



# Assessing COVID-19 Vulnerability Among HIV-positive Men Who Have Sex With Men in Korea: The Role of Vaccination and Sexual Behaviors

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**Objectives:** Comorbidities increase susceptibility to severe coronavirus disease 2019 (COVID-19) infections, but limited information has been published regarding human immunodeficiency virus (HIV) and COVID-19 co-infections. This study explored the relationships among socioeconomic characteristics, sexual behaviors, and COVID-19 infection rates among Korean men who have sex with men (MSM) who are also living with HIV.

**Methods:** Data were collected through a web survey aimed at members of the largest gay portal site in Korea, supported by the National Research Foundation of Korea (n = 1005). The primary independent variables included COVID-19-related vaccinations and sexual behaviors. The dependent variable was the incidence of COVID-19 infection among respondents during the pandemic. For statistical analysis, hierarchical multiple logistic regression was performed, controlling for potential confounding variables.

**Results:** Model I indicated that older MSM were less likely to contract COVID-19 (adjusted odds ratio [aOR], 0.98; 95% confidence interval [CI], 0.96 to 0.99). Model II demonstrated that HIV-positive MSM were nearly twice as likely to be infected with COVID-19 compared to their HIV-negative counterparts (aOR, 1.97; 95% CI, 1.14 to 3.41). Furthermore, even after accounting for COVID-19 vaccination status in model III, HIV-positive MSM continued to show a higher risk of infection (aOR, 1.93; 95% CI, 1.12 to 3.35).

**Conclusions:** The findings of this study indicate that HIV-positive MSM are at an increased risk of contracting COVID-19, even when their vaccination status is considered. Therefore, it is essential to prioritize the prevention of COVID-19 infections in HIV-positive individuals by administering appropriate antiretroviral therapy and ensuring adherence to public health guidelines.

**Key words:** COVID-19, HIV, Homosexuality, Male, Republic of Korea

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## INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic has inflicted significant socioeconomic damage and a substantial disease burden globally [1-3]. Despite ongoing efforts to curb the spread of the virus and reduce its fatality rate, the death toll from COVID-19 continues to be high. As of February 22, 2023, around 756 581 850 cases of COVID-19 have been reported, with 6 844 267 deaths attributed to the virus worldwide [4]. Furthermore, individuals who are fully vaccinated against COVID-19 exhibit significantly lower rates of reinfection compared

to those who are unvaccinated or only partially vaccinated, regardless of the variant involved [5-7].

Although a wide range of demographic variables are likely to be associated with COVID-19, recent studies have indicated that patients with comorbidities are particularly vulnerable to the infection compared to those without [8]. For instance, patients who have hypertension, obesity, or diabetes are at a higher risk of mortality, require more frequent admissions to intensive care units, and are prone to developing severe forms of the infection [9]. However, there is conflicting evidence regarding the susceptibility of individuals with human immunodeficiency virus (HIV) to COVID-19 compared to the general population or men who have sex with men (MSM) when exposed to the virus [10-13]. Specifically, it has been presumed that the risk for COVID-19 in HIV patients who have not received highly active antiretroviral therapy (ART) in sub-Saharan Africa is elevated, although clear evidence is lacking [14,15].

HIV causes immunosuppression by depleting CD4 cells, which diminishes the body's ability to defend itself against bacterial, fungal, parasitic, and viral infections, including COVID-19 [16]. This susceptibility to opportunistic infections is exacerbated when immunosuppression is severe and patients are not on ART, increasing their risk [17]. Previous studies have indicated that sexual behaviors and inadequate preventive and health-care practices among people living with HIV could heighten the vulnerability of the 38 million individuals affected globally to COVID-19 infection during the pandemic [18]. Therefore, from a public health perspective, it is important to identify populations that are particularly susceptible to COVID-19.

Information on patients co-infected with HIV and COVID-19 is still scarce, both globally and in Korea. The total number of cumulative HIV infections in Korea is approximately 14 000. One significant issue is that the disruption of medical access due to the COVID-19 pandemic has been particularly severe for people living with HIV in Korea. According to the 2022 HIV/AIDS management guidelines released by the Korea Disease Control and Prevention Agency on April 11, 2022, there were 1016 new HIV infections, marking a decrease of 16.9% (207 cases) from 2019, which recorded 1223 cases. This decline is attributed not to a reduction in the disease prevalence, but rather to a decrease in reporting and testing. This is because individuals who prefer anonymous HIV testing at public health centers have faced disruptions, as these centers have prioritized COVID-19 prevention and suspended HIV-related services since 2020 due to the pandemic. Therefore, it is crucial to

investigate the vulnerability of people living with HIV to COVID-19 throughout the disease continuum. Specifically, it is important to assess whether the socio-demographic characteristics and sexual behaviors of MSM influence COVID-19 infection rates in this group. This study aimed to determine whether factors related to the socioeconomic status and sexual behaviors of Korean MSM are associated with COVID-19 infection in this demographic.

## METHODS

### Sample

The participants in this study were paying members of Ivan City, Korea's largest online portal for the LGBTQ+ community. Operated by LGBT KOREA since 1999, Ivan City primarily serves MSM, who constitute approximately 95% of its membership [19]. In estimating the HIV transmission rate through sexual contact, a maximum prevalence rate of 30% was assumed, based on the domestic rates of sexually transmitted diseases among MSM, such as syphilis, gonorrhea, and chlamydia. To achieve a 95% confidence interval (CI), the required sample size was calculated to be 1063, but was rounded down to 1000 for practicality.

To collect data, a random selection of 10 000 active Ivan City accounts, approximately 5% of the total, was made under a business agreement with the platform's management team. A web survey was conducted through Hankook Research, a leading research institute in Korea, yielding 1005 responses, which represents about 10% of the sample ( $n = 1005$ ). For confidentiality purposes, all information collected by Hankook Research was anonymized.

The web survey incorporated a double-confirmation process to exclude ineligible respondents: those who identified as female, were under 19 years or over 60 years old, or lacked experience in same-sex sexual contact. The term "double-confirmation process" refers to the method used by the survey agency, Hankook Research, in collaboration with Ivan City, to obtain the sampling frame and initially verify the eligibility of respondents when distributing the web survey link. A second verification of respondent eligibility was then conducted during the actual survey administration. Additionally, this study targeted an adult population; therefore, minors and the elderly were excluded. Data collection took place from July 22, 2022 to July 29, 2022, coinciding with the resumption of anonymous free HIV screening at public health centers in Korea. Respondents

accessed the Ivan City website, read a survey notice, and followed an external link provided by Hankook Research to participate in the approximately 20-minute self-administered questionnaire. As an incentive, respondents received a 5000 Korean won coupon (approximately US\$3.8) credited to their Ivan City account, ensuring anonymity without the collection of personal identification information such as mobile phone numbers and maintaining the reliability and validity of responses.

## Measures

The measures of this study were based on the MSM behavioral indicators defined by United Nations Programme on HIV/AIDS and Family Health International [20]. These indicators focus on critical aspects such as the types of sexual partnerships, participation in anal sex, and condom use. For example, individuals who engage in unprotected anal sex or have one-time sexual partners are at an increased risk of contracting HIV.

### *Dependent variable*

The dependent variable in this study was whether the respondents had been infected with COVID-19 during the pandemic. We inquired if the respondents had ever contracted COVID-19, including those currently infected. The responses were categorized as “yes” (1) or “no” (0).

### *Independent variables*

The independent variables in this study are COVID-19-related variables and variables related to sexual behavior.

First, variables related to sexual behavior were assessed, including condom use, type of sexual partnership (primary/casual), preference for anal sex, history of sexually transmitted infections, and HIV infection status. Participants were asked, “How often do you usually use a condom during sexual intercourse?” The response options were “every time (used 100%)” (1), “frequently used (used between 50 and 90%)” (2), “occasionally used (used between 10 and 50%)” (3), and “mostly not used (less than 10% used)” (4). The question regarding the type of sexual partners was phrased as, “Do you have a sex partner of the same sex with whom you are in a primary relationship?” The responses were categorized as “yes” (1) and “no” (0). For anal sex preferences, the question posed was, “Do you prefer anal sex?” with responses “prefer” (1) and “don’t like” (0). Regarding sexually transmitted infections, participants were asked, “Have you been diagnosed with or treated for a sexually transmitted disease in the past year?” The possible responses were

“yes” (1) and “no” (0). Lastly, the question concerning HIV infection status was, “Are you infected with HIV?” with response options “yes” (1) and “no” (0).

Second, the COVID-19-related variable was completion of vaccination. Participants were asked, “How many times have you been vaccinated with a COVID-19 vaccine?” Responses were categorized as “never vaccinated” (1), “once” (2), “twice” (3), and “3 times or more” (4). We then classified the type of vaccine received by each respondent and reorganized the data into 2 categories: “inoculation complete” (1) and “inoculation incomplete” (0). These categories were subsequently entered into the model.

### *Potential confounders*

The model controlled for age, educational attainment, and income as potential confounding variables.

## Statistical Analysis

The study utilized a 3-step statistical analysis approach. Initially, a descriptive statistical analysis was performed to summarize the general characteristics of the respondents. Subsequently, the chi-square test was employed to evaluate the association between COVID-19 infection and the key variables under investigation. Finally, a hierarchical multiple logistic regression analysis was carried out to identify predictors of COVID-19 infection in MSM. All statistical analyses were conducted using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

## Ethics Statement

Sampling and recruitment procedures complied with the research ethics guidelines established by the National Research Foundation of Korea and received approval from the Institutional Review Board (IRB) of Dongduk Women’s University (2206-02). To safeguard vulnerable participants, informed consent was obtained prior to conducting the survey. Hankook Research Inc. managed the data collection for this study, securing written informed consent from each of the 1005 respondents. The entire data collection process underwent review and received approval from the Dongduk Women’s University IRB.

## RESULTS

### Descriptive Statistics of the Sample

The general characteristics of the respondents are as follows (Table 1). The largest age group (39.9%) consisted of individu-

als between 19 years and 29 years of age, and 55.1% were college graduates, representing the highest level of educational attainment. The most common income range was from 21 001 US dollars to 28 000 US dollars (21.3%). Regarding sexual behavior, 32.6% of respondents indicated frequent condom use. About 59.5% reported not having a primary sex partner, while 40.5% indicated they did have one. In preferences related to anal sex, 41.9% expressed dislike, whereas 58.1% preferred it. Furthermore, 14.0% of respondents had been diagnosed with a sexually transmitted infection within the past year, and 6.6% of respondents reported being HIV-positive. As for COVID-19 vaccination status, 6.5% reported being incompletely vaccinated, while 93.5% reported complete vaccination. Concerning COVID-19 infection history, 59.7% had never been infected, while 40.3% had been infected.

### Associations Between Sexual Behaviors and Coronavirus Disease 2019 Infection

The results examining the associations between sexual behaviors and COVID-19 infection are presented in Table 2. At the socio-demographic level, older respondents were less likely to be infected with COVID-19 ( $p=0.004$ ). Regarding sexual behavior, MSM who had previously contracted a sexually transmitted infection were more likely to be infected with COVID-19 ( $p=0.015$ ). Similarly, MSM who were HIV-positive also showed a higher likelihood of COVID-19 infection ( $p=0.007$ ). Additionally, although the statistical significance was marginal, MSM who had completed their COVID-19 vaccination series exhibited a lower infection rate compared to those who were unvaccinated ( $p=0.075$ ).

### Risk Factors for Coronavirus Disease 2019 Infection Among Men Who Have Sex With Men

The results of hierarchical multiple logistic regression analyses of risk factors affecting COVID-19 infection are presented in Table 3. According to model I, older MSM were 0.98 times less likely to contract COVID-19 (95% CI, 0.96 to 0.99;  $p<0.001$ ). In model II, which included sexual behavior characteristics in addition to the factors in model I, HIV-positive MSM were 1.97 times more likely to be infected with COVID-19 than HIV-negative MSM (95% CI, 1.14 to 3.41;  $p<0.05$ ). Finally, model III, which further incorporated the COVID-19 vaccination status of the respondents, showed that HIV-positive MSM were still 1.93 times more likely to contract COVID-19 than those who were HIV-negative (95% CI, 1.12 to 3.35;  $p<0.05$ ).

**Table 1.** General characteristics of the sample (n = 1005)

Characteristics	Categories	n (%)	
Socioeconomic status	Age (y)	19-29	401 (39.9)
		30-39	302 (30.0)
		40-49	202 (20.1)
		50-59	100 (10.0)
	Educational attainment	Middle school or less	10 (1.0)
		High school	299 (29.8)
		College	554 (55.1)
		Post-graduate	142 (14.1)
	Annual income (USD) <sup>1</sup>	<7000	176 (17.5)
		7001-14 000	52 (5.2)
		14 001-21 000	205 (20.4)
		21 001-28 000	214 (21.3)
		28 001-35 000	128 (12.7)
35 001-42 000		77 (7.7)	
42 001-48 000	36 (3.6)		
48 001-56 000	43 (4.3)		
56 001-63 000	21 (2.1)		
63 001-70 000	20 (2.0)		
≥70 001	33 (3.3)		
Sexual behavior characteristics	Condom use (%)	Every time (used 100)	288 (28.7)
		Frequently used (50-90)	328 (32.6)
		Occasionally used (10-50)	196 (19.5)
		Almost not used (less than 10)	148 (14.7)
		No response	45 (4.5)
	Primary sex partner	Do not have	598 (59.5)
		Have	407 (40.5)
	Anal sex	Not preferred	421 (41.9)
		Preferred	584 (58.1)
	Sexually transmitted infection history	Never	864 (86.0)
Ever		141 (14.0)	
HIV status	Negative	939 (93.4)	
	Positive	66 (6.6)	
COVID-19-related characteristics	Vaccination status	Not vaccinated	65 (6.5)
		Fully vaccinated (second dose)	940 (93.5)
	Infection status	Never	600 (59.7)
		Ever	405 (40.3)
Total		1005 (100)	

USD, US dollar; HIV, human immunodeficiency virus; COVID-19, coronavirus disease 2019.

<sup>1</sup>Equivalized household annual income; USD \$1 = Korean won 1412.00 (Oct 2022).

**Table 2.** Associations between sexual risky behaviors and COVID-19 infection

Variables	Categories	COVID-19 infection status		Total	
		Negative	Positive		
Socioeconomic status	Age (y)	19-29	216 (53.9)	185 (46.1)	401 (100)
		30-39	181 (59.9)	121 (40.1)	302 (100)
		40-49	133 (65.8)	69 (34.2)	202 (100)
		50-59	70 (70.0)	30 (30.0)	100 (100)
			$\chi^2$ ( <i>p</i> -value)=13.258 ( <i>p</i> =0.004)		
	Educational attainment	Middle school or less	7 (70.0)	3 (30.0)	10 (100)
		High school	185 (61.9)	114 (38.1)	299 (100)
		College	324 (58.5)	230 (41.5)	554 (100)
		Post-graduate	84 (59.2)	58 (40.8)	142 (100)
			$\chi^2$ ( <i>p</i> -value)=1.386 ( <i>p</i> =0.709)		
	Annual income (USD)	<7000	112 (63.6)	64 (36.4)	176 (100)
		7001-14 000	25 (48.1)	27 (51.9)	52 (100)
		14 001-21 000	118 (57.6)	87 (42.4)	205 (100)
		21 001-28 000	130 (60.7)	84 (39.3)	214 (100)
		28 001-35 000	75 (58.6)	53 (41.4)	128 (100)
		35 001-42 000	45 (58.4)	32 (41.6)	77 (100)
		42 001-48 000	23 (63.9)	13 (36.1)	36 (100)
		48 001-56 000	23 (53.5)	20 (46.5)	43 (100)
		56 001-63 000	11 (52.4)	10 (47.6)	21 (100)
63 001-70 000		13 (65.0)	7 (35.0)	20 (100)	
		$\chi^2$ ( <i>p</i> -value)=9.847 ( <i>p</i> =0.454)			
Sexual behavior characteristics	Condom use (%)	Every time (used 100)	182 (63.2)	106 (36.8)	288 (100)
		Frequently used (50-90)	184 (56.1)	144 (43.9)	328 (100)
		Occasionally used (10-50)	115 (58.7)	81 (41.3)	196 (100)
		Almost not used (<10)	92 (62.2)	56 (37.8)	148 (100)
			$\chi^2$ ( <i>p</i> -value)=3.689 ( <i>p</i> =0.297)		
	Primary sex partner	Do not have	360 (60.2)	238 (39.8)	598 (100)
		Have	240 (59.0)	167 (41.0)	407 (100)
			$\chi^2$ ( <i>p</i> -value)=0.153 ( <i>p</i> =0.696)		
	Anal sex	Not preferred	259 (61.5)	162 (38.5)	421 (100)
		Preferred	341 (58.4)	243 (41.6)	584 (100)
			$\chi^2$ ( <i>p</i> -value)=0.996 ( <i>p</i> =0.318)		
	STD infection	Never	529 (61.2)	335 (38.8)	864 (100)
		Ever	71 (50.4)	70 (49.6)	141 (100)
			$\chi^2$ ( <i>p</i> -value)=5.956 ( <i>p</i> =0.015)		
	HIV status	Negative	571 (60.8)	368 (39.2)	939 (100)
Positive		29 (43.9)	37 (56.1)	66 (100)	
		$\chi^2$ ( <i>p</i> -value)=7.295 ( <i>p</i> =0.007)			
COVID-19-related characteristics	Vaccination status	Not vaccinated	32 (49.2)	33 (50.8)	65 (100)
		Fully vaccinated (second dose)	568 (60.4)	372 (39.6)	940 (100)
		$\chi^2$ ( <i>p</i> -value)=3.167 ( <i>p</i> =0.075)			

Values are presented as number (%).

COVID-19, coronavirus disease 2019; USD, US dollar; STD, sexually transmitted disease; HIV, human immunodeficiency virus.

**Table 3.** Results of hierarchical multiple logistic regression analyses for risk factors of COVID-19 infection among MSMs

Variables		Model I	Model II	Model III
Socioeconomic status	Age	0.98 (0.96, 0.99)***	0.97 (0.96, 0.99)***	0.97 (0.96, 0.99)***
	Education	1.11 (0.91, 1.36)	1.14 (0.93, 1.40)	1.16 (0.94, 1.42)
	Income	1.00 (0.95, 1.06)	1.01 (0.96, 1.07)	1.01 (0.97, 1.07)
Sexual behavior characteristics	Condom use	-	0.99 (0.86, 1.12)	0.98 (0.86, 1.12)
	Primary sex partner (Ref.: none)	-	1.01 (0.77, 1.33)	1.01 (0.77, 1.33)
	Anal sex (Ref.: not preferred)	-	1.09 (0.82, 1.45)	1.10 (0.83, 1.47)
	Sexually transmitted infection history (Ref.: no history of infection)	-	1.27 (0.86, 1.88)	1.27 (0.86, 1.89)
	HIV-positive (Ref.: negative)	-	1.97 (1.14, 3.41)*	1.93 (1.12, 3.35)*
COVID-19-related characteristics	Fully vaccinated (Ref.: not vaccinated)	-	-	0.61 (0.36, 1.04)
Nagelkerke $R^2$		0.118	0.226	0.251

Values are presented as odds ratio (95% confidence interval).

COVID-19, coronavirus disease 2019; MSMs, men who have sex with men; HIV, human immunodeficiency virus; Ref., reference.

\* $p < 0.05$ , \*\*\* $p < 0.001$ .

## DISCUSSION

Information on patients co-infected with HIV and COVID-19 remains scarce, both globally and in Korea. This study investigated whether socioeconomic characteristics and sexual behavior-related factors among Korean MSM were linked to their COVID-19 infection rates. The results from hierarchical multiple logistic regression analyses indicated that older MSM were less likely to contract COVID-19, while HIV-positive MSM had a higher likelihood of infection. This elevated risk among HIV-positive MSM continued to be significant even after adjusting for COVID-19 vaccination status. These findings imply that although HIV-positive MSM may face a higher risk of severe COVID-19 outcomes, effective antiretroviral therapy and adherence to public health guidelines can help reduce some of this risk.

The COVID-19 pandemic has disproportionately affected various subpopulations, with certain groups being more susceptible to severe disease outcomes than others. Among these, people living with HIV (PLWH) have been identified as a potentially vulnerable group due to their underlying immunocompromised status [21]. Several risk factors have been suggested to contribute to the increased vulnerability of PLWH to COVID-19 infection. These factors include the immunosuppressive effects of HIV, the presence of other comorbidities, and sexual behaviors that could expose this population to the virus [22]. This study revealed that active members of the gay community were 1.93 times more likely to contract COVID-19 among MSM with HIV than MSM without HIV. However, it was

not possible to determine which of the potential factors predisposed MSM with HIV to COVID-19 infection. Nevertheless, through a confidential and individual-level self-response questionnaire, we discovered that MSM with HIV remained vulnerable to COVID-19 even after completing their COVID-19 vaccination.

HIV infection leads to the depletion of CD4 cells, compromising the immune system's ability to defend against various infections, including COVID-19 [23]. This weakened immune response may result in more severe COVID-19 outcomes among PLWH. However, the use of ART has been shown to improve immune function and may help mitigate this risk [24]. PLWH are also more likely to have comorbidities such as cardiovascular disease, hypertension, and diabetes, which are associated with severe COVID-19 outcomes [10-13,18]. Additionally, certain comorbidities, such as sexually transmitted infections, may be more prevalent in this population, further increasing their vulnerability [25]. PLWH may engage in sexual behaviors that increase their risk of exposure to COVID-19, such as having multiple sexual partners or participating in social gatherings [26]. These behaviors can contribute to a higher risk of COVID-19 transmission compared to the general population. The use of ART in HIV-positive individuals has been associated with improved immune function and better control of the virus [27]. Studies have suggested that HIV-positive individuals on ART may have COVID-19 outcomes similar to those of the general population when accounting for comorbidities and other risk factors [28]. However, more research is needed to confirm this relationship and to understand the potential in-

teractions between ART and COVID-19 treatments [29].

This study has the following public health implications. Considering the increased vulnerability of PLWH to COVID-19 infection and its severe outcomes, targeted public health interventions are essential for this group. Efforts should concentrate on promoting adherence to ART, encouraging regular HIV and COVID-19 testing, and delivering tailored public health messages that emphasize the importance of preventive measures, including mask-wearing, social distancing, and vaccination [29].

Nonetheless, this study has several potential limitations. First, there is an issue of selection bias concerning the representativeness of the respondents. In Korean society, sexual minorities are often socially stigmatized and discriminated against, which may lead respondents to conceal their identities and refuse participation [30]. Second, the cross-sectional design of this study prevents the direct interpretation of associations between multiple variables as causal relationships. Third, our research did not explore non-pharmacological intervention practices that might influence COVID-19 infection rates [31,32]. However, it is important to note that Korea has enforced stringent quarantine measures, which have been widely accepted by the public.

Data on patients co-infected with HIV and COVID-19 are limited both globally and in Korea. This study explored the relationship between socioeconomic factors and sexual behaviors of Korean MSM and their risk of contracting COVID-19. The results indicated that HIV-positive MSM are at a higher risk of COVID-19 infection, even when their vaccination status is considered. Consequently, it is crucial to prevent COVID-19 infection in HIV-positive individuals by ensuring they receive proper antiretroviral therapy and adhere to public health guidelines. These actions are vital to prevent the ongoing mutations of COVID-19, particularly in regions like sub-Saharan Africa, where many HIV-positive individuals face a lack of adequate healthcare infrastructure to combat COVID-19. PLWH may face a higher risk of severe COVID-19 outcomes due to their compromised immune systems, existing comorbidities, and potential engagement in certain sexual behaviors. However, effective use of ART and compliance with public health measures can help reduce these risks. Further research is essential to better understand the interactions between HIV, ART, and COVID-19 outcomes and to develop targeted public health policies for this vulnerable population.

## NOTES

### Conflict of Interest

The author has no conflicts of interest associated with the material presented in this paper.

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None.

### Author Contributions

All work was done by MJ.

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