

Original Article
Public Health & Preventive
Medicine



Comparison of the Prevalence of Obesity and Overweight Among Adults With HIV and the Adult General Population in Korea

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OPEN ACCESS

Received: Jun 10, 2025
Accepted: Aug 12, 2025
Published online: Apr 10, 2026

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ABSTRACT

Background: This study compared the prevalence of overweight and obesity in people living with human immunodeficiency virus (PLWH) with the general population and the trend of overweight/obesity in PLWH and the general population from 2009 to 2020.

Methods: A total of 10,980 PLWH aged ≥ 20 years with national health examination records and 76,783 adults in the general adult population of the Korea National Health and Nutrition Examination Survey were included. The overall and yearly obesity and overweight prevalence rates and standardized prevalence ratios are described.

Results: The prevalence of obesity and overweight in PLWH during 2009–2020 was 27.9% (95% confidence interval [CI], 27.0–28.7%) and 23.1% (95% CI, 22.3–23.9%), while those in the general population were 33.7% (95% CI, 33.7–33.7%) and 22.8% (95% CI, 22.8–22.8%), with identical bounds reflecting the high precision facilitated by the large sample size. During 2009–2020, the standardized prevalence ratio of obesity and overweight in the PLWH compared with that in the general population was 0.70 (95% CI, 0.68–0.73) and 0.92 (95% CI, 0.89–0.96). The annual percent change in obesity prevalence was 3.0% annually ($P < 0.001$) in PLWH and 1.4% ($P < 0.001$) annually in the general population between 2009 and 2020. Owing to the rapid increase, the prevalence of obesity was higher in PLWH than in the general population in 2019 and 2020. In contrast, the prevalence of overweight did not show a clear increasing or decreasing trend in either group between 2009 and 2020.

Conclusion: The prevalence of obesity and overweight in PLWH was lower than that in the general population. However, the rate of increase in obesity prevalence was faster in

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Disclosure

The authors have no potential conflicts of interest to disclose.

Data Availability Statement

The data used in this study were obtained from the National Health Insurance Service (NHIS). Researchers interested in accessing similar data can apply for access through the NHIS's official website (<https://nhiss.nhis.or.kr>).

Author Contributions

Conceptualization: Jang Y, Song JY, Kim JH, Park B. Data curation: Jang Y, Park B. Formal analysis: Jang Y, Kim T, Nguyen THT. Investigation: Jang Y. Methodology: Jang Y, Kim T, Nguyen THT, Park B. Project administration: Park B. Resources: Seong H, Kim SW, Kim SI. Supervision: Park B. Validation: Choi JY, Kim YJ. Writing - original draft: Jang Y. Writing - review & editing: Seong H, Song JY, Kim JH, Choi JY, Kim SW, Kim YJ, Kim SI, Park B.

PLWH than that in the general population. As obesity is associated with the onset of chronic diseases, pathological conditions, and various forms of cancer, more detailed obesity management for PLWH is warranted.

Keywords: Human Immunodeficiency Virus; Overweight; Obesity; Body Mass Index; Trend in Overweight/Obesity Prevalence

INTRODUCTION

Obesity prevalence in the general population has increased globally, which poses a significant disease burden.^{1,2} Patients with human immunodeficiency virus (HIV) infection, which was referred to as “slimming disease” due to viral replication-related weight loss and muscle wasting,³ have reported living longer and gaining weight after initiation of highly active anti-retroviral therapy (HAART) treatment.³⁻⁵ Weight gain following HAART treatment deemed a “return to health” should be delineated as obesity among people living with human immunodeficiency virus (PLWH).^{3,4} As life expectancy has increased in PLWH, followed by age-related issues, comorbidities of chronic diseases such as diabetes, hypertension, cardiovascular disease, and cancer, which are closely linked to obesity, have increased.⁴⁻⁶ Thus, in recent years, concerns regarding obesity and its effect on chronic comorbidities have been raised for the care of PLWH.^{3,4,7}

In several studies, the increased prevalence of overweight/obesity in PLWH has been observed⁸⁻¹⁰ and the increasing trend is parallel to that in the general population.¹¹ However, most previous studies have reported only overweight/obesity prevalence in PLWH, and only a few studies have compared obesity prevalence in PLWH with that in the general population.¹²⁻¹⁴ Furthermore, studies on obesity in PLWH have targeted Western or African populations, and no studies have targeted PLWH in the Western Pacific region. The number of people acquiring HIV in the Western Pacific region was the lowest compared to that in other regions but showed an increasing trend, in contrast to other regions where the prevalence of PLWH has decreased.¹⁵ In these regions, different criteria for obesity definition have been suggested considering the higher vulnerability to metabolic diseases occurring at a lower body mass index (BMI),¹⁶ suggesting an increased burden of HIV and obesity in this region in the future.

In this study, we compared the prevalence of overweight and obesity in PLWH with that in the general population of Korea. Additionally, an increasing trend of overweight/obesity in PLWH and the general population was observed in 2009–2020 through modern HAART.

METHODS

The prevalence of obesity and overweight was estimated using the National Health Insurance Service-National Health Information Database (NHIS-NHID) for PLWH and the Korea National Health and Nutrition Examination Survey (KNHANES) for the general population.

The NHIS is a compulsory, single-insurance system for all Korean residents.¹⁷ Moreover, it manages information related to birth, residential area, income, and medical usage due to specific diseases based on fee-for-service systems, drug prescriptions, health checkups, and

deaths of all citizens through its administrative system.¹⁷ New HIV infections were defined based on International Classification of Diseases-10 codes (B20–B24) and the rare incurable disease system code (V103) from the medical usage database.¹⁸ Korea's rare incurable disease system is designed to reduce the financial burden on patients with costly diseases by lowering their out-of-pocket expenses from the total medical costs.¹⁹ To include new HIV infections, individuals who satisfy the above definition from 2004, when the rare incurable disease system was employed for HIV, were included. People who had HIV-related medical records in 2002 and 2003 were excluded. A total of 16,671 PLWH were identified between 2004 and 2020.

Because individuals' measurement results were not included in the medical usage database, national health screening data, which included results of anthropometric measurements including blood and urine tests, were linked to obtaining obesity-related information. In Korea, health screenings are conducted annually or biennially for those with medical insurance through employment, regardless of age. All residents in Korea aged 40 years or older can undergo health screenings every other year, irrespective of their insurance status.²⁰ We considered BMI measured after 2009 because items, including national health screening, were standardized after 2009. Out of the 16,671 study participants, 5,681 (34.1%) who did not have health screening records after HIV infection were excluded, leaving a final study population of 10,980 PLWH aged ≥ 20 with BMI information in the year 2009 or after.

The KNHANES is a nationwide survey conducted by the Korea Disease Control and Prevention Agency, which annually collects health status, clinical measurements, and nutritional intake information from approximately 10,000 individuals based on the National Health Promotion Act.²¹ Considering the sampling strategy, which included stratified cluster sampling to obtain representative samples nationwide, weights based on the population structure and response rates were employed.²² We applied the KNHANES data collected from 2009 to 2020 with a total of 98,753 participants to match the health screening years of PLWH. Out of them, 76,786 adults aged 20 and above (77.8%) were selected as the study participants.

Definition of variable

In both studies, BMI was calculated by measuring the height and weight of well-trained nurses or researchers. According to Asian standards, obesity is defined as ≥ 25.0 kg/m² or more, overweight as 23.0–24.9 kg/m², and normal weight as < 23.0 kg/m².¹⁶ Sociodemographic variables, including sex, age in 5-year increments, health insurance type, and lifestyle habits, such as alcohol consumption and smoking, were considered. Alcohol consumption was defined as the consumption of alcohol at least once per month in the preceding year. For the health insurance type, the NHIS contained information confirmed via the administrative system, whereas the KNHANES was identified through surveys. Information regarding smoking and alcohol consumption was collected by trained medical staff using a questionnaire.

Statistical analysis

We estimated the pooled and annual prevalence of obesity and overweight status with 95% confidence intervals (95% CIs) from 2009 to 2020. When calculating the pooled proportion, health check-up information, including the BMI closest to the HIV diagnosis, was applied to the NHIS-NHID. Obesity and overweight prevalence in individual years were determined using the measured records for each year. The KNHANES assigns weights when estimating the pooled and annual proportions of people living with obesity and overweight to represent the general population.²² Among the estimates of obesity and overweight in the general

population, certain 95% CIs had identical lower and upper bounds, reflecting the high statistical precision associated with the large sample size.

For an intuitive comparison, we calculated the difference in the prevalence between PLWH (NHIS-NHID) and the general population (KNHANES) and stratified by sex, age group, income, alcohol use, and year. We estimated the change pattern using linear regression analysis and annual percent change (APC) to observe the trend in the prevalence of obesity and overweight from 2009 to 2020. The standardized prevalence ratio (SPR) for comparing the prevalence of obesity and overweight between PLWH and the general population was estimated after adjusting for sex, age at 5-year intervals, smoking status, and alcohol consumption. We used SAS version 9.4 as the statistical package, and statistical significance was set at a $P < 0.05$ (two-sided test).

Ethics statement

All data from the NHIS-NHID are pseudonymized, rendering personal identification impossible; thus, informed consent to use NHIS-NHID data for this study was waived. This study was approved by the Institutional Review Board of Hanyang University in Korea (approval No. HYUIRB-202309-022).

RESULTS

Although in the general population (KNHANES), the sex ratio was approximately 50%, among PLWH (NHIS-NHID), the proportion of males was over 90%. In terms of age distribution, PLWH comprised a high proportion (87.8%) of individuals aged < 60 years, whereas in the general population (KNHANES), the age distribution was relatively even across groups, excluding those in their 20s (11.5%), with each remaining group accounting for approximately 16.9% to 18.9%. The total of 76,783 individuals aged 20 years and older in KNHANES represent the general adult population of Korea (**Table 1**).

The overall prevalence of obesity in PLWH (27.9%; 95% CI, 27.0–28.7%) was lower than that in the general population (33.7%; 95% CI, 33.7–33.7%; **Table 2**). In PLWH, the prevalence of obesity was comparable between males and females; however, the prevalence of obesity was higher in males than females in the general population, leading to a larger gap in obesity prevalence between the general male population and males living with HIV. However, the prevalence of obesity among females and those with HIV infection was comparable. In all age groups, the obesity prevalence in PLWH was lower than that in the general population, except in the age group ≥ 70 . The prevalence of obesity in PLWH across categories of medical insurance, alcohol consumption, and smoking status was consistently lower than that in the general population.

The prevalence of being overweight in PLWH and the general population was 23.1% (95% CI, 22.3–23.9%) and 22.8% (95% CI, 22.8–22.8%; **Table 2**), respectively. When stratified by sex, both males and females with HIV demonstrated a higher prevalence of being overweight than that in the general population. Among PLWH, males (23.7%; 95% CI, 22.8–24.5%) showed a higher prevalence of obesity than females (17.4%; 95% CI, 15.1–19.7%).

The trends in the prevalence of obesity and overweight between 2009 and 2020 among PLWH and the general population are shown in **Fig. 1**. The obesity prevalence rate in 2009

Table 1. Characteristics of PLWH in Korea identified by the National Health Insurance Service and the general population from the Korea National Health and Nutrition Examination Survey in 2009–2020

Characteristics	PLWH in Korea		General population			
	Values	95% CI	Values	95% CI	Weighted values	95% CI
Total	10,980 (100.0)	-	76,783 (100.0)	-	40,122,739 (100.0)	-
Sex						
Male	9,915 (90.3)	89.7–90.9	33,630 (43.8)	43.4–44.2	19,906,741 (49.6)	49.6–49.6
Female	1,065 (9.7)	9.1–10.3	43,153 (56.2)	55.8–56.6	20,215,998 (50.4)	50.4–50.4
Age, yr	42.4 ± 13.4	-	51.2 ± 16.6	-	-	-
20–29	2,214 (20.2)	19.4–20.9	8,822 (11.5)	11.3–11.7	6,890,092 (17.2)	17.2–17.2
30–39	2,631 (24.0)	23.2–24.8	12,959 (16.9)	16.6–17.1	7,767,767 (19.4)	19.3–19.4
40–49	2,807 (25.6)	24.7–26.4	14,161 (18.4)	18.2–18.7	8,477,697 (21.1)	21.1–21.1
50–59	1,983 (18.1)	17.3–18.8	14,516 (18.9)	18.6–19.2	7,750,003 (19.3)	19.3–19.3
60–69	955 (8.7)	8.2–9.2	13,196 (17.2)	16.9–17.5	4,876,043 (12.2)	12.1–12.2
70–	390 (3.6)	3.2–3.9	13,129 (17.1)	16.8–17.4	4,361,137 (10.9)	10.9–10.9
Income						
Medical aid	366 (3.3)	3.0–3.7	2,738 (3.6)	3.4–3.7	1,244,731 (3.1)	3.1–3.1
National Health Insurance	10,610 (96.6)	96.3–97.0	74,000 (96.4)	96.2–96.5	38,517,406 (96.0)	96.0–96.0
None	4 (0.0)	0.0–0.1	45 (0.1)	0.0–0.1	360,602 (0.9)	0.9–0.9
Alcohol use						
Never, past	5,027 (45.8)	44.9–46.7	33,501 (43.6)	43.3–44.0	20,385,583 (50.8)	50.8–50.8
Current	5,858 (53.4)	52.4–54.3	37,323 (48.6)	48.3–49.0	18,429,730 (45.9)	45.9–45.9
Unknown	95 (0.9)	0.7–1.0	5,959 (7.8)	7.6–8.0	1,307,426 (3.3)	3.3–3.3
Smoking						
Never	4,322 (39.4)	38.5–40.3	43,802 (57.1)	56.7–57.4	22,544,665 (56.2)	56.2–56.2
Former	1,710 (15.6)	14.9–16.3	13,530 (17.6)	17.4–17.9	7,251,335 (18.1)	18.1–18.1
Current	4,849 (44.2)	43.2–45.1	13,507 (17.6)	17.3–17.9	9,020,045 (22.5)	22.5–22.5
Unknown	99 (0.9)	0.7–1.1	5,944 (7.7)	7.6–7.9	1,306,694 (3.3)	3.3–3.3

Values are presented as number (%) or mean ± standard deviation.

The identical lower and upper bounds of the 95% CIs reflect the high statistical precision facilitated by the large sample size.

PLWH = people living with human immunodeficiency virus, CI = confidence interval.

was 28.0% (95% CI, 26.2–29.8) for PLWH and 31.9% (95% CI, 31.9–31.9) in the general population. From 2009 to 2020, the prevalence of obesity increased by 3.0% annually ($P < 0.001$) in PLWH and 1.4% ($P < 0.001$) in the general population. Whereas until 2018, the prevalence of obesity was higher in the general population than among PLWH, in 2019 and 2020, the trend reversed, with a higher prevalence observed among PLWH. In 2020, the prevalence of obesity was 39.7% among PLWH and 38.1% among the general population. The overweight prevalence rate in 2009 was 25.0% (95% CI, 23.3–26.7) in PLWH and 23.6% (95% CI, 23.6–23.6) in the general population. The prevalence of overweight failed to show an increasing or decreasing trend in either group between 2009 and 2020. The prevalence of being overweight in PLWH was 26.0 (95% CI, 24.5–27.4%) and 23.0% (95% CI, 23.0%–23.0%) in the general population in 2020.

Table 3 illustrates the SPR of obesity in the PLWH compared with that in the general population. Overall, the SPR is 0.70 (95% CI, 0.68–0.73) when adjusted for sex, age, smoking, and alcohol drinking. The SPRs were consistently lower than 1 from 2009 to 2020, indicating a lower obesity prevalence in PLWH compared with that in the general population. HIV-infected men exhibited a lower obesity prevalence than the general population when stratified by sex; contrarily, HIV-infected women showed no difference in the prevalence of obesity compared to that in the general population. These observations were consistent from 2009 to 2020.

After adjusting for sex, age, cigarette smoking, and alcohol drinking, the overall prevalence of overweight among PLWH was lower than that in the general population with an SPR of

Table 2. Prevalence and standardized prevalence ratio of obesity and overweight among PLWH in Korea identified by the NHIS and the general population from the KNHANES in 2009–2020

Characteristics	PLWH in Korea identified by NHIS in 2004–2020	General population from the KNHANES in 2009–2020, weighted %	Prevalence difference (PLWH–general population)
Obesity			
Total	27.9 (27.0, 28.7)	33.7 (33.7, 33.7)	–5.9 (–6.7, –5.0)
Sex			
Male	27.9 (27.0, 28.8)	39.3 (39.3, 39.3)	–11.4 (–12.3, –10.6)
Female	27.6 (24.9, 30.3)	28.2 (28.2, 28.2)	–0.6 (–3.2, 2.1)
Age, yr			
20–29	21.1 (19.4, 22.8)	25.4 (25.3, 25.4)	–4.2 (–5.9, –2.6)
30–39	30.2 (28.4, 31.9)	33.2 (33.1, 33.2)	–3.0 (–4.7, –1.3)
40–49	30.4 (28.7, 32.1)	35.6 (35.6, 35.6)	–5.2 (–6.9, –3.6)
50–59	27.3 (25.4, 29.3)	36.8 (36.7, 36.8)	–9.4 (–11.4, –7.5)
60–69	28.2 (25.3, 31.0)	38.3 (38.2, 38.3)	–10.1 (–12.9, –7.3)
70–	34.1 (29.4, 38.8)	33.5 (33.5, 33.6)	0.6 (–4.1, 5.2)
Income			
Medical aid	26.0 (21.5, 30.4)	36.7 (36.7, 36.8)	–10.8 (–15.2, –6.4)
National Health Insurance	27.9 (27.1, 28.8)	33.6 (33.6, 33.7)	–5.7 (–6.6, –4.9)
None	50.0 (1.0, 99.0)	29.4 (29.2, 29.5)	20.6 (–)
Alcohol use			
Never, past	27.3 (26.0, 28.5)	32.3 (32.3, 32.3)	–5.0 (–6.3, –3.8)
Current	28.4 (27.2, 29.5)	35.3 (35.3, 35.3)	–6.9 (–8.1, –5.8)
Unknown	28.4 (19.4, 37.5)	33.2 (33.1, 33.3)	–4.8 (–13.8, 4.2)
Smoking			
Never	28.5 (27.1, 29.8)	30.4 (30.4, 30.4)	–1.9 (–3.2, –0.6)
Former	32.3 (30.1, 34.6)	39.6 (39.6, 39.6)	–7.3 (–9.4, –5.1)
Current	25.7 (24.5, 26.9)	37.3 (37.3, 37.3)	–11.6 (–12.8, –10.4)
Unknown	28.3 (19.4, 37.2)	33.3 (33.2, 33.4)	–5.0 (–13.8, 3.8)
Overweight			
Total	23.1 (22.3, 23.9)	22.8 (22.8, 22.8)	0.3 (–0.5, 1.0)
Sex			
Male	23.7 (22.8, 24.5)	25.5 (25.5, 25.5)	–1.8 (–2.6, –1.0)
Female	17.4 (15.1, 19.6)	20.2 (20.2, 20.2)	–2.8 (–5.1, –0.6)
Age, yr			
20–29	19.9 (18.3, 21.6)	16.4 (16.4, 16.4)	3.5 (1.9, 5.1)
30–39	22.1 (20.5, 23.7)	20.0 (20.0, 20.0)	2.1 (0.6, 3.7)
40–49	22.9 (21.4, 24.5)	23.5 (23.5, 23.6)	–0.6 (–2.1, 0.9)
50–59	26.5 (24.5, 28.4)	26.9 (26.9, 27.0)	–0.5 (–2.4, 1.5)
60–69	26.4 (23.6, 29.2)	26.8 (26.8, 26.8)	–0.4 (–3.2, 2.3)
70–	23.1 (18.9, 27.3)	24.7 (24.7, 24.8)	–1.6 (–5.8, 2.5)
Income			
Medical aid	24.3 (19.9, 28.7)	20.9 (20.8, 20.9)	3.5 (–0.9, 7.8)
National Health Insurance	23.0 (22.2, 23.8)	22.9 (22.9, 22.9)	0.1 (–0.7, 0.9)
None	–	18.4 (18.3, 18.6)	–
Alcohol use			
Never, past	22.8 (21.6, 23.9)	22.2 (22.2, 22.2)	0.6 (–0.6, 1.7)
Current	23.4 (22.3, 24.5)	23.6 (23.6, 23.7)	–0.3 (–1.3, 0.8)
Unknown	18.9 (11.1, 26.8)	20.8 (20.7, 20.8)	–1.8 (–9.6, 6.0)
Smoking			
Never	23.0 (21.8, 24.3)	21.5 (21.5, 21.5)	1.5 (0.3, 2.7)
Former	24.7 (22.7, 26.8)	26.7 (26.7, 26.7)	–1.9 (–4.0, 0.1)
Current	22.6 (21.4, 23.7)	23.2 (23.2, 23.2)	–0.6 (–1.8, 0.5)
Unknown	21.2 (13.2, 29.3)	20.8 (20.7, 20.9)	0.4 (–7.6, 8.4)

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

The identical lower and upper bounds of the 95% confidence intervals reflect the high statistical precision facilitated by the large sample size.

PLWH = people living with human immunodeficiency virus, NHIS = National Health Insurance Service, KNHANES = Korea National Health and Nutrition Examination Survey.

0.92 (95% CI, 0.89–0.96; **Table 3**). Both males and females with HIV infection have a lower prevalence of obesity than that in the general population. However, there were no statistically

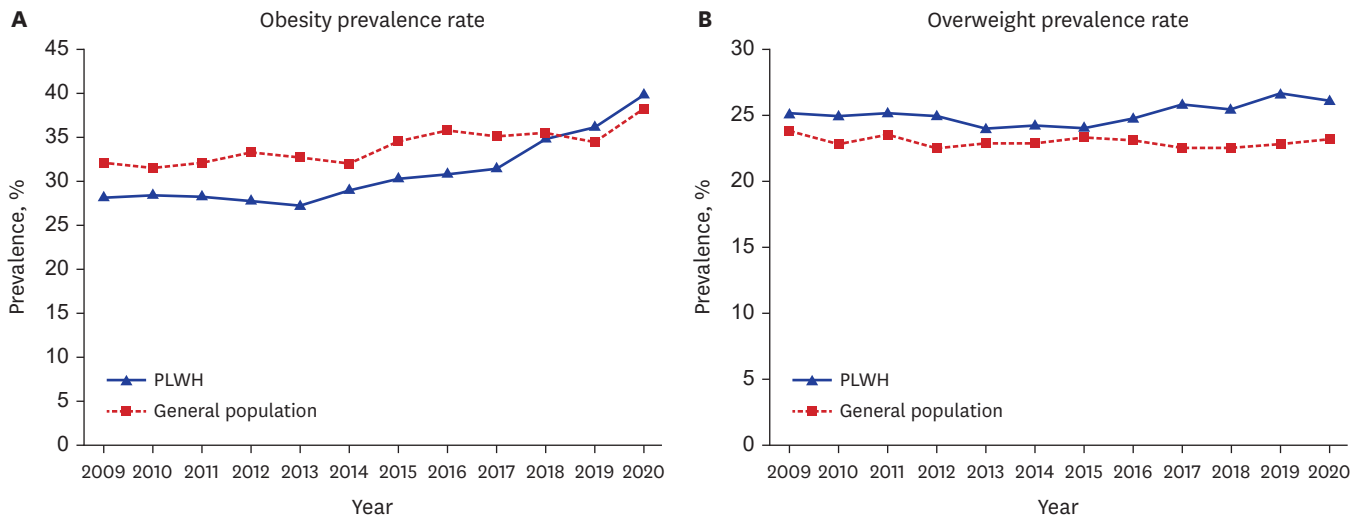


Fig. 1. Prevalence of obesity and overweight among PLWH and the general population from 2009 to 2020. PLWH was identified through the NHIS-NHID, and the general population was estimated using the KNHANES. **(A)** The APC for obesity prevalence was 3.01% (NHIS-NHID; 95% CI, 1.88–4.15; $P < 0.001$), and 1.44% (KNHANES; 95% CI, 0.87–2.02; $P = 0.001$). **(B)** The APC for overweight prevalence was 0.47% (NHIS-NHID; 95% CI, -0.08, 1.02; $P = 0.087$) and -0.21% (KNHANES; 95% CI, -0.54, 0.12; $P = 0.179$). PLWH = people living with human immunodeficiency virus, NHIS-NHID = National Health Insurance Service-National Health Information Database, KNHANES = Korea National Health and Nutrition Examination Survey, APC = annual percent change, CI = confidence interval.

Table 3. Standardized prevalence ratio of obesity and overweight and their trends in people living with human immunodeficiency virus in Korea identified by the National Health Insurance Service compared with the general population from the Korea National Health and Nutrition Examination Survey in 2009–2020

Year	Overall		Male		Female	
	Adjusted by sex and age	Adjusted by sex, age, cigarette smoking, and alcohol use	Adjusted by sex and age	Adjusted by sex, age, cigarette smoking, and alcohol use	Adjusted by sex and age	Adjusted by sex, age, cigarette smoking, and alcohol use
Obesity						
Total	0.82 (0.79–0.85)	0.70 (0.68–0.73)	0.67 (0.65–0.70)	0.68 (0.66–0.71)	0.93 (0.82–1.04)	0.92 (0.82–1.03)
2009	0.86 (0.79–0.92)	0.76 (0.70–0.82)	0.74 (0.68–0.79)	0.75 (0.69–0.81)	0.93 (0.72–1.13)	0.90 (0.70–1.10)
2010	0.87 (0.80–0.93)	0.75 (0.70–0.81)	0.73 (0.67–0.78)	0.74 (0.69–0.80)	0.91 (0.69–1.13)	0.88 (0.67–1.09)
2011	0.85 (0.79–0.91)	0.79 (0.73–0.84)	0.75 (0.70–0.81)	0.78 (0.72–0.84)	0.84 (0.65–1.02)	0.81 (0.63–0.99)
2012	0.81 (0.75–0.86)	0.75 (0.69–0.80)	0.72 (0.66–0.77)	0.73 (0.68–0.79)	0.91 (0.71–1.11)	0.88 (0.69–1.08)
2013	0.81 (0.75–0.86)	0.69 (0.64–0.74)	0.67 (0.62–0.72)	0.68 (0.63–0.73)	0.83 (0.65–1.01)	0.83 (0.65–1.01)
2014	0.89 (0.83–0.95)	0.75 (0.70–0.80)	0.72 (0.67–0.77)	0.73 (0.68–0.78)	1.07 (0.85–1.29)	1.09 (0.86–1.32)
2015	0.85 (0.80–0.91)	0.75 (0.70–0.79)	0.73 (0.68–0.78)	0.75 (0.70–0.80)	0.78 (0.61–0.95)	0.76 (0.60–0.92)
2016	0.85 (0.80–0.90)	0.73 (0.69–0.78)	0.70 (0.66–0.75)	0.72 (0.67–0.76)	0.95 (0.76–1.15)	0.94 (0.75–1.13)
2017	0.88 (0.83–0.93)	0.74 (0.70–0.78)	0.71 (0.67–0.76)	0.72 (0.67–0.76)	1.01 (0.82–1.20)	1.02 (0.83–1.22)
2018	0.96 (0.91–1.02)	0.81 (0.76–0.85)	0.78 (0.73–0.82)	0.79 (0.74–0.83)	1.10 (0.89–1.30)	1.11 (0.90–1.32)
2019	1.02 (0.97–1.07)	0.86 (0.82–0.91)	0.83 (0.79–0.87)	0.85 (0.81–0.90)	1.05 (0.86–1.25)	1.06 (0.86–1.26)
2020	0.99 (0.94–1.04)	0.84 (0.79–0.88)	0.80 (0.76–0.84)	0.82 (0.78–0.87)	1.03 (0.83–1.24)	1.03 (0.82–1.23)
Overweight						
Total	1.03 (0.99–1.07)	0.92 (0.89–0.96)	0.93 (0.90–0.97)	0.93 (0.90–0.97)	0.81 (0.69–0.93)	0.80 (0.68–0.92)
2009	1.04 (0.95–1.12)	0.98 (0.90–1.05)	0.97 (0.89–1.05)	0.99 (0.91–1.07)	0.87 (0.65–1.10)	0.84 (0.62–1.06)
2010	1.06 (0.98–1.14)	1.01 (0.93–1.09)	1.00 (0.91–1.08)	1.04 (0.95–1.12)	0.79 (0.56–1.03)	0.77 (0.55–1.00)
2011	1.05 (0.97–1.13)	0.92 (0.85–1.00)	0.95 (0.88–1.03)	0.93 (0.86–1.00)	0.86 (0.63–1.09)	0.87 (0.64–1.10)
2012	1.09 (1.01–1.17)	0.94 (0.87–1.01)	1.01 (0.93–1.08)	0.95 (0.87–1.02)	0.93 (0.68–1.17)	0.89 (0.65–1.12)
2013	1.04 (0.96–1.12)	0.96 (0.89–1.03)	0.97 (0.89–1.04)	0.97 (0.89–1.04)	0.91 (0.69–1.13)	0.90 (0.68–1.12)
2014	1.03 (0.96–1.11)	0.96 (0.89–1.03)	0.94 (0.87–1.01)	0.97 (0.90–1.04)	0.89 (0.66–1.11)	0.87 (0.65–1.09)
2015	1.03 (0.96–1.10)	0.94 (0.87–1.00)	0.91 (0.84–0.98)	0.91 (0.84–0.98)	1.16 (0.91–1.42)	1.20 (0.94–1.45)
2016	1.07 (1.00–1.15)	0.96 (0.89–1.02)	1.00 (0.93–1.07)	0.97 (0.90–1.04)	0.81 (0.60–1.02)	0.81 (0.60–1.02)
2017	1.13 (1.06–1.21)	1.02 (0.96–1.09)	1.03 (0.96–1.10)	1.04 (0.97–1.11)	0.88 (0.66–1.09)	0.87 (0.65–1.08)
2018	1.12 (1.05–1.20)	1.01 (0.94–1.07)	1.00 (0.93–1.06)	1.01 (0.94–1.07)	0.94 (0.72–1.17)	0.97 (0.74–1.20)
2019	1.17 (1.10–1.24)	1.02 (0.96–1.08)	1.04 (0.97–1.10)	1.03 (0.97–1.09)	0.88 (0.67–1.09)	0.87 (0.66–1.08)
2020	1.13 (1.05–1.20)	0.97 (0.91–1.04)	0.99 (0.92–1.05)	0.97 (0.91–1.04)	1.03 (0.77–1.28)	0.99 (0.75–1.24)

Values are presented as number (%) or standardized prevalence ratio (95% confidence interval).

significant differences in the prevalence of obesity between PLWH and the general population each year.

DISCUSSION

Obesity and overweight prevalence among PLWH in 2009–2020 were 27.9% (95% CI, 27.0–28.7) and 23.1% (95% CI, 22.3–23.9). The prevalence of obesity in PLWH rapidly increased from 28.0% in 2009 to 39.7% in 2020, with an APC of 3.0% ($P < 0.001$). Despite the lower prevalence of obesity in PLWH up to 2018, they demonstrated a higher prevalence of obesity than that in the general population in 2019 and 2020. However, the prevalence of being overweight failed to show an increasing trend in PLWH. After adjusting for sex, age, smoking, and alcohol consumption, the SPR of obesity and overweight were 0.70 (95% CI, 0.68–0.73) and 0.92 (95% CI, 0.89–0.96), indicating that the prevalence of obesity and overweight in PLWH was lower than that in the general population. However, when stratified by sex, despite the lower prevalence of obesity and overweight in both males and females with HIV infection, a consistently lower prevalence of obesity was noted in men with HIV infection than that in the general population across all study years based on the SPRs.

A recent study in the United States reported that the prevalence of obesity and overweight among PLWH was 17.9% and 35.5%, respectively, at the start of HAART, which was lower than 37.2% and 38.2% in matched people without HIV infection.²³ This study employed a cutoff for obesity and overweight as a BMI of ≥ 30.0 kg/m² and ≥ 25.0 kg/m². When applying the Asian-Pacific cutoff for obesity as in this study (BMI of ≥ 25.0 kg/m²),¹⁶ the prevalence of obesity was 53.4% in PLWH and 75.4% in people without HIV.²⁴ The lower prevalence of obesity in PLWH compared to that in people without HIV infection was comparable to the findings of this study; however, the prevalence of obesity itself was higher in both groups than in this study. A meta-analysis regarding obesity prevalence defined as BMI ≥ 30.0 kg/m² identified a lower obesity prevalence in PLWH compared with that in the general population from the National Health and Nutrition Examination Survey, a nationally representative survey, but with a similar prevalence of being overweight defined as a BMI 25.0–29.9 kg/m² in the United States²⁴ as this study did. However, reflecting the higher prevalence of obesity in the United States, the prevalence of overweight/obesity in both PLWH and the general population was higher than that in this study. A meta-analysis of the prevalence of obesity/overweight defined as BMI ≥ 24.0 kg/m² using studies from China observed that the prevalence of obesity/overweight in PLWH was 22.4%, which was lower than the prevalence in the general population of 42.6%.²⁵ Recent studies have demonstrated a lower prevalence of obesity in PLWH than that in the general population.^{12,26} Despite the various obesity/overweight prevalence rates between countries or ethnicities, PLWH show a lower prevalence of obesity/overweight than people without HIV or the general population.

Although HAART has extended the life expectancy of PLWH,^{4,5} the prevalence of obesity among PLWH is increasing, raising concerns regarding the increased risk of metabolic and chronic diseases and resistance to HAART.^{27,28} The prevalence of obesity has escalated rapidly in PLWH and the general population, resulting in an obesity epidemic worldwide.²⁹ However, weight gain with HAART has been faster in PLWH than that in the general population, especially during the first 2 years after HAART.^{23,26} Studies have revealed that despite the lower prevalence of obesity in PLWH at baseline compared with that in people without HIV, an increased BMI was noted in PLWH, especially rapidly increasing in the

first 2 years after HAART, irrespective of the baseline BMI, and the prevalence of obesity in PLWH did not differ from that in the general population.^{8,23} This study did not consider the BMI changes after HAART treatment; however, the increased prevalence of obesity by year might reflect an increased BMI in PLWH and an even higher prevalence of obesity than that in the general population during 2019 and 2020.

Studies have indicated that the increased prevalence of obesity in PLWH has an association with increased alcohol consumption and aging and with decreased smoking.^{30,31} PLWH manifests higher current or ever-smoking rates and lower smoking cessation rates than those in the general population^{24,25,32} and hazardous alcohol consumption is commonly observed in this group.^{24,25} Thus, this study estimated the SPR of obesity in PLWH compared with that in the general population, adjusting for possible covariates, including age, sex, smoking, and alcohol consumption. After adjustment, the prevalence of obesity in PLWH in Korea was lower than that in the general population, and the lower obesity prevalence remained for 11 years from 2009 to 2020, despite the more rapid increase in obesity in PLWH than that in the general population in terms of APC. In previous studies, similar trends in obesity prevalence were noted.^{26,33} Although our study did not precisely account for HAART treatment, HAART was introduced and widely employed during the study period (2009–2020). In Korea, HAART is initiated immediately after an HIV diagnosis,³⁴ and the rate of viral suppression is approximately 90%.³⁵ Despite the similar prevalence of obesity in men and women with HIV, the SPR of obesity in women with HIV, which demonstrated a similar obesity prevalence as the general population, could be attributed to the lower obesity prevalence in women than that in men.

This study has certain limitations that should be considered. First, while previous research has indicated that measures of abdominal obesity are more accurate than BMI in predicting diseases,³⁶ the health examination data of PLWH has a significant proportion of missing information on waist circumference, rendering it challenging to consider abdominal obesity. Second, the NHIS-NHID data were originally collected for administrative purposes and lacked clinical information. This absence prevents assessment of the immune status of PLWH, such as the viral load or CD4 cell count. Because there is a relationship between the immune status of PLWH and weight,³⁷ further studies that connect clinical data to longitudinally track weight changes in PLWH in Korea are needed. Third, the prevalence of obesity among PLWH could only be evaluated based on those who received national health examination data provided by the NHIS national health examinations, which makes it impossible to ascertain data regarding undiagnosed PLWH. Consequently, a comprehensive understanding of the entire PLWH population could not be achieved. Fourth, the KNHANES includes information on the general population, which does not exclude PLWH, indicating that the two datasets are not entirely independent. However, given that the prevalence of HIV in Korea is as low as 0.02%,³⁸ this does not pose a significant problem for the representativeness of the KNHANES data in determining the prevalence of obesity among the general population.

While the prevalence of obesity among PLWH in Korea is lower than that in the general population, it is higher among PLWH than that in the general population, showing a higher prevalence of obesity in 2019 and 2020. In the past, underweight issues were common due to immune suppression caused by HIV infection. However, with the widespread use of HAART, concerns have been raised regarding weight gain in PLWH in recent years. As obesity is associated with the onset of chronic diseases, pathological conditions, and various forms of cancer, more detailed obesity management for PLWH is warranted.

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