PSY). Additionally, global indices include the global severity index, overall positive symptoms, and the positive symptom distress index. A total score of over 160 points indicates mild psychological distress, while scores exceeding 200 and 250 points suggest moderate and significant psychological difficulties, respectively.

#### *Arizona Sexual Experience Scale*

The ASEX, whether self- or clinician administered, comprises 5 key items recognized as fundamental to sexual function based previous comprehensive literature review. These items encompass arousal, sex drive, ability to achieve orgasm, satisfaction with orgasm, and either penile erection for males or vaginal lubrication for females.<sup>35</sup> The Chinese ASEX version

was selected due to its effectiveness in Chinese individuals had been confirmed, and it has a Cronbach's alpha of 0.85.<sup>21</sup> The ASEX offers potential total scores ranging from 5 to 30. Sexual difficulties are defined as follows: (1) total ASEX scores >19, (2) any 1 item with a score >5, and (3) any 3 items with a score >4. Demonstrating reliability, validity, and sensitivity, the ASEX serves as a robust tool for assessing sexual difficulties in both males and females.

#### *36-Item Short Form Health Survey*

The 36-Item Short Form Health Survey (SF-36) is a comprehensive questionnaire for assessing HRQoL. It comprises 36 items and measures 8 different health domains: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role-emotional, and mental health). Scores on each dimension range from 0 to 100, with higher scores indicating better HRQoL in the respective domain.<sup>36,37</sup>

### Statistical analysis

SPSS version 26.0 (IBM) and GraphPad Prism (version 9.0.2; GraphPad Software) were used to perform statistical analysis. Data are expressed as counts and percentages for count data and as the mean  $\pm$  SD for measurement data. Measurement data were analyzed by independent-samples *t* test and 1-way analysis of variance, and count data were analyzed by the chi-square test. Univariate and multivariate logistic regression analysis was used to determine factors related to sexual difficulties and high SF-36 scores among the HIV-positive MSM. We analyzed the correlation between SF-36 scores and ASEX scores, as well as SF-36 scores and SCL-90, using Pearson's correlation. A *P* < .05 (2-tailed) was set as significance. Path analysis, conducted using AMOS 25.0 (IBM), aimed to unveil the potential mechanism behind sexual difficulties and HRQoL.<sup>38,39</sup> The standardized regression weights ( $\beta$  coefficients) were reported along with their corresponding *P* values. Model fit was evaluated using several indices, including  $\chi^2$ ,  $\chi^2$ /degrees of freedom, goodness-of-fit index, normed fit index, incremental fit index, Tucker-Lewis index, comparative fit index, and root mean square error of approximation.

## Results

### Demographic and clinical data in HIV-positive MSM with sexual difficulties

A total of 391 HIV-positive MSM were enrolled in the control group, and 84 HIV-positive MSM were enrolled in the sexual difficulties group according to ASEX criteria for sexual difficulties. The characteristics of the entire cohort are summarized in Table 1. The proportions of regular exercise were lower (*P* = .045) and alcohol consumption (*P* = .009) was higher in the sexual difficulties group.

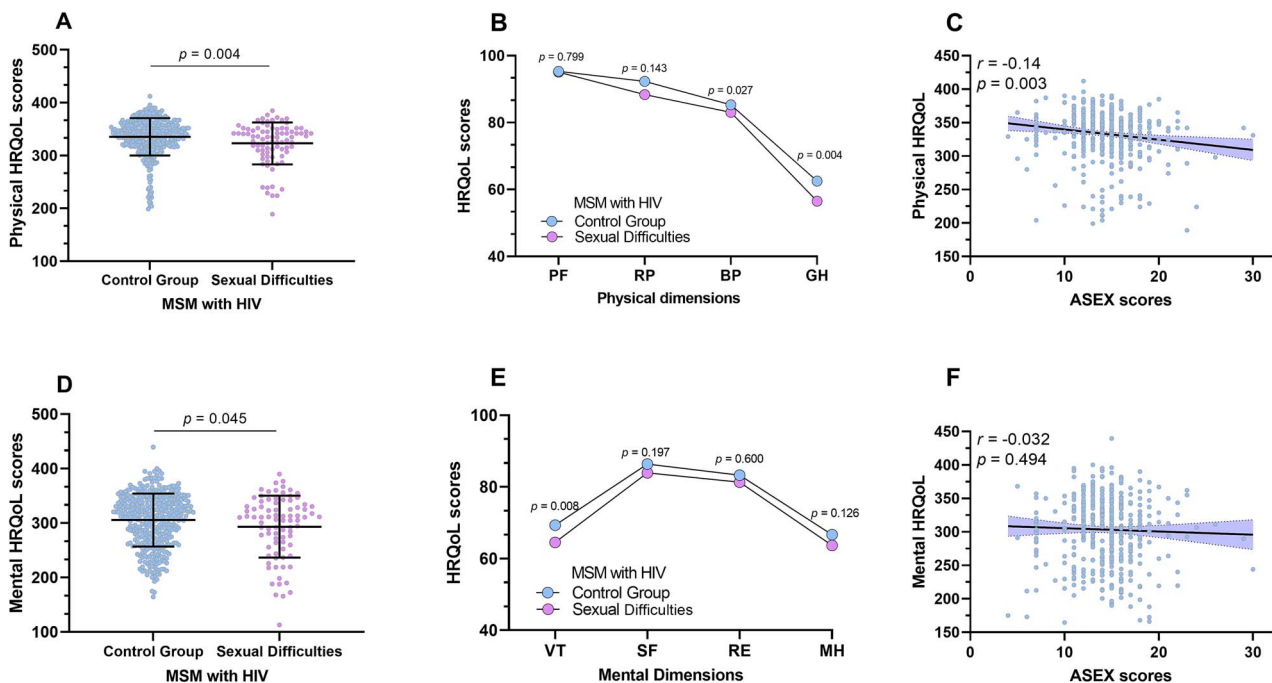
### Association between HRQoL and sexual difficulties in HIV-positive MSM.

Physical HRQoL scores were significantly higher in the control group compared with the sexual difficulties group (323.0  $\pm$  39.6 vs 335.5  $\pm$  35.2; *P* = .004) (Figure 1A). Physical dimensions of HRQoL were therefore compared and blood pressure scores (*P* = .027) and general health scores (*P* = .004) were significantly lower in the sexual difficulties group (Figure 1B). Moreover, sexual function evaluated by ASEX

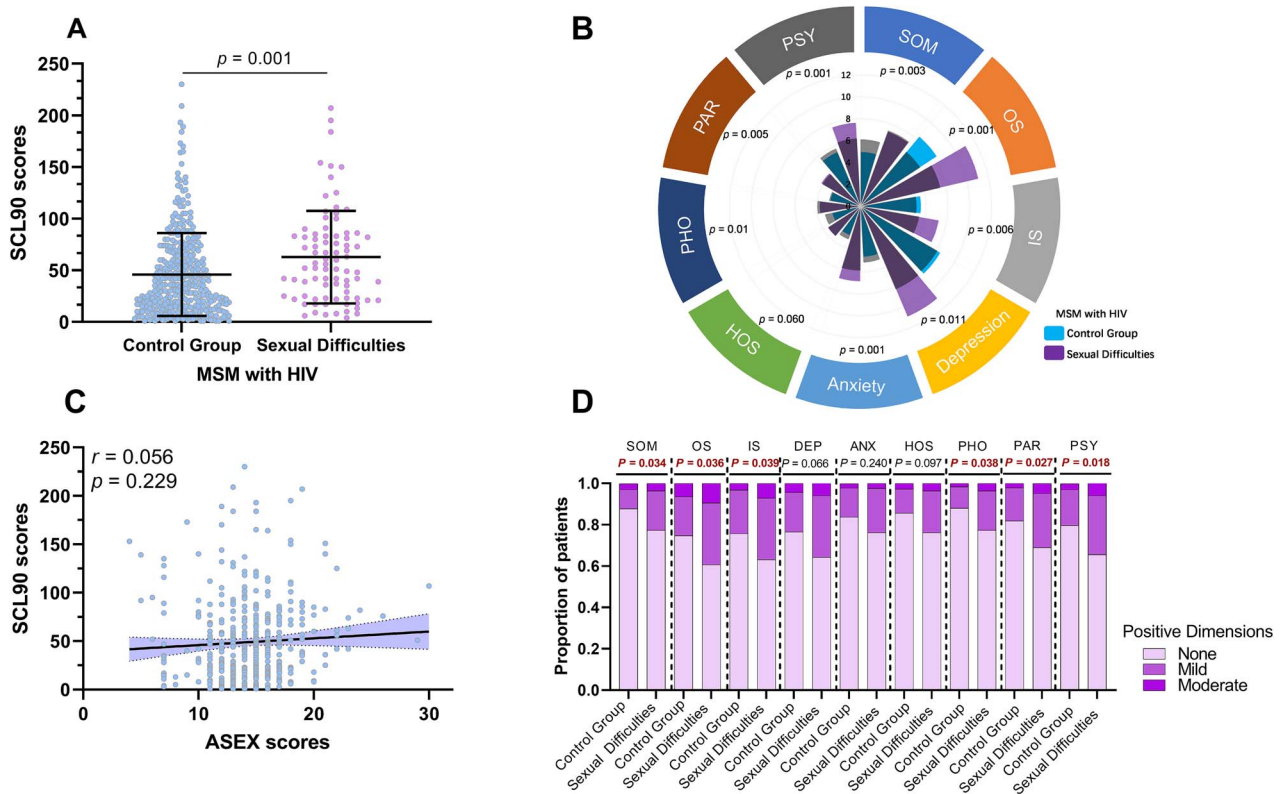
**Table 1.** Characteristics of PLWHIV with and without sexual difficulties according to the ASEX score.

Characteristic	Control group (n = 375)	Sexual dysfunction group (n = 84)	P valve
Age, y	30.6 ± 8.7	30.1 ± 7.9	.645
BMI, kg/m <sup>2</sup>	21.3 ± 3.3	20.9 ± 3.4	.373
Education levels			.071
≤12 y	219 (58.4)	58 (69.0)	
>12 y	156 (41.6)	26 (31.0)	
Income level			.742
Regular income	335 (89.3)	74 (88.1)	
High income	40 (10.7)	10 (11.9)	
Regular exercise			.045
<1 time/wk	201 (53.6)	57 (67.9)	
1 time/wk	136 (36.3)	23 (27.3)	
>1 time/wk	38 (10.1)	4 (4.8)	
Sleep duration			.488
>8 h/d	50 (13.3)	15 (17.9)	
6-8 h/d	285 (76.0)	58 (69.0)	
<6 h/d	40 (10.7)	11 (13.1)	
Circadian disruption			.322
<1 time/wk	49 (13.1)	9 (10.7)	
1-3 times/wk	212 (56.5)	55 (65.5)	
>3 times/wk	114 (30.4)	20 (23.8)	
Alcohol consumption			.009
Barely drink	289 (77.1)	55 (65.5)	
<1 time/wk	62 (16.5)	13 (15.5)	
1-3 times/wk	20 (5.3)	14 (16.7)	
>3 times/wk	4 (1.1)	2 (2.4)	
Tobacco smoking			.109
Yes	89 (23.7)	27 (32.1)	
No	286 (76.3)	57 (67.9)	
OIs before			.990
Yes	94 (25.1)	21 (25.0)	
No	281 (74.9)	63 (75.0)	

Abbreviations: ASEX, Arizona Sexual Experience Scale; BMI, body mass index; OI, opportunistic infection; PLWHIV, people living with human immunodeficiency virus.



**Figure 1.** The health-related quality-of-life (HRQoL) scores in the control and sexual difficulties groups in men who have sex with men (MSM) with human immunodeficiency virus (HIV). (A) Physical HRQoL scores in the control and sexual difficulties groups. (B) Physical HRQoL dimensions scores in the control and sexual difficulties groups. (C) Correlation between physical HRQoL scores and Arizona Sexual Experience Scale (ASEX) scores. (D) Mental HRQoL scores in the control and sexual difficulties groups. (E) Mental HRQoL dimensions scores in the control and sexual difficulties groups. (F) Correlation between mental HRQoL scores and ASEX scores. BP, bodily pain; GH, general health; MH, mental health; PF, physical functioning; RE, role-emotional; RP, role-physical; SF, social functioning; VT, vitality.



**Figure 2.** The Symptom Checklist-90 (SCL-90) in the control and sexual difficulties groups in men who have sex with men (MSM) with human immunodeficiency virus (HIV). (A) SCL-90 scores in the control and sexual difficulties groups. (B) SCL-90 dimensions scores in the control and sexual difficulties groups. (C) Correlation between SCL-90 scores and Arizona Sexual Experience Scale (ASEX) scores. (D) the proportion of SCL-90 dimension positive levels in the control and sexual difficulties groups. ANX, anxiety; DEP, depression; HOS, hostility; IS, interpersonal sensibility; OS, obsessive-compulsive; PAR, paranoid ideation; PHO, phobic anxiety; PSY, psychoticism; SOM, somatization.

scores was negatively correlated with physical HRQoL score ( $P = .003$ ,  $r = -0.140$ ) (Figure 1C).

Mental HRQoL scores was also assessed and the results showed that in the sexual difficulties group HRQoL was lower when compared with control group ( $293.5 \pm 56.8$  vs  $305.6 \pm 48.6$ ;  $P = .045$ ) (Figure 1D). Mental dimensions of HRQoL were compared and only vitality scores ( $P = .008$ ) (Figure 1E) were significant lower in the sexual difficulties group. However, we observed no significant correlation between ASEX scores and mental HRQoL score ( $P = .494$ ,  $r = -0.032$ ) (Figure 1F).

### Association between psychological symptoms and sexual difficulties in HIV-positive MSM.

SCL-90 scores in the control group w significantly lower ( $45.8 \pm 40.1$  vs  $62.8 \pm 44.8$ ;  $P = .001$ ) (Figure 2A). Hence, we further compared dimensions of SCL-90 between control group and sexual difficulties group. We observed that dimensions of SOM ( $P = .003$ ), OS ( $P = .001$ ), IS ( $P = .006$ ), DEP ( $P = .011$ ), ANX ( $P = .001$ ), PHO ( $P = .010$ ), PAR ( $P = .010$ ), and PSY ( $P = .005$ ) were significantly higher in the sexual difficulties group compared with control group (Figure 2B). However, no significant correlation was found between SCL-90 scores and ASEX scores ( $P = .229$ ) (Figure 2C). We found that the proportion of positive symptoms in mental health were different between the 2 groups. The proportion of positive symptoms in SOM ( $P = .034$ ), OS ( $P = .036$ ), IS ( $P = .039$ ), PHO ( $P = .038$ ), PAR ( $P = .027$ ), and PSY ( $P = .018$ ) were significant higher in the sexual difficulties group (Figure 2D).

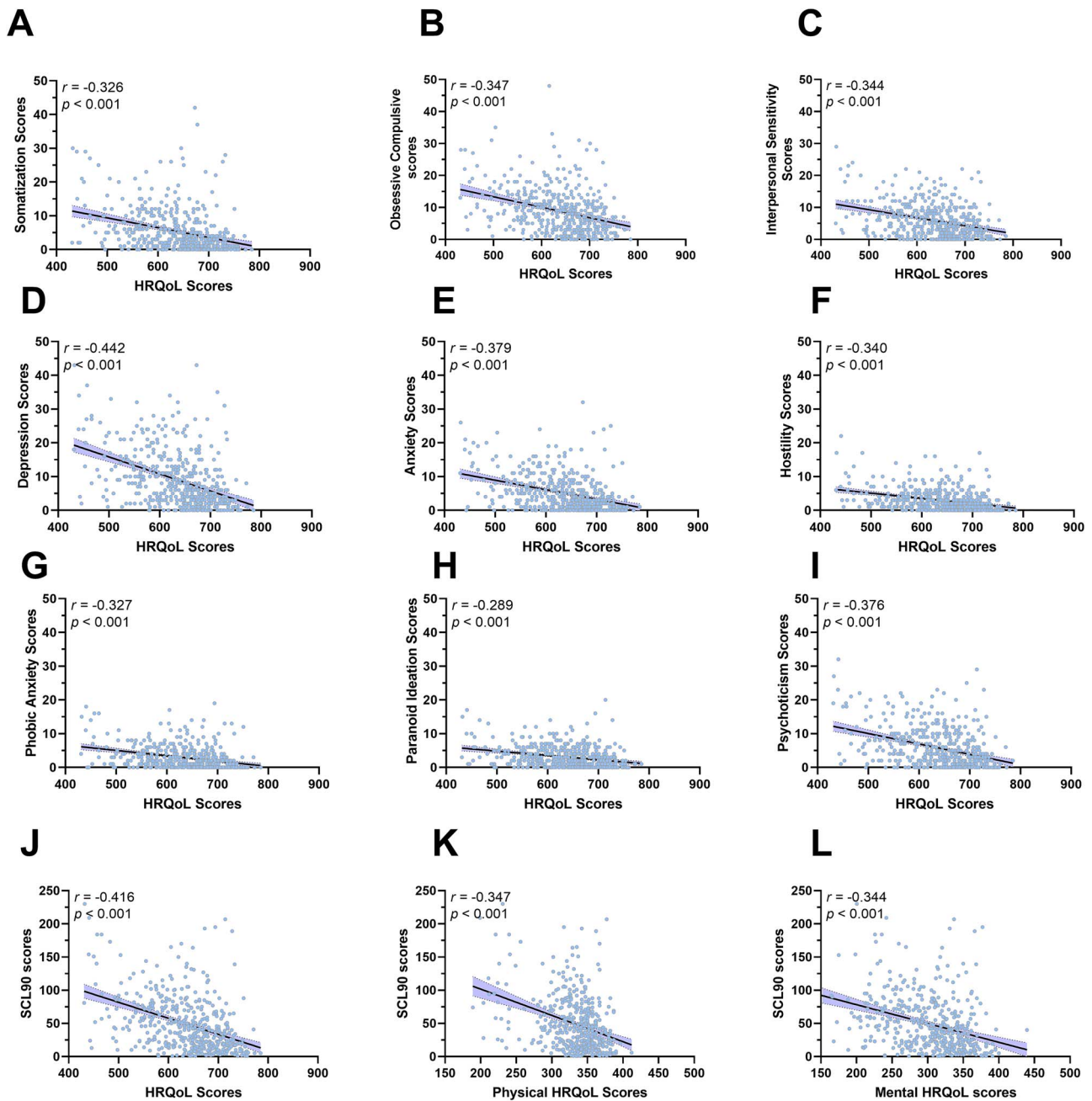
### Correlation among HRQoL levels and psychological symptoms

To further analyze the potential association between HRQoL scores and SCL-90 dimensions in MSM with HIV, we conducted correlation analysis (Figure 3A-I). We found that the HRQoL score was negatively correlated with SOM, OS, IS, DEP, ANX, HOS, PHO, PAR, and PSY. We also further analyzed the correlation between SCL-90 scores and the dimensions of HRQoL, in which SCL-90 score was negatively correlated with total ( $P < .001$ ,  $r = -0.416$ ), physical ( $P < .001$ ,  $r = -0.347$ ), and mental ( $P < .001$ ,  $r = -0.344$ ) HRQoL scores.

### Risk factors associated with sexual difficulties, HRQoL, and psychological symptoms in MSM with HIV

To evaluate the risk factors associated with sexual difficulties in MSM with HIV, univariate and multivariate logistic regression analysis were conducted. Regular exercise and alcohol consumption were risk factors associated with sexual difficulties (Figure 4A). Multivariate analyses showed regular exercise (odds ratio [OR], 0.553; 95% confidence interval [CI], 0.331-0.926;  $P = .024$ ) and alcohol consumption (OR, 1.780; 95% CI, 1.046-3.028;  $P = .033$ ) were independent factors of sexual difficulties (Figure 4B).

Further, we analyzed risk factors associated with HRQoL in MSM with HIV. Univariate analysis showed body mass index level and ASEX score were risk factors in HRQoL (Figure 4C).



**Figure 3.** Correlation of health-related quality of life (HRQoL) dimension scores and Symptom Checklist-90 (SCL-90) dimension scores in men who have sex with men (MSM) with human immunodeficiency virus (HIV). (A) Correlation between somatization scores and HRQoL scores. (B) Correlation between obsessive compulsive scores and HRQoL scores. (C) Correlation between interpersonal sensitivity scores and HRQoL scores. (D) Correlation between depression scores and HRQoL scores. (E) Correlation between anxiety scores and HRQoL scores. (F) Correlation between hostility scores and HRQoL scores. (G) Correlation between phobic anxiety scores and HRQoL scores. (H) Correlation between paranoid ideation scores and HRQoL scores. (I) Correlation between psychoticism scores and HRQoL scores. (J) Correlation between SCL-90 scores and HRQoL scores. (K) Correlation between SCL-90 scores and physical HRQoL scores. (L) Correlation between SCL-90 scores and mental HRQoL scores.

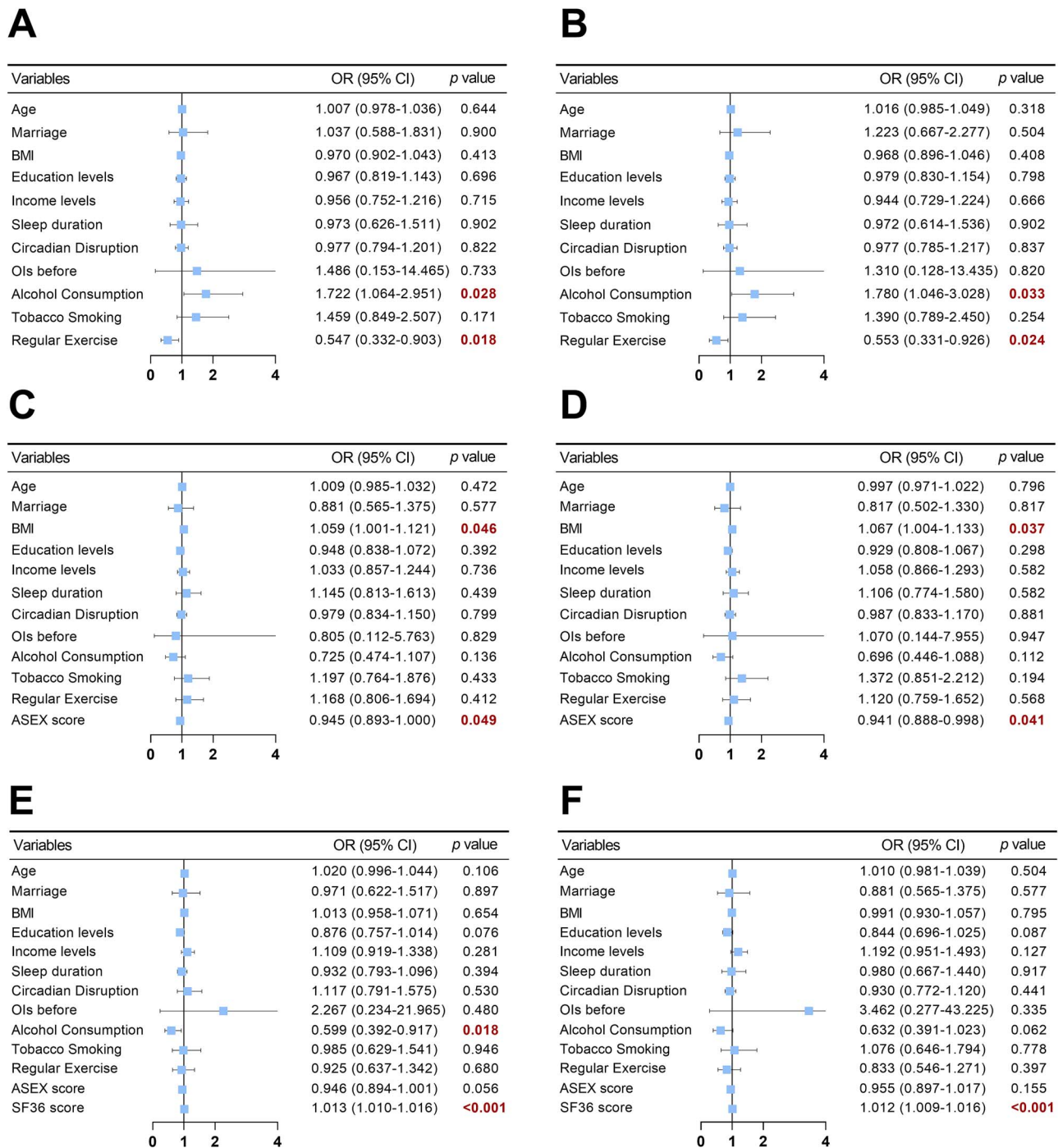
Multivariate analysis showed body mass index (OR, 1.067; 95% CI, 1.004-1.133;  $P = .037$ ) and ASEX score (OR, 0.941; 95% CI, 0.888-0.998;  $P = .041$ ) were independent factors associated with HRQoL (Figure 4D).

The risk factors associated with psychological symptom in MSM with HIV were also evaluated. Alcohol consumption and SF-36 score were risk factors in psychological symptoms (Figure 4E). However, only the SF-36 score (OR, 1.012; 95%

CI, 1.009-1.016;  $P < .001$ ) was an independent factor of psychological symptoms (Figure 4F).

### One potential mediational mechanism of psychological symptoms

To identify the mechanism between psychological status, HRQoL, and sexual function, we further explored and



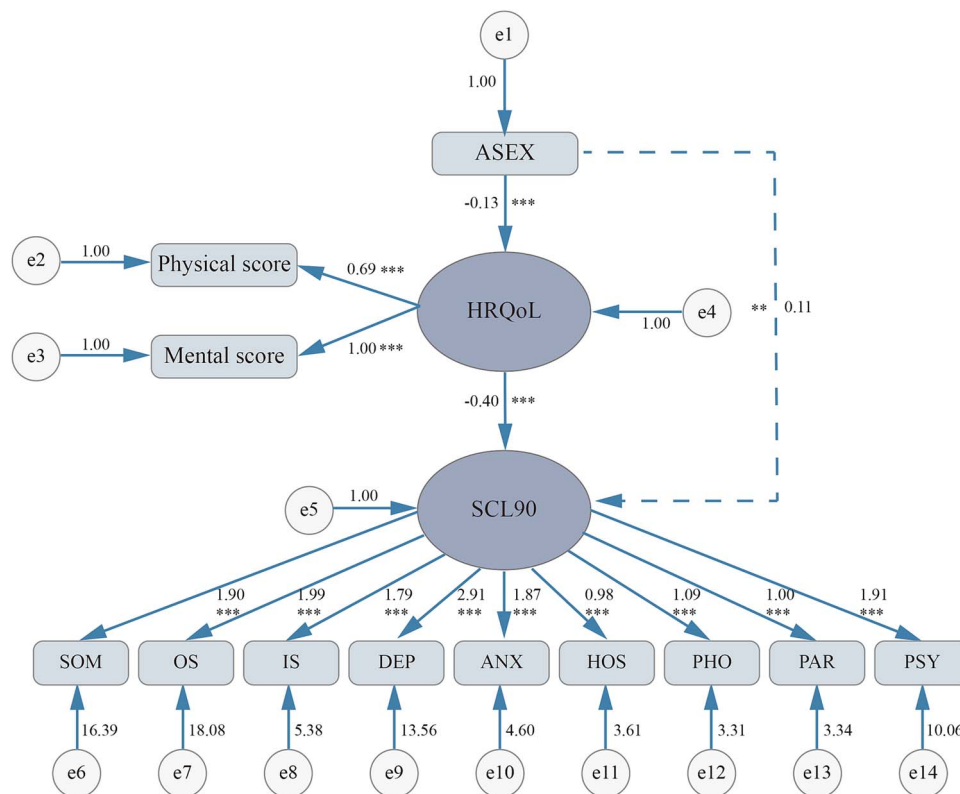
**Figure 4.** Univariate and multivariate analyses associated with sexual difficulties, health-related quality of life (HRQoL), and psychological symptoms in men who have sex with men (MSM) with human immunodeficiency virus (HIV). (A) Forest plot of univariate regression analysis associated with sexual difficulties. (B) Forest plot of multivariate regression analysis associated with sexual difficulties. (C) Forest plot of univariate regression analysis associated with HRQoL. (D) Forest plot of multivariate regression analysis associated with HRQoL. (E) Forest plot of univariate regression analysis associated with psychological symptom. (F) Forest plot of multivariate regression analysis associated with psychological symptom.

developed a psychosocial model (Figure 5). The HRQoL was negatively associated with ASEX scores ( $\beta = -0.13$ ,  $P < .001$ ) and SCL-90 scores ( $\beta = -0.40$ ,  $P < .001$ ). However, ASEX scores was positively associated with SCL-90 scores ( $\beta = 0.11$ ,  $P = .014$ ). The model reflected a good model fit ( $\chi^2$ : 266.922; degrees of freedom: 52;  $\chi^2$ /degrees of freedom: 5.133; goodness-of-fit index: 0.913; normed fit index: 0.942; incremental fit index: 0.953; Tucker-Lewis

index: 0.940; comparative fit index: 0.953; root mean square error of approximation: 0.094).

### Association between regular exercise and sexual difficulties.

Due to regular exercise being a protective factor associated with sexual function, we further analyzed the role of regular



**Figure 5.** Structural equation model for the mediation mechanism of health-related quality of life (HRQoL) with standardized beta weights and significant level. \*\*\* $P < .001$ ; the model reflected a good model fit: ( $\chi^2$ : 266.922; degrees of freedom: 52;  $\chi^2$ /degrees of freedom: 5.133; goodness-of-fit index: 0.913; normed fit index: 0.942; incremental fit index: 0.953; Tucker-Lewis index: 0.940; comparative fit index: 0.953; root mean square error of approximation: 0.094).

exercise in MSM with HIV. The proportion of regular exercise in the control group was significantly higher than in the sexual difficulties group ( $P = .017$ ) (Figure 6A and B). Additionally, the ASEX score was significantly lower in HIV-positive MSM with regular exercise ( $P = .042$ ) (Figure 6C).

We also evaluated HRQoL and SCL-90 scores in patients with regular exercise. No significant difference was found in physical ( $P = .058$ ) and mental ( $P = .152$ ) HRQoL scores in patients with or without regular exercise but saw a significant increase in total HRQoL scores in patients with regular exercise ( $P = .039$ ). Regular exercise was significant higher in general health ( $P = .021$ ) and vitality ( $P = .045$ ) (Figure 6F).

Although no significant difference was found in SCL-90 dimension scores in patients with or without regular exercise (Figure 6G), the proportion of patients with anger-hostility symptom was significantly lower in HIV-positive MSM with regular exercise ( $P = .026$ ) (Figure 6H).

### Association between alcohol consumption and sexual difficulties.

Alcohol consumption was proven as a risk factor associated with sexual function. Hence, we further analyzed the role of alcohol consumption in MSM with HIV. The proportion of alcohol consumption in the sexual difficulties group was significantly higher than in the control group ( $P = .003$ ) (Figure 7A). ASEX scores were gradually rising with increasing frequency of alcohol consumption ( $P = .031$ ) (Figure 7B). Moreover, the proportion of alcohol consumption were significantly higher in psychological symptoms including OS ( $P = .030$ ), DEP ( $P = .037$ ), and PHO ( $P = .036$ ) (Figure 7C). We

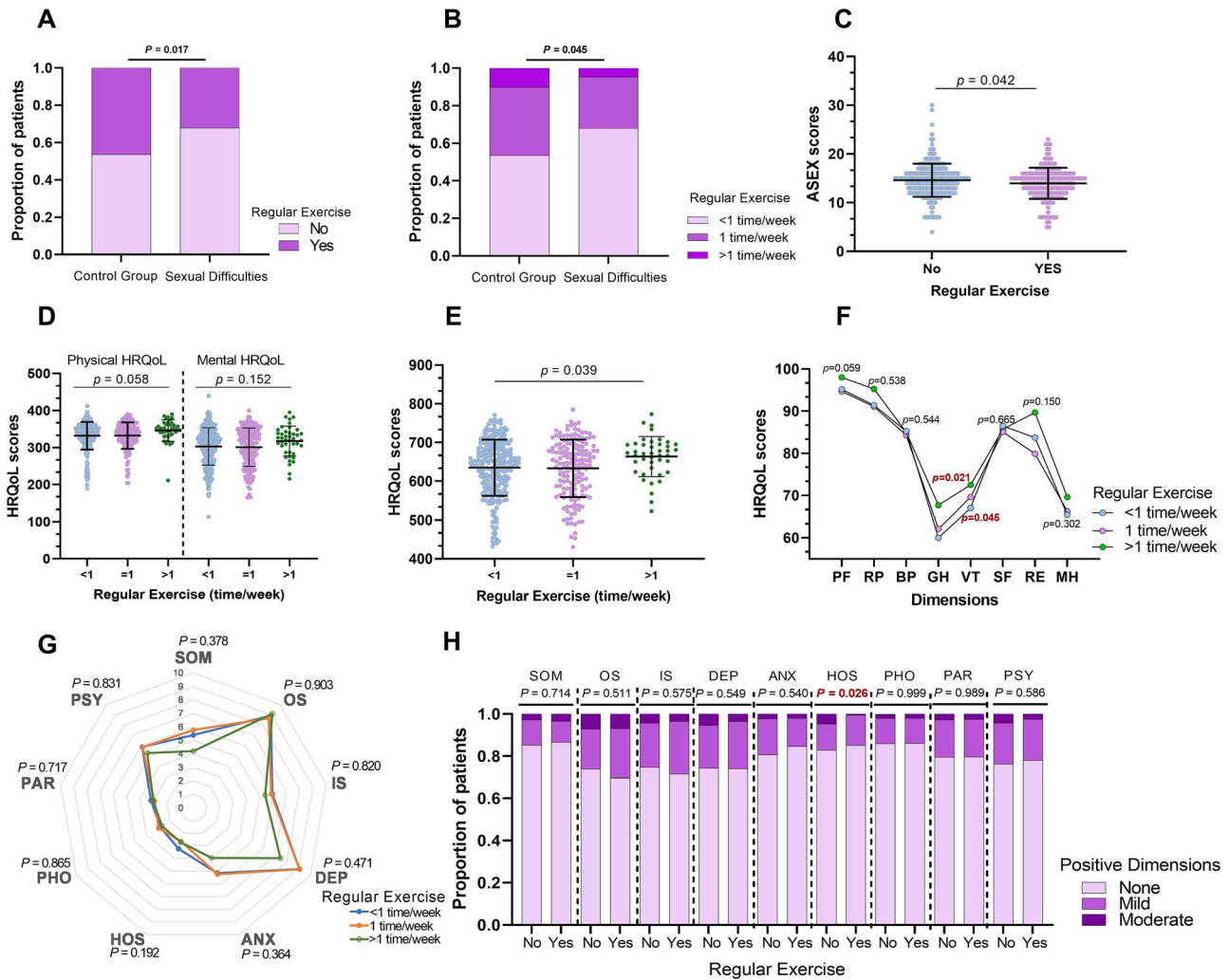
also compared the dimensions scores of SCL-90 in patients with or without alcohol consumption. SOM ( $P = .027$ ), OS ( $P = .005$ ), DEP ( $P = .019$ ), ANX ( $P = .046$ ), PAR ( $P = .047$ ), and total SCL-90 scores ( $P = .013$ ) were significantly higher in the sexual difficulties group (Figure 7D).

### Discussion

Our study established that HRQoL functions as a mediating variable between sexual difficulties and psychological symptoms in HIV-positive MSM undergoing HAART. Our results indicate that HIV-positive MSM experiencing sexual difficulties tend to have lower scores on HRQoL and higher scores on the SCL-90. A previous study showed that sexual function was associated with HRQoL in PLWHIV.<sup>40</sup> Another study also showed sexual difficulties negatively impact HRQoL in men.<sup>41</sup> In our study, HIV-positive MSM with sexual difficulties reported significantly lower physical HRQoL for body pain and general health dimensions and mental HRQoL scores for vitality dimensions.

Psychiatric health is closely linked to sexual difficulties. According to a cross-national study, depression was associated with erectile dysfunction in a graded manner, and men with erectile dysfunction had a 2.09 times greater risk of depression.<sup>42</sup> In present study, HIV-positive MSM with sexual difficulties had a significantly higher score of psychological symptoms. In addition, previous studies showed psychological and physical disorders negatively impact the HRQoL and treatment outcomes of PLWHIV.<sup>43</sup> The results of our study also suggest a close correlation between HRQoL and





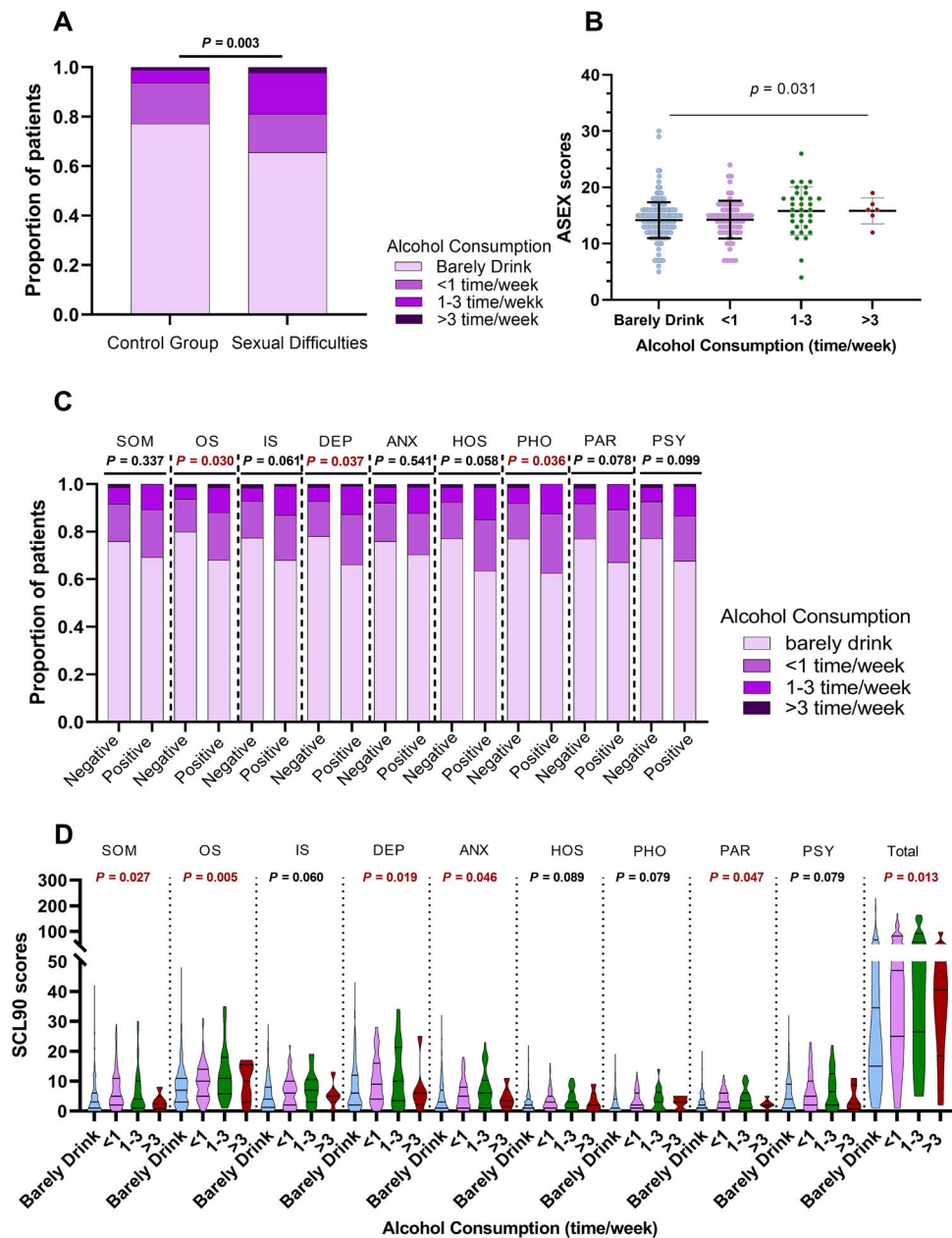
**Figure 6.** The role of regular exercise in sexual difficulties, health-related quality of life (HRQoL), and psychological symptom in men who have sex with men (MSM) with human immunodeficiency virus (HIV). (A) Proportion of regular exercise in the control and sexual difficulties groups. (B) Proportion of different regular exercise frequency in the control and sexual difficulties groups. (C) Arizona Sexual Experience Scale (ASEX) scores in MSM with HIV with or without regular exercise. (D) Physical HRQoL scores and mental HRQoL scores according to different regular exercise frequency. (E) Total HRQoL scores according to different regular exercise frequency. (F) HRQoL dimensions scores according to different regular exercise frequency. (G) Symptom Checklist-90 (SCL-90) dimension scores according to different regular exercise frequency. (H) the proportion of SCL-90 dimension positive levels in different regular exercise. ANX, anxiety; DEP, depression; HOS, hostility; IS, interpersonal sensibility; OS, obsessive-compulsive; PAR, paranoid ideation; PHO, phobic anxiety; PSY, psychoticism; SOM, somatization.

psychological symptoms. Based on these findings, we hypothesized that HRQoL may mediate the relationship between sexual difficulties and greater psychological symptoms among HIV-positive MSM. We observed effects between sexual difficulties and HRQoL. Higher levels of sexual difficulties were associated with increased psychological symptoms, which, in turn, predicted poorer HRQoL. In the mediation analysis, we observed that among HIV-positive MSM, quality of life acted as a mediating factor between sexual function and psychological symptoms, indicating that sexual function has an indirect effect on psychological symptoms. However, we also noted that sexual function could directly influence psychological symptoms ( $\beta = 0.11, P = .014$ ). This underscores the intricate relationship between physiological and psychological changes. Further investigation may be warranted to elucidate the underlying mechanisms of this mediation more comprehensively.

In our study, the choice of quality of life as a mediator variable was based on several considerations, including its

theoretical relevance to the relationship between sexual difficulties and psychological symptoms, as well as its potential to provide valuable insights into the mechanisms underlying this association. Especially, previous studies had indicated quality of life as a mediator on psychological symptoms.<sup>31,44,45</sup> Our study had confirmed the results. However, this model can only represent one possible interpretation among several. Mental health may also affect quality of life reversely, as highlighted in the study by Veronese et al,<sup>44</sup> in which they found bidirectional influences between quality of life and mental health.

According to the results of our study, one major protective factor associated with sexual difficulties was regular physical exercise. One meta-analysis showed that higher physical exercise had dose-dependent associations with a lower risk of sexual difficulties.<sup>46</sup> The connection between physical exercise and sexual function might be attributed to the increase in testosterone<sup>47</sup> and improve the function of the pelvic floor muscles.<sup>48,49</sup> A recent study showed that exercise duration had a significant impact on HRQoL for PLWHIV.<sup>50</sup> In



**Figure 7.** The role of alcohol consumption in sexual difficulties, health-related quality of life (HRQoL), and psychological symptoms in the men who have sex with men (MSM) with human immunodeficiency virus (HIV). (A) Proportion of different alcohol consumption frequency in the control and sexual difficulties groups. (B) Arizona Sexual Experience Scale (ASEX) scores according to different regular exercise frequency. (C) Proportion of alcohol consumption frequency in positive or negative Symptom Checklist-90 (SCL-90) dimensions. (D) SCL-90 dimension scores according to different alcohol consumption frequency. ANX, anxiety; BP, bodily pain; DEP, depression; GH, general health; HOS, hostility; IS, interpersonal sensibility; MH, mental health; OS, obsessive-compulsive; PAR, paranoid ideation; PF, physical functioning; PHO, phobic anxiety; PSY, psychoticism; RE, role-emotional; RP, role-physical; SF, social functioning; SOM, somatization; VT, vitality.

addition, several studies demonstrated that physical exercise has beneficial effects on HRQoL of PLWHIV including aerobics<sup>51</sup> and strength training.<sup>52,53</sup> Our data confirmed that physical exercise was associated with higher HRQoL and less sexual difficulties in HIV-positive MSM. For HIV-positive MSM, increasing the frequency of physical exercise is necessary to improve quality of life and prevent sexual difficulties. Further studies are necessary to confirm that increased physical exercise can improve sexual difficulties and that promoting sexual function can improve quality of life in HIV-positive MSM.

Another risk factor associated with sexual difficulties in our study was alcohol consumption. A recent study showed sexual difficulties to be positively associated with alcohol consumption in men.<sup>54</sup> Additionally, previous studies reported that harmful alcohol consumption had a negative association with ART adherence and HRQoL in PLWHIV.<sup>55,56</sup> A cross-sectional study showed alcohol use disorders decreased performance, physical, social, spirituality, and environment quality of life domains in PLWHIV.<sup>57</sup> One study from South Africa also showed that high-risk drinking was positively associated with more depressive symptoms compared with

low-risk drinking in PLWHIV, which is consistent with our findings.<sup>58</sup> Therefore, stop alcohol consumption maybe necessary for improve sexual difficulties, HRQoL, and psychological symptoms in HIV-positive MSM.

Our study presents several limitations. Primarily, this is a cross-sectional study. The data were sourced from a single medical center. Additionally, alcohol consumption was evaluated based on the frequency of drinking episodes per week, with each instance defined as consuming more than 40 g of alcohol (a standard used in assessing alcoholic liver disease). Assessing the exact volume of alcohol consumption proved challenging in practice. Furthermore, the frequency of exercise, defined as sessions lasting over 30 minutes, was set at once per week as a threshold due to the generally low level of physical activity observed in our study population. This could be attributed to various factors, as previously analyzed. To further substantiate the relationship between sexual difficulties and HRQoL among HIV-positive MSM on HAART, a multicenter, large-scale study is necessary.

## Conclusion

Our data showed that lower HRQoL and higher SCL-90 scores were found in HIV-positive MSM with sexual difficulties. Hence, the investigation of sexual function and psychiatric health is necessary and should be included in the assessment of quality of life in HIV-positive MSM during follow-up. Moreover, regular exercise and alcohol consumption were found as independent factors that contribute to sexual difficulties. It is essential to provide timely assessment and intervention for HIV-positive MSM with risk factors.

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## Author contribution

Y.X., X.L., and X.W. contributed equally to this work. Conceptualization, B.L. and S.Ch.; Methodology, Y.X., S.Ch., Y.J., and X.X.; Investigation, X.L., S.Ch., BL, X.X., and H.Z.; Data curation, Y.X., X.L., S.Ca., and H.C.; Writing – Original Draft, X.W., S.Ca., H.C., and X.X.; Writing – Review & Editing, H.Z., X.X., S.Ch., and Y.X.; Funding Acquisition, S.Ca. and Y.X.; Resources, X.W., H.C., and H.Z.; Supervision, H.C., Y.X., and S.Ca.

## Conflicts of interest

The authors declare no conflicts of interest.

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