Prevalence and patterns of e-cigarette use among U.S. adults: a repeated cross-sectional analysis of the All of Us Research Program, 2017–2023

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Abstract

Introduction: Large-scale, ongoing cohort studies may offer a complementary approach for monitoring population patterns of e-cigarette use alongside established national surveillance systems. This study assessed the prevalence and patterns of current and daily e-cigarette use among adults in the All of Us Research Program from 2017 to 2023 and compared observed patterns with those from established national surveys.

Material and methods: This repeated cross-sectional analysis included adults aged 18 years or older who completed the All of Us Lifestyle Survey between 2017 and 2023. Current and daily e-cigarette use were ascertained through self-reported survey items. The analytic cohort was sex-balanced through random subsampling of female participants (1 : 1 ratio), and overall prevalence estimates were age-standardized to the 2020 U.S. Census adult age distribution. All analyses were descriptive.

Results: The analytic sample included 418,772 participants. Age-standardized prevalence of current e-cigarette use was 6.1% (95% CI: 6.0–6.2), and daily use was 2.4% (95% CI: 2.3–2.4). Prevalence was highest among adults aged 18–24 years (13.3%), male participants (7.0%), and those with depression (7.5%). Annual current use prevalence rose from 3.8% in 2017 to 8.5% in 2023, with a dip to 4.5% in 2020. Among young adults reporting current e-cigarette use, the proportion reporting never having used combustible cigarettes use grew from 51.5% in 2017 to 65.2% in 2023.

Conclusions: E-cigarette use was most common among young adults, with patterns consistent with nationally representative datasets. These findings support the potential of the All of Us Research Program as a complementary resource for monitoring e-cigarette use.

Key words: e-cigarettes, prevalence, All of Us Research Program, surveillance, young adults.

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Introduction

Electronic cigarettes (e-cigarettes) are battery-operated devices that heat a liquid to generate an inhaled aerosol, typically containing nicotine and other additives [1, 2]. E-cigarette use remains a pressing public health concern in the United States (U.S.), with adult prevalence across national surveys consistently exceeding 3% in recent years [3–7]. This sustained level of use may partly reflect continued consumption among adults who began using e-cigarettes earlier in life.

Because adult e-cigarette use continues at substantial levels and the balance of potential benefits and harms remains under active investigation [8–11], ongoing monitoring is warranted. Patterns of use differ by demographic characteristics and may shift in response to changes in product availability, marketing practices, and the regulatory environment [12].

National surveillance systems, including the National Health Interview Survey (NHIS), Behavioral Risk Factor Surveillance System (BRFSS), and National Health and Nutrition Examination Survey, provide essential population-level estimates of adult e-cigarette use, alongside other federal and state surveillance programs [5–7, 13–19]. These surveys support monitoring of population trends, assessment of demographic variation over time, and the formulation and evaluation of policy. However, because data collection follows periodic cycles, these systems may be less well positioned to capture rapidly emerging changes in use patterns.

The All of Us Research Program is a large, ongoing U.S.-based cohort designed to reflect the diversity of the U.S. population and support a broad range of health research [20–24]. Since its national launch, the program has enrolled hundreds of thousands of participants, with large numbers contributing survey data and biospecimens. Although All of Us is not nationally representative, its large sample size and rolling data collection may permit more timely assessment of e-cigarette use patterns across demographic subgroups and calendar years, complementing established surveillance systems.

The objective of this study was to assess whether the All of Us Research Program can serve as a complementary data source for monitoring population patterns of e-cigarette use among U.S. adults. To this end, the prevalence and patterns of current and daily e-cigarette use were described from 2017 to 2023. Prevalence was examined overall and by survey year, demographic characteristics, and combustible cigarette use history. Observed patterns were then compared with those reported by established national surveillance systems, including the NHIS and BRFSS.

Material and methods

Study design and data source

This study used repeated cross-sectional survey data from adult participants enrolled in the All of Us Research Program. All of Us is a large, ongoing U.S.-based cohort supported by the National Institutes of Health that collects participant-provided information through standardized surveys and, for a subset of participants, linked electronic health record (EHR) data. The program is designed to support a broad range of biomedical and public health research and includes participants from a wide range of demographic backgrounds [20–22, 24].

Participants enroll through affiliated health care organizations or directly through the program and provide informed consent prior to participation. They complete standardized self-report surveys, including the Lifestyle Survey, which collects information on tobacco and nicotine product use and health-related behaviors. Sociodemographic characteristics are obtained from the Basics Survey, completed by all participants at study entry. Detailed descriptions of the overall study design and data collection procedures have been published previously [20, 23].

For this analysis, Lifestyle Survey data from the Registered Tier Curated Data Repository (CDR, version 8), collected between 2017 and 2023, were used. Because participants complete surveys at different times, annual estimates represent repeated cross-sectional samples rather than longitudinal follow-up of the same individuals.

Study population

Our initial study population included adults aged 18 years or older who completed the Lifestyle Survey during the study period. We excluded participants with missing e-cigarette use, age, or sex data (n = 12,166; 2.8% of Lifestyle Survey respondents), yielding a final analytic sample of 418,772 participants. Although the proportion excluded was small, potential selection bias due to missing data cannot be ruled out.

Measures

We assessed e-cigarette use using self-reported Lifestyle Survey items and categorized it as never, former, or current use. Among those reporting current use, we further classified frequency as daily or occasional (non-daily). Our primary outcomes were current e-cigarette use and daily e-cigarette use.

Combustible cigarette use history was self-reported and categorized as never, former, or current use. We used this measure to characterize combustible cigarette use history among participants reporting current and daily e-cigarette use.

Demographic characteristics, including age, sex, race and ethnicity, and sexual orientation, were self-reported. We categorized age into standard adult groups. We identified chronic health conditions using linked EHR data where available; these included asthma, type 2 diabetes, hypertension, cardiovascular disease, and depression. These conditions were ascertained from the linked electronic health record and were not anchored to the timing of Lifestyle Survey completion. We selected these conditions on the basis of their prevalence in the adult population and established or hypothesized associations with tobacco and nicotine product use. EHR-derived covariates were available for participants with linked data (n = 277,232); we restricted analyses involving chronic conditions to this subset.

Statistical analysis

All analyses were descriptive. We estimated the prevalence of current and daily e-cigarette use overall, by calendar year (2017–2023), and across demographic subgroups. Because the objective was descriptive characterization rather than hypothesis testing, we conducted no statistical comparisons, and adjustment for multiple comparisons was not applicable.

Voluntary recruitment into the All of Us Research Program produced a female-predominant sample that limits direct comparability with nationally representative benchmarks. Rather than applying post-stratification weights, which require known population inclusion probabilities that were unavailable under this non-probability design, we used random subsampling to create a sex-balanced analytic cohort with a 1 : 1 male-to-female ratio by randomly sampling female participants to match the number of male participants. We selected this approach as a transparent and reproducible step intended to improve descriptive comparability with national surveillance estimates; it is not a representativeness correction, and all estimates should be interpreted as reflecting patterns within the All of Us cohort rather than population-level parameters. A single fixed random subsample was used for the primary analysis; to assess sensitivity to this random selection, the subsampling was repeated across multiple independent draws, which produced consistent estimates. We age-standardized overall prevalence estimates to the 2020 U.S. Census adult age distribution to facilitate descriptive comparison with national surveillance systems [25]. We applied age-standardization to overall prevalence estimates only; subgroup-specific estimates represent crude (unstandardized) prevalence and reflect the age composition of each subgroup.

We calculated annual prevalence estimates of current and daily e-cigarette use separately for each calendar year. We calculated daily-to-current use ratios for each year by dividing the prevalence of daily use by the prevalence of current use to describe patterns in use intensity over time. Because respondents differed across years and the objective was descriptive monitoring, we conducted no statistical tests for time trends; year-to-year differences are presented as observed patterns within the All of Us cohort. Because the Lifestyle Survey is completed once near enrollment, estimates for each calendar year reflect the composition of participants enrolling in that year as well as the timing of behavior. We examined combustible cigarette use status (never, former, current) among participants reporting current or daily e-cigarette use, stratified by age group and calendar year.

We conducted analyses using R version 4.3.1 in the All of Us Researcher Workbench (embedded Jupyter environment), with the dplyr, tidyr, and ggplot2 packages.

Results

Study population

The analytic sample included 418,772 participants. Most were aged 25–64 years (318,511 [76.0%]), identified as heterosexual (357,501 [85.4%]), and were employed (242,371 [57.9%]). The most frequently reported racial and ethnic identities were non-Hispanic White (222,704 [53.2%]), Hispanic (79,025 [18.9%]), and non-Hispanic Black (75,378 [18.0%]) (Table I).

Overall and annual prevalence of e-cigarette use

Overall age-standardized prevalence of current and daily e-cigarette use was 6.1% (95% CI: 6.0–6.2) and 2.4% (95% CI: 2.3–2.4), respectively, corresponding to a daily-to-current use ratio of 39.1% (Table II).

Annual prevalence of current e-cigarette use ranged from 3.8% (95% CI: 3.4–4.2) in 2017 to 8.5% (95% CI: 8.3–8.7) in 2023. Prevalence was lower in 2020 (4.5% [95% CI: 4.3–4.7]) than in 2019 (5.2% [95% CI: 5.1–5.4]). Annual prevalence of daily use ranged from 1.0% (95% CI: 0.8–1.2) in 2017 to 4.1% (95% CI: 3.9–4.2) in 2023. The daily-to-current use ratio ranged from 25.3% in 2017 to 47.1% in 2022 and 48.0% in 2023 (Figure 1).

Prevalence of e-cigarette use by participant characteristics

Current e-cigarette use prevalence was highest among adults aged 18–24 years (13.3% [95% CI:

Table I. Characteristics of the analytic sample and participants reporting current and daily e-cigarette use, All of Us Research Program, 2017–2023

Participant characteristics	Total (*N* = 418,772) *N* (%)	Current (*n* = 25,441) *n* (%)	Daily (*n* = 9,936) *n* (%)
Sex			
Male	210,076 (50.2)	14,598 (57.4)	6,022 (60.6)
Female	208,696 (49.8)	10,843 (42.6)	3,914 (39.4)
Age [years]			
18–24	31,530 (7.5)	4,187 (16.5)	1,603 (16.1)
25–44	170,902 (40.8)	14,514 (57.0)	5,759 (58.0)
45–64	147,609 (35.2)	6,136 (24.1)	2,324 (23.4)
≥ 65	68,731 (16.4)	604 (2.4)	250 (2.5)
Race and ethnicity			
Non-Hispanic White	222,704 (53.2)	14,715 (57.8)	6,833 (68.8)
Non-Hispanic Black	75,378 (18.0)	4,014 (15.8)	979 (9.9)
Non-Hispanic Asian	20,441 (4.9)	947 (3.7)	390 (3.9)
Hispanic	79,025 (18.9)	4,084 (16.1)	1,183 (11.9)
Other	10,939 (2.6)	914 (3.6)	335 (3.4)
Sexual orientation			
Heterosexual	357,501 (85.4)	18,953 (74.5)	7,085 (71.3)
Lesbian/gay	18,478 (4.4)	1,649 (6.5)	706 (7.1)
Bisexual	23,446 (5.6)	3,512 (13.8)	1,583 (15.9)
Other	10,750 (2.6)	873 (3.4)	413 (4.2)
Transgender			
No	417,212 (99.6)	25,260 (99.3)	9,845 (99.1)
Yes	1,560 (0.4)	181 (0.7)	91 (0.9)
Body mass index [kg/m²]			
< 18.5	4,489 (1.1)	480 (1.9)	212 (2.1)
18.5–24.9	92,390 (22.1)	5,974 (23.5)	2,070 (20.8)
25–29.9	106,975 (25.5)	5,378 (21.1)	1,887 (19.0)
≥ 30	141,779 (33.9)	7,847 (30.8)	3,065 (30.8)
Marital status			
Single	154,238 (36.8)	13,686 (53.8)	5,053 (50.9)
Married	183,846 (43.9)	5,894 (23.2)	2,691 (27.1)
Divorced	61,407 (14.7)	4,710 (18.5)	1,835 (18.5)
Widowed	9,849 (2.4)	446 (1.8)	148 (1.5)
Highest education level			
< High school	111,225 (26.6)	9,510 (37.4)	3,270 (32.9)
High school or some college	108,309 (25.9)	9,726 (38.2)	4,062 (40.9)
College graduate	190,999 (45.6)	5,683 (22.3)	2,384 (24.0)
Income status			
Low (< $50k)	64,902 (15.5)	5,184 (20.4)	2,279 (22.9)
Lower middle ($50–< 100k)	81,761 (19.5)	4,215 (16.6)	2,056 (20.7)
Middle ($100–< 150k)	45,853 (10.9)	1,468 (5.8)	701 (7.1)
Upper middle ($150–< 200k)	22,434 (5.4)	557 (2.2)	252 (2.5)
High (≥ $200k)	30,622 (7.3)	591 (2.3)	267 (2.7)
Employment status			
Employed	242,371 (57.9)	14,114 (55.5)	6,127 (61.7)
Unemployed	85,163 (20.3)	7,669 (30.1)	2,516 (25.3)

Table I. Cont.

Participant characteristics	Total (*N* = 418,772) *N* (%)	Current (*n* = 25,441) *n* (%)	Daily (*n* = 9,936) *n* (%)
Retired	57,176 (13.7)	649 (2.6)	271 (2.7)
Student	22,866 (5.5)	2,128 (8.4)	782 (7.9)
Combustible cigarette use			
Never	253,060 (60.4)	5,401 (21.2)	1,527 (15.4)
Former	87,050 (20.8)	7,200 (28.3)	4,728 (47.6)
Current	68,869 (16.4)	11,754 (46.2)	3,289 (33.1)
Asthma			
No	242,588 (87.5)	13,036 (86.2)	4,677 (85.8)
Yes	34,644 (12.5)	2,092 (13.8)	771 (14.2)
Type 2 diabetes			
No	239,378 (86.3)	13,876 (91.8)	5,018 (92.1)
Yes	37,854 (13.7)	1,252 (8.2)	430 (7.9)
Hypertension			
No	194,213 (70.1)	12,190 (80.6)	4,423 (81.2)
Yes	83,019 (29.9)	2,938 (19.4)	1,025 (18.8)
Cardiovascular disease			
No	252,687 (91.1)	14,457 (95.6)	5,243 (96.2)
Yes	24,545 (8.9)	671 (4.4)	205 (3.8)
Depression			
No	217,318 (78.4)	10,660 (70.5)	3,605 (66.2)
Yes	59,914 (21.6)	4,468 (29.5)	1,843 (33.8)

Values are presented as n (%). The Total column reflects the full analytic sample (N = 418,772); Current and Daily columns reflect participants reporting current (n = 25,441) and daily (n = 9,936) e-cigarette use, respectively. Percentages represent the proportion within each column and may not sum to 100 due to missing data or rounding. Participants with less than a high school education are over-represented relative to the U.S. adult population, consistent with the program's emphasis on enrolling groups historically underrepresented in biomedical research.

12.9–13.7]), followed by adults aged 25–44 years (8.5% [95% CI: 8.4–8.6]). Daily use followed a similar age pattern, with prevalence of 5.1% (95% CI: 4.8–5.3) among adults aged 18–24 years and 3.4% (95% CI: 3.3–3.5) among adults aged 25–44 years (Table II).

Higher prevalence of current e-cigarette use was observed among male participants (7.0%), non-Hispanic White participants (6.6%), and participants identifying as bisexual (15.0%). Prevalence was also higher among those with body mass index less than 18.5 kg/m² (10.7%), participants who were students (9.3%), those who were single (8.9%), those with a high school degree or some college education (9.0%), participants with low income (8.0%), and participants with depression (7.5%) or asthma (6.0%) (Table II).

Across combustible cigarette use categories, current e-cigarette use was highest among participants reporting current combustible cigarette use (17.1% [95% CI: 16.8–17.4]), followed by those reporting former combustible cigarette use (8.3% [95% CI: 8.1–8.5]), and was lowest among those reporting never combustible cigarette use (2.1% [95% CI: 2.1–2.2]) (Table II).

Patterns of combustible cigarette use by e-cigarette use status

Patterns of combustible cigarette use history varied by age among participants reporting current e-cigarette use. Among those aged 18–24 years, most reported never combustible cigarette use (59.2% [95% CI: 57.7–60.7]), while 10.6% (95% CI: 9.6–11.5) reported former use and 22.8% (95% CI: 21.6–24.1) reported current combustible cigarette use. The proportion reporting never combustible cigarette use among participants aged 18–24 years reporting current e-cigarette use ranged from 51.5% in 2017 to 65.2% in 2023 (Figure 2; Supplementary Table SI).

In contrast, among adults aged 25 years and older reporting current e-cigarette use, former or current combustible cigarette use was more common. Among those aged 25–44 years, 17.0% (95% CI: 16.4–17.6) reported never, 31.0% (95% CI: 30.3–31.8) reported former, and 48.0% (95% CI: 47.2–48.8) reported current combustible cigarette use (Supplementary Table SI).

Among participants aged 45–64 years, 6.9% (95% CI: 6.3–7.6) reported never, 32.4% (95% CI:

Table II. Prevalence of current and daily e-cigarette use by participant characteristics, All of Us Research Program, 2017–2023

Participant characteristics	Current e-cigarette use % (95% CI)	Daily e-cigarette use % (95% CI)
Overall	6.1 (6.0–6.2)	2.4 (2.3–2.4)
Sex		
Male	7.0 (6.8–7.1)	2.9 (2.8–2.9)
Female	5.2 (5.1–5.3)	1.9 (1.8–1.9)
Age [years]		
18–24	13.3 (12.9–13.7)	5.1 (4.8–5.3)
25–44	8.5 (8.4–8.6)	3.4 (3.3–3.5)
45–64	4.2 (4.1–4.3)	1.6 (1.5–1.6)
≥ 65	0.9 (0.8–1.0)	0.4 (0.3–0.4)
Race and ethnicity		
Non-Hispanic White	6.6 (6.5–6.7)	3.1 (3.0–3.1)
Non-Hispanic Black	5.3 (5.2–5.5)	1.3 (1.2–1.4)
Non-Hispanic Asian	4.6 (4.4–4.9)	1.9 (1.7–2.1)
Hispanic	5.2 (5.0–5.3)	1.5 (1.4–1.6)
Other	8.4 (7.8–8.9)	3.1 (2.8–3.4)
Sexual orientation		
Heterosexual	5.3 (5.2–5.4)	2.0 (1.9–2.0)
Lesbian/gay	8.9 (8.5–9.3)	3.8 (3.6–4.1)
Bisexual	15.0 (14.5–15.4)	6.8 (6.4–7.1)
Other	8.1 (7.6–8.7)	3.8 (3.5–4.2)
Transgender		
Yes	11.6 (10.1–13.3)	5.8 (4.7–7.1)
No	6.1 (6.0–6.1)	2.4 (2.3–2.4)
Body mass index [kg/m²]		
< 18.5	10.7 (9.8–11.6)	4.7 (4.1–5.4)
18.5 to < 25	6.5 (6.3–6.6)	2.2 (2.1–2.3)
25 to < 30	5.0 (4.9–5.2)	1.8 (1.7–1.8)
≥ 30	5.5 (5.4–5.7)	2.2 (2.1–2.2)
Marital status		
Single	8.9 (8.7–9.0)	3.3 (3.2–3.4)
Married	3.2 (3.1–3.3)	1.5 (1.4–1.5)
Divorced	7.7 (7.5–7.9)	3.0 (2.9–3.1)
Widowed	4.5 (4.1–5.0)	1.5 (1.3–1.8)
Highest education level		
Less than high school	8.6 (8.4–8.7)	2.9 (2.8–3.0)
High school or some college	9.0 (8.8–9.2)	3.8 (3.6–3.9)
College graduate	3.0 (2.9–3.1)	1.3 (1.2–1.3)
Income status		
Low (< $50k)	8.0 (7.8–8.2)	3.5 (3.4–3.7)
Lower middle ($50–< 100k)	5.2 (5.0–5.3)	2.5 (2.4–2.6)
Middle ($100–< 150k)	3.2 (3.0–3.4)	1.5 (1.4–1.7)
Upper middle ($150–< 200k)	2.5 (2.3–2.7)	1.1 (1.0–1.3)
High (≥ $200k)	1.9 (1.8–2.1)	0.9 (0.8–1.0)
Employment status		
Employed	5.8 (5.7–5.9)	2.5 (2.5–2.6)

Table II. Cont.

Participant characteristics	Current e-cigarette use % (95% CI)	Daily e-cigarette use % (95% CI)
Unemployed	9.0 (8.8–9.2)	3.0 (2.8–3.1)
Retired	1.1 (1.1–1.2)	0.5 (0.4–0.5)
Student	9.3 (8.9–9.7)	3.4 (3.2–3.7)
Combustible cigarette use		
Never	2.1 (2.1–2.2)	0.6 (0.6–0.6)
Former	8.3 (8.1–8.5)	5.4 (5.3–5.6)
Current	17.1 (16.8–17.4)	4.8 (4.6–4.9)
Asthma		
Yes	6.0 (5.8–6.3)	2.2 (2.1–2.4)
No	5.4 (5.3–5.5)	1.9 (1.9–2.0)
Type 2 diabetes		
Yes	3.3 (3.1–3.5)	1.1 (1.0–1.3)
No	5.8 (5.7–5.9)	2.1 (2.0–2.2)
Hypertension		
Yes	3.5 (3.4–3.7)	1.2 (1.2–1.3)
No	6.3 (6.2–6.4)	2.3 (2.2–2.3)
Cardiovascular disease		
Yes	2.7 (2.5–3.0)	0.8 (0.7–1.0)
No	5.7 (5.6–5.8)	2.1 (2.0–2.1)
Depression		
Yes	7.5 (7.3–7.7)	3.1 (2.9–3.2)
No	4.9 (4.8–5.0)	1.7 (1.6–1.7)

Values are presented as prevalence (%) with 95% confidence intervals (CI), representing row percentages. Overall prevalence is age-standardized to the 2020 U.S. Census adult age distribution; subgroup-specific estimates are crude (not age-standardized). Estimates are unweighted and are not intended to be nationally representative.

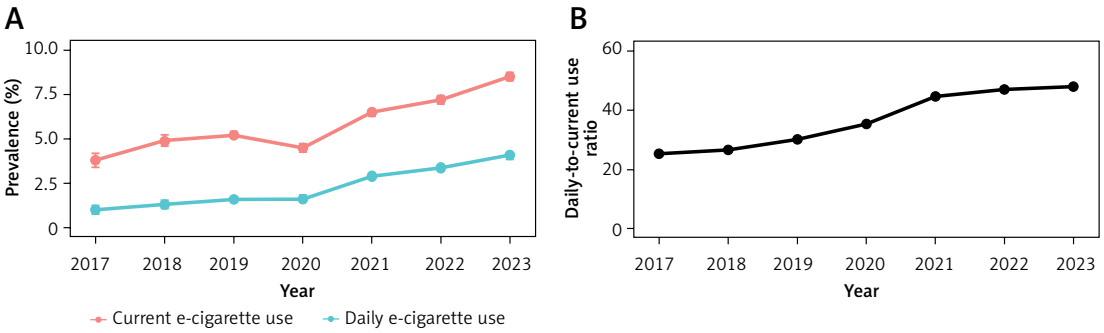

Figure 1. Patterns of current and daily e-cigarette use in the All of Us Research Program, 2017–2023. Panel **A** shows annual prevalence estimates with 95% confidence intervals. Panel **B** shows the annual daily-to-current e-cigarette use ratio

31.3–33.6) reported former, and 57.8% (95% CI: 56.5–59.0) reported current combustible cigarette use. Adults aged 65 years and older showed a similar distribution. A comparable age-related pattern was observed among participants reporting daily e-cigarette use (Supplementary Tables SI and SII).

Discussion

In this large cohort of U.S. adults, we found that the prevalence of current e-cigarette use and the proportion reporting daily use were generally higher in later calendar years, with consistently higher values among young adults aged 18–24 years. We observed a lower prevalence in 2020 compared with 2019 that deviated from this otherwise rising pattern. Across calendar years, younger adults who used e-cigarettes were more likely to report never using combustible cigarettes, whereas older adults more often reported concurrent or former combustible cigarette use. We also found mark-

edly higher use among participants identifying as bisexual and among those with depression, and modestly higher use among those with asthma (6.0% vs. 5.4%).

To assess whether alternative data sources such as All of Us can contribute to monitoring population patterns of e-cigarette use, we compared our findings with those from established national surveillance systems. The overall age-standardized prevalence of current e-cigarette use in All of Us (6.1%) was higher than NHIS estimates for most years during this period [18, 19, 26, 27]. Despite differences in absolute prevalence, both data sources showed similar patterns across calendar years. In All of Us, prevalence rose from 3.8% in 2017 to 8.5% in 2023, with a lower observed value in 2020 compared with 2019 (4.5% vs. 5.2%) that deviated from the otherwise rising pattern. NHIS data showed a comparable trajectory, with prevalence rising from 2.8% in 2017 to 6.5% in 2023 and a similar deviation in 2020. In both datasets, current e-cigarette use was consistently higher among male participants and most common among young adults. Differences in absolute prevalence are expected and may reflect differences in sampling designs, survey weights, and population calibration procedures between All of Us and national surveillance systems.

Similar patterns were also evident when comparing findings with the BRFSS, a nationally representative annual survey in which e-cigarette use was assessed in select years. Across available survey years, BRFSS estimates of current e-cigarette use were higher in later years than in earlier years, reaching 6.9% in 2021 [6], a value similar to that observed in All of Us for the same year. As in both NHIS and All of Us, BRFSS data showed a lower observed prevalence of current e-cigarette use in 2020 compared with the most proximate preceding survey year (5.1% vs. 5.5%) [5]. Consistent with All of Us, BRFSS analyses from 2017 to 2021 showed a greater proportion of individuals reporting current e-cigarette use and never combustible cigarette use in later survey years [5, 6]. Additionally, All of Us data showed a higher ratio of daily to current e-cigarette use in later calendar years, increasing from 25.3% in 2017 to 48.0% in 2023; a comparable pattern was observed in BRFSS, where this ratio increased from 34.5% in 2017 to 46.6% in 2021.

The patterns observed across datasets suggest that e-cigarette use is disproportionately concentrated among young adults. The higher ratio of daily to current e-cigarette use among adults aged 18–24 years suggests a greater frequency of use among current users and may reflect greater potential for nicotine dependence and sustained use over time. The daily-to-current use ratio, which rose from 25.3% in 2017 to 48.0% in 2023, is a particularly informative metric because it describes the proportion of current users who report daily use; a rising ratio indicates that a growing share of those who currently use e-cigarettes do so daily, a shift suggestive of more intensive use that may correspond to greater nicotine dependence and could have implications for cessation. In contrast, older adults who used e-cigarettes more often reported concurrent or former combustible cigarette use, suggesting different patterns of adoption. Consistent with this, daily e-cigarette use was slightly lower among current combustible cigarette smokers than among former smokers, suggesting a higher prevalence of daily e-cigarette use among those who no longer smoke combustible cigarettes. Whether e-cigarette use among older adults reflects attempted cessation from combustible cigarettes, concurrent use of both products, or other factors warrants further investigation.

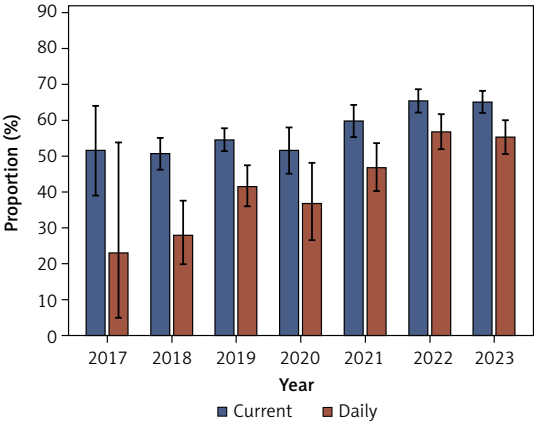

Figure 2. Proportion of never combustible cigarette use among adults aged 18–24 reporting current or daily e-cigarette use, 2017–2023. Error bars represent 95% confidence intervals. Estimates for 2017 and 2018 are based on small numbers of respondents and have correspondingly wide confidence intervals; they should be interpreted with caution

The lower observed prevalence in 2020 was evident across All of Us, NHIS, and BRFSS. The consistency of this dip across independent data sources with different sampling designs suggests that it may not be specific to a single dataset, although it does not establish a shared external cause. The most plausible explanation is disruption associated with the early phase of the COVID-19 pandemic, which may have affected product access, daily routines, and survey participation [28]. Concurrent regulatory actions affecting certain flavored e-cigarette products may have contributed, and pandemic-related changes in survey participation could also have played a role. Because participants complete the survey near enrollment, some of the observed change over time, including

the 2020 decline, could reflect shifts in the demographic and geographic composition of enrollees, such as pandemic-era changes in recruitment, rather than changes in population-level behavior. Future studies using probability-based samples could help separate the contributions of access, behavior, and survey participation.

We also observed substantially higher use among participants identifying as bisexual (15.0%), a prevalence higher than that observed in every other demographic subgroup examined, except current combustible cigarette users. This is consistent with a substantial literature documenting elevated tobacco and e-cigarette use among sexual minority populations, with bisexual individuals, and bisexual women in particular, often at greatest risk [29–31]. Absolute figures vary across studies because of differences in population and design. A population-level analysis of U.S. adults reported e-cigarette prevalence of approximately 13% among lesbian, gay, bisexual, and transgender adults, nearly twice the prevalence among heterosexual adults [30], while studies of young adults report higher absolute use and the strongest disparities among bisexual women [29, 31]. Despite these differences, the overall picture is consistent, with sexual minority adults, and bisexual individuals especially, using e-cigarettes at substantially higher rates than their heterosexual counterparts. These disparities are commonly attributed to minority stress, in which stigma and discrimination contribute to higher substance use, and may be compounded by tobacco marketing directed toward sexual minority communities [30, 31]. The magnitude of this disparity in a large, diverse cohort highlights the need for tailored prevention and cessation efforts.

Across multiple data sources, similar patterns of e-cigarette use were observed over time. It is important to delineate what this concordance does and does not establish. Agreement in the direction and timing of trends across independent data sources supports the possibility that All of Us captures temporal patterns also observed in established surveillance systems, rather than dataset-specific artifacts. However, because All of Us is a non-probability cohort, such concordance does not by itself establish that the program can substitute for probability-based, nationally representative surveillance or generate unbiased prevalence estimates. Rather, directional agreement supports a narrower, complementary role: corroborating signals observed elsewhere, generating hypotheses, and providing timely, granular data on subgroups that periodic national surveys may sample sparsely. Absolute prevalence estimates from All of Us should continue to be benchmarked against probability-based, nationally representative sources. Within these bounds, the correspondence of patterns suggests that All of Us can complement established surveillance systems in monitoring patterns of e-cigarette use alongside changing contexts and policies and in identifying emerging patterns that warrant further investigation.

This study used a large and diverse cohort with detailed demographic and behavioral data, enabling descriptive assessment of e-cigarette use across subgroups and calendar years. The scale and ongoing data accrual of the All of Us Research Program provide an opportunity to characterize behavioral patterns and detect emerging changes that can complement established surveillance systems and inform policy evaluation.

Several limitations should be considered. All of Us is a voluntary, non-probability cohort not designed to produce nationally representative prevalence estimates; findings should not be interpreted as population-level estimates. Participation and survey completion varied across years, and respondent composition differed over time, with some demographic groups overrepresented relative to the U.S. adult population. To improve descriptive comparability with national surveillance systems, the analytic cohort was balanced by sex through random subsampling of female participants, and overall estimates were age-standardized to the 2020 U.S. Census adult age distribution. These methods were selected for transparency and reproducibility; they may improve comparability but do not fully correct for differences in selection, participation, or response. Sex-balancing through random subsampling was chosen because it is straightforward to implement and interpret and removes a known source of compositional difference from the general adult population; direct standardization to an external sex distribution is a reasonable alternative that retains all participants. This procedure reduces the number of female participants included in the analysis and the precision of sex-specific comparisons.

Analyses were descriptive and based on repeated cross-sectional samples rather than longitudinal follow-up. Formal statistical tests for time trends were not conducted; observed year-to-year differences should be interpreted as descriptive patterns that may reflect sampling variability and changes in respondent composition rather than true population-level change. Estimates for the earliest years (2017–2018) were based on smaller numbers of respondents and had correspondingly wider confidence intervals, and some subgroup estimates, particularly in earlier years, were less stable owing to smaller sample sizes; year-to-year comparisons involving these years should be interpreted with caution. Estimates based on very small cell sizes were suppressed.

E-cigarette use and combustible cigarette use history were self-reported and may be subject to misclassification. EHR-derived covariates were available for only 277,232 of 418,772 participants (66%). Because EHR linkage occurs through participating health care provider organizations, the linked subset is likely more engaged with the health care system and may differ in age and comorbidity burden from the unlinked subset; estimates of chronic-condition prevalence and associations between chronic conditions and e-cigarette use should therefore be interpreted with caution and not generalized to the full cohort. Because these conditions were ascertained from electronic health record data not anchored to survey completion, the temporal relationship between the conditions and e-cigarette use cannot be established, and the condition-specific prevalences should not be interpreted as causal or directional.

In conclusion, in this large cohort of U.S. adults, e-cigarette use was most common among young adults and varied by demographic characteristics and combustible cigarette use history. Across survey years, descriptive patterns in current and daily e-cigarette use, including age-specific variation, the proportion of younger adults who had never used combustible cigarettes, and the higher ratio of daily to current use in this age group, were consistent with those reported in established surveillance systems and may carry implications for nicotine dependence and sustained use.

Although the All of Us Research Program is not designed to generate nationally representative prevalence estimates, and enrollment and survey participation varied across survey years, the correspondence of observed patterns with well-validated, nationally representative datasets supports the potential of All of Us as a complementary data source for monitoring population patterns of e-cigarette use. The scale, diversity, and ongoing data accrual of the program may be particularly useful for surfacing emerging signals and generating hypotheses for subsequent validation in nationally representative datasets, and for providing contextual and subgroup-level information to inform future research and policy evaluation.

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Data availability statement

This study used data from the All of Us Research Program's Registered Tier Curated Data Repository (version 8), available to authorized users on the Researcher Workbench. For more information on requesting access, please visit https://www.researchallofus.org/.

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Ethical approval

Not applicable.

Conflict of interest

The authors declare no conflict of interest.

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