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Research and Applications

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Assessing how frailty and healthcare delays mediate the association between sexual and gender minority status and healthcare utilization in the *All of Us* Research Program

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Abstract

Objectives: To understand how frailty and healthcare delays differentially mediate the association between sexual and gender minority older adults (OSGM) status and healthcare utilization.

Materials and Methods: Data from the *All of Us* Research Program participants ≥50 years old were analyzed using marginal structural modelling to assess if frailty or healthcare delays mediated OSGM status and healthcare utilization. OSGM status, healthcare delays, and frailty were assessed using survey data. Electronic health record (EHR) data was used to measure the number of medical visits or mental health (MH) visit days, following 12 months from the calculated *All of Us* Frailty Index. Analyses adjusted for age, race and ethnicity, income, HIV, marital status ± general MH (only MH analyses).

Results: Compared to non-OSGM, OSGM adults have higher rates of medical visits (adjusted rate ratio [aRR]: 1.14; 95% CI: 1.03, 1.24) and MH visits (aRR: 1.85; 95% CI: 1.07, 2.91). Frailty mediated the association between OSGM status medical visits (Controlled direct effect [Rcde] aRR: 1.03, 95% CI [0.87, 1.22]), but not MH visits (Rcde aRR: 0.37 [95% CI: 0.06, 1.47]). Delays mediated the association between OSGM status and MH visit days (Rcde aRR: 2.27, 95% CI [1.15, 3.76]), but not medical visits (Rcde aRR: 1.06 [95% CI: 0.97, 1.17]).

Discussion: Frailty represents a need for medical care among OSGM adults, highlighting the importance of addressing it to improve health and healthcare utilization disparities. In contrast, healthcare delays are a barrier to MH care, underscoring the necessity of targeted strategies to ensure timely MH care for OSGM adults.

Key words: sexual and gender minority; older adult; frailty; healthcare utilization; electronic health records; healthcare delays.

Introduction

In the United States, there are approximately 3 million sexual and gender minority adults over the age of 50 (OSGM), and this population is estimated to increase to over 5 million by 2030.[1] With this population growth, it is critical to integrate novel methods to understand the syndemics between health status, healthcare delays, and healthcare utilization among OSGM adults, a population underrepresented in biomedical research.

Frailty represents physiological vulnerability to a stressor, such as injury, acute illness, or chronic disease.[2] Prior research has demonstrated OSGM adults have a higher burden of frailty at earlier ages compared to non-OSGM adults.[3] Moreover, a report documenting experiences of discrimination among sexual and gender minority (SGM) adults found that roughly 1 in 6 SGM adults reported avoiding medical care out of fear of discrimination.[4] Also, a geographically limited study of gender minority adults linked healthcare delays to lower healthcare utilization.[5] The minority stress theory describes that health disparities among SGM populations may result from the physical and psychological manifestations of external stressors of stigma and discrimination related to sexual and/or gender identity which become internalized, resulting in negative beliefs of their identity.[6] The minority stress theory has

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been extended and applied to aging populations,[7] where self-perceived agism is associated with poorer health.[8] The intersection of SGM identity with aging, engenders a life course experience with considerable accumulation of biological and social stressors, including frailty and healthcare delays.

Studies comparing outpatient healthcare utilization between OSGM and non-OSGM populations have produced inconsistent findings. Sexual minority older adults are more than twice as likely to self-report receiving mental health (MH) care,[9] yet report no difference in "usual source of care" (eg, primary care)[10] compared to heterosexual older adults. Similarly, gender minority older adults were almost 7% more likely to have outpatient MH visits.[11] However, gender minority older adults were also 2% more likely to have an annual wellness visit.[11] There is a lack of evidence simultaneously evaluating both sexual minority and gender minority older adult populations using a consistent measure of outpatient healthcare utilization, possibly contributing to the observed discrepancies of patterns of outpatient healthcare utilization.

Among non-OSGM adults, healthcare utilization has been linked to both frailty and healthcare delays. A study using electronic health record (EHR) data in England found that frail participants had 1.5 times the rate outpatient visits compared to robust participants.[12] High need older adults with multiple chronic conditions or functional limitations, reported more delays due to cost and care coordination as well as higher healthcare utilization compared to older adults without high needs.[13] Therefore, due to the higher burden of frailty and healthcare delays among OSGM adults, we propose that frailty and/or delays may play a mediating role between OSGM status the frequency of different types of outpatient healthcare visits.

Historically, one key challenge to investigating healthcare utilization among OSGM adults is that available data sources with sexual and gender identity (SOGI) information only include self-reported utilization data rather than utilization data from claims or EHR. The use of EHR healthcare utilization data has been limited as EHR data tend to lack SOGI information. In 2015, the US Centers for Medicare and Medicaid Services along with the Office of the National Coordinator for Health Information announced hospital-based EHR systems must include SOGI data fields.[14] Despite a growth in patients reporting SOGI data from 14.9% to 53.0% from 2016 to 2019,[15] many patients still lack SOGI EHR data. This precludes the ability to leverage EHR data for SGM research. The NIH-funded *All of Us* Research Program is uniquely positioned to address this gap with the aim to create a diverse cohort of at least 1 million United States participants, focusing on populations underrepresented in biomedical research, including SGM individuals. The *All of Us* Research Program participants complete health surveys with SOGI questions and may volunteer to share their EHR data, advancing the integration of SOGI information and EHR data therefore reducing the reliance on EHR SOGI fields.

Here, we integrate EHR and survey data to evaluate objective healthcare utilization measured as EHR outpatient visit days and survey-derived measures of frailty, healthcare delays, and OSGM status. The aim of the study is to assess whether frailty or healthcare delays mediate the association between OSGM status and healthcare utilization. First, we examined baseline demographic, frailty, and healthcare delay differences between OSGM and non-OSGM adults. Then, we examined associations between frailty, delays, and healthcare utilization. Finally, we combined these pieces into marginal structural causal models to examine the mediating role of frailty and healthcare delays on healthcare utilization by OSGM status. We have distinct hypotheses for each mediator. Accounting for frailty would reduce the disparity of healthcare utilization by OSGM status. Whereas accounting for healthcare delays would increase the disparity of healthcare utilization by OSGM status.

Methods

Data source and participants

We conducted a longitudinal analysis of the *All of Us* Research Program Version 7 Curated Data Repository of the Controlled Tier Database C2022Q4R11. Data was collected by the *All of Us* Research Program from May 31, 2017, to June 30, 2022, from over 340 healthcare organizations or the enrollment website where patients elected to participate. This study utilized survey and EHR data that have been mapped to the Observational Medical Outcomes Partnership (OMOP) common data model.[16] Details of the *All of Us* Research Program goals, scientific rational, recruitment methods, and sites have been previously described.[17] All experimental protocols and data collection involving human participants were approved by the Ethics Committee/Institutional Review Board (IRB) of the *All of Us* Research Program. The current study was reviewed and deemed exempt by the Northeastern University IRB.

We included participants ≥50 years old who completed the Basics, Overall Health, Personal/Family Health History, and Health Access and Utilization Surveys as they were necessary to calculate the *All of Us* Frailty Index[3] as well as consented to sharing EHR data. The completion date of the final survey required for the *All of Us* Frailty Index serves as the index date, which is the start of follow up time.

Independent variable

Sexual orientation and gender identity were self-reported as sex assigned at birth, gender identity, and sexual orientation. Participants were classified as OSGM if they reported a sexual orientation of gay, lesbian, bisexual; a gender identity of non-binary, transgender, additional options: genderqueer/fluid, two-spirit, questioning; a sex assigned at birth of intersex; and/or having discordance between gender and sex assigned at birth. Cisgender heterosexual participants were classified as non-OSGM.

Potential mediators

The *All of Us* Frailty Index,[3] a deficit accumulation index, evaluates domains of cognition, morbidity, physical function, geriatric syndromes, general health status, MH, and sensory impairment. The following *All of Us* Frailty Index cutoffs were used to categorize participants as robust (*All of Us* Frailty Index <0.15), prefrail (≥0.15 to ≤0.25), and frail (>0.25).[18]

Healthcare delays were measured by 9 questions (see **Appendix S1**), which ascertained delays due to transportation, provider and patient level factors, and finances. A binary "ever delayed"/"never delayed" care variable was created based on those who identified ever experiencing at least one or more of these delays versus those reporting never experiencing any of these delays.

Dependent variables

Objective EHR healthcare utilization was measured as the number of outpatient medical visits and MH visit days from index date to 12 months or censored date. Participants were censored if they died within the 12 month follow up time. The OMOP Visit Occurrence and Procedure Occurrence tables were used to derive the EHR visits of interest.

Outpatient visit identification

Outpatient visits were identified from the Visit Occurrence table using 3 visit occurrence identification numbers (ID): 9202-Outpatient Visit, 581477-Office Visit, and 38004207-Ambulatory Clinic/Center. Then, the Procedure Occurrence Table was used to identify the type of visit: medical and MH visits. To identify medical visits, 8 standard Current Procedural Terminology (CPT) procedure concept IDs were used (see **Appendix S1**): 4 correspond to new patient visits with increasing visit durations from 15 to 74 minutes and 4 correspond to established patient visits with increasing durations from 10 to 54 minutes. To identify MH visits, 38 procedure concept IDs were used (see **Appendix S1**), 36 were CPT and 2 were SNOMED vocabulary codes, all were standard codes.

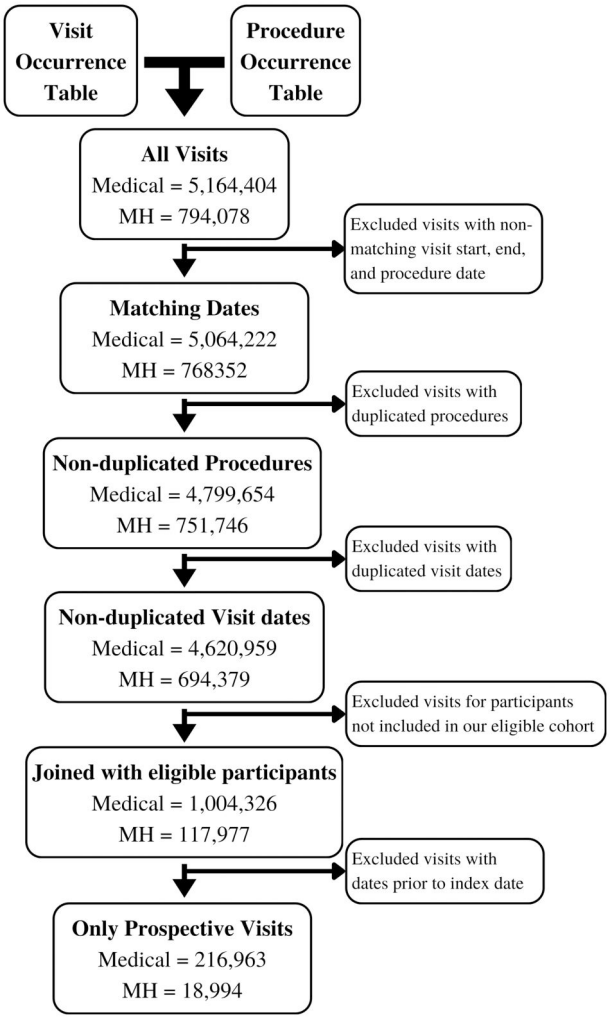

Figure 1. Flow diagram to identify visits of interest and visit data quality steps for medical visits and mental health visits. *Notes*: Medical, medical visits; MH, mental health visits.

Data quality steps

We managed data quality issues in the following ways (Figure 1). There were outpatient visits that were longer than 1 day, as a result we excluded visits with different start and end dates. The visit occurrence ID and person ID were used to merge the Visit Occurrence and Procedure Occurrence tables. There were visits that did not have the same visit and procedure date, these visits were excluded to ensure we were capturing only outpatient visits of interest. Also, there were duplicated procedures for the same visit; we excluded duplicates resulting in a single visit-procedure pair. Finally, there were duplicated visits on the same day, as a result we counted the number of visit-days rather than the total number of visits. Visit days were counted over a 12-month period following the index date for medical and MH visit days, respectively. We assumed 12 months of EHR follow up by limiting our sample to participants with an index date at least 12 months prior to June 30, 2022.

Covariates

Covariates included age as a continuous variable, race, and ethnicity (Black, White, Hispanic, Other: included Asian, Native Hawaiian or Pacific Islander, Middle Eastern, Northern African, or Mixed), annual income (>100k, 50-100k, <50k) marital status (married or living with a partner, divorced or separated, widowed, never married), and human immunodeficiency virus (HIV) status (yes or no). Self-reported general MH, with answer options of excellent, very good, good, fair, was included from the overall health survey as a covariate for the MH analyses.

Statistical analyses

Differences in baseline characteristics between OSGM and non-OSGM adults were assessed by Fisher's exact, Wilcoxon rank sum, and Pearson's Chi-squared test as appropriate; statistical significance was defined as a 2-sided P-value <.05.

Prior to the mediation analyses, we examined the association between OSGM status and the mediators, and then the mediators to healthcare utilization. To do this, we assessed the association between OSGM status and frailty category (frail, prefrail, robust) using multinomial regression and assessed the association between OSGM status and any delay (binary) using logistic regression. Next, we assessed the association between the mediators: frailty and delays with healthcare utilization using Poisson regression and included an offset of follow-up time. All regression models adjusted for covariates. We report the adjusted odds ratio (aOR) or adjusted rate ratio (aRR) and 95% confidence intervals (CIs).

Finally, marginal structural modelling was used to examine whether frailty or delays mediated the association between OSGM status and healthcare utilization (Figure 2). Marginal structural modeling is a statistical approach to estimate causal effects of the exposure and mediators by modeling the counterfactual outcome—in this study, the counterfactual outcome is what is the association between OSGM status and healthcare utilization if all participants were robust or reported no delays. The model uses inverse probability weighting to adjust for time-invariant and time-varying confounding.[19] Separate models were used for each mediator (frailty or delays) and each utilization outcome (medical and MH visits), resulting in 4 marginal structural models, using Poisson regression with offset. The total effect RR represents the association between OSGM status and healthcare utilization. The controlled direct

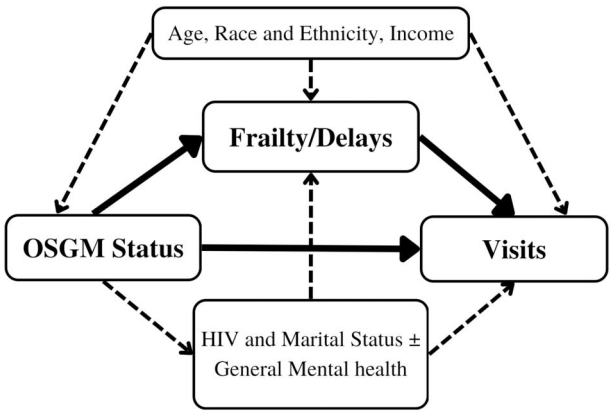

Figure 2. Directed acyclic graph of the marginal structural model with frailty or healthcare delays mediating the association between older sexual and gender minority status and healthcare utilization, adjusting for covariates of age, race and ethnicity, income, HIV, and marital status. Also included general mental health for mental health visit analyses. *Note*: OSGM, older sexual and gender minority.

effect RR represents the same association if all participants were "not frail" or had "no delays." Both estimates were adjusted for covariates and we report aRR and 95% CI from 1000 bootstrap samples using the CMAverse R package.[20] All analyses were conducted in the *All of Us* Researcher Workbench cloud-based platform using R version 4.2.2.[21]

Results

Of the 78 882 participants ≥50 years old with necessary survey data and EHR data, 8449 had insufficient data to calculate the *All of Us* Frailty Index,[3] 32 988 had no prospective EHR visits recorded, and 1463 were missing data for SGM classification. These exclusions resulted in a final analytic sample of 35 992 with 1925 OSGM and 34 067 non-OSGM participants.

Demographic differences

Compared to their non-OSGM peers, OSGM adults were younger (mean age: 63 versus 66), less likely to be women (40% versus 63%), married or living with a partner (50% versus 66%), and more likely to report annual income <50k (36% versus 25%) (Table 1). There was no difference in insurance coverage across groups.

Regarding health status, compared to non-OSGM, OSGM adults were less likely to report "excellent" general MH (24% versus 31%), and more likely to report HIV (12% versus 0.3%) (Table 1). Regarding healthcare utilization, OSGM adults had similar medical visit days in 12 months (mean visit days: 2.6 [standard deviation (sd) 4.3] versus 2.4 [sd 4.1]) and higher MH visit days in 12 months (mean visit days: 0.45 [sd 3.53] versus 0.22 [sd 2.17]) compared to non-OSGM adults (Table 1).

OSGM status, frailty, and healthcare delays

After adjustment, OSGM adults were more likely to be frail (aOR frail versus robust: 1.52, 95% CI [1.34, 1.73]) and prefrail (aOR prefrail versus robust: 1.22, 95% CI [1.09, 1.37]) compared to non-OSGM adults (Table 2). OSGM adults were also more likely report any healthcare delay (aOR delay versus no delay: 1.19, 95% CI [1.07, 1.33]) compared to non-OSGM adults (Table 2).

Table 1. Characteristics of *All of Us* participants by sexual and gender minority status.

Characteristic	Non-OSGM *n* (%)	OSGM *n* (%)	*P*-value[a]
Sample size	34 067	1925	
Sex assigned at birth			<.001[b]
Diverse	–	<20 (<1%)	
Female	21 465 (63%)	831 (43%)	
Male	12 602 (37%)	1077 (56%)	
Skip	–	<20 (<1%)	
Gender			<.001[b]
Diverse	–	86 (4.5%)	
Man	12 602 (37%)	1049 (54%)	
Woman	21 465 (63%)	778 (40%)	
Skip	–	<20 (<1%)	
Sexual orientation			
Bisexual	–	532 (28%)	
Gay or lesbian	–	1315 (68%)	
Skip	–	27 (1.4%)	
Heterosexual	34 067 (100%)	51 (2.6%)	
Age, mean (sd)	66 (8)	63 (8)	<.001[b]
Age category			<.001[b]
50-59	8448 (25%)	722 (38%)	
60-69	13 518 (40%)	742 (39%)	
70-79	10 144 (30%)	411 (21%)	
80+	1957 (5.7%)	50 (2.6%)	
Race and ethnicity			.3
Black	2545 (7.5%)	121 (6.3%)	
Hispanic	1331 (3.9%)	74 (3.8%)	
Asian/NHPI/MENA/ Mixed/Other	1541 (4.5%)	93 (4.8%)	
White	28 195 (83%)	1,607 (83%)	
Skip	455 (1.3%)	30 (1.6%)	
Education			<.001[b]
College graduate	22 152 (65%)	1369 (71%)	
Some college	7955 (23%)	416 (22%)	
High school graduate	2990 (8.8%)	109 (5.7%)	
Less than high school	764 (2.2%)	22 (1.1%)	
Skip	206 (0.6%)	<20 (<1%)	
Income			<.001[b]
>100k	12 427 (36%)	655 (34%)	
50-100k	9403 (28%)	490 (25%)	
<50k	8525 (25%)	687 (36%)	
Skip	3712 (11%)	93 (4.8%)	
Marital status			<.001[b]
Divorced or separated	5776 (17%)	297 (15%)	
Married or living w/partner	22 417 (66%)	969 (50%)	
Never married	2903 (8.5%)	564 (29%)	
Widow	2736 (8.0%)	73 (3.8%)	
Skip	235 (0.7%)	22 (1.1%)	
HIV			<.001[b]
Yes	112 (0.3%)	224 (12%)	
No	33 453 (98%)	1675 (87%)	
Skip	502 (1.5%)	26 (1.4%)	
General mental health			<.001[b]
Excellent	10 645 (31%)	457 (24%)	
Very good	13 523 (40%)	667 (35%)	
Good	7105 (21%)	489 (25%)	
Fair	2310 (6.8%)	245 (13%)	
Poor	345 (1.0%)	58 (3.0%)	
Skip	139 (0.4%)	<20 (<1%)	
Insurance			.5
Yes	33 290 (98%)	1885 (98%)	
No	512 (1.5%)	30 (1.6%)	
Skip	258 (0.8%)	<20 (<1%)	
Healthcare delays	7654 (22%)	567 (30%)	<.001[b]
Skip	576 (2%)	27 (1.4%)	

(continued)

Table 1. (continued)

Characteristic	Non-OSGM *n* (%)	OSGM *n* (%)	*P*-value[a]
Frailty category			<.001[b]
Robust	16 452 (48%)	753 (39%)	
Pre-frail	11 056 (32%)	644 (33%)	
Frail	6559 (19%)	528 (27%)	
Frailty index, mean (sd)	0.17 (0.10)	0.19 (0.11)	<.001[b]
Medical visit days, mean (sd)	2.4 (4.1)	2.6 (4.3)	.2
Mental health visit days, mean (sd)	0.2151 (2.2)	0.4530 (3.5)	<.001[b]

[a] Fisher's exact test; Wilcoxon rank sum test; Pearson's Chi-squared test.
[b] *P* value <.05, which reflect overall differences between groups.
Abbreviations: MENA, Middle Eastern North African; NHPI, Native Hawaiian Pacific Islander; OSGM, older sexual and gender minority; sd, standard deviation.

Table 2. Associations between older sexual and gender minority status, frailty, delays, and healthcare utilization.

Exposure	Outcome	Estimate[a]	95% CI
Multinomial regression (aOR)			
OSGM status[b]	Frail[c]	1.52*	1.34, 1.73
	Prefrail[c]	1.22*	1.09, 1.37
	Delays[d]	1.19*	1.07, 1.33
Poisson regression (aRR)			
Frail[c]	Medical visits	2.30*	2.26, 2.34
Prefrail[c]		1.56*	1.53, 1.59
Frail[c]	Mental health visits	4.62*	4.22, 5.05
Prefrail[c]		3.03*	2.78, 3.30
Delays[d]	Medical visits	1.07*	1.05, 1.09
	Mental health visits	1.21*	1.15, 1.26

[a] Adjusted for age, race and ethnicity, income, HIV status, and marital status, as well as general mental health only for mental health visits.
Reference groups:
[b] non-OSGM.
[c] Robust.
[d] No delays.
* *P* value <.05.
Abbreviations: CI, confidence interval; OR, odds ratio; OSGM, older sexual and gender minority; RR, rate ratio.

Frailty, healthcare delays, and healthcare utilization

In the overall sample, compared to robust, frail (aRR frail versus robust: 2.30, 95% CI [2.26, 2.34]) and prefrail (aRR prefrail versus robust: 1.56, 95% CI [1.53, 1.59]) individuals had higher medical visit days (Table 2). Similarly, for MH visit days, frail (aRR frail versus robust: 4.62, 95% CI [4.22, 5.05]) and prefrail (aRR prefrail versus robust 3.03, 95% CI [2.78, 3.30]) individuals reported higher utilization, compared to robust. In the overall sample, those with delays had higher medical visit days (aRR delay versus no delay: 1.07, 95% CI [1.05, 1.09]) and MH visit days (aRR delay versus no delay: 1.21, 95% CI [1.15, 1.26]) compared to those with no delays (Table 2).

Marginal structural model analyses

Frailty

OSGM adults had higher healthcare utilization in the past 12 months; the adjusted total effect aRR was 1.14 (95% CI: 1.03, 1.24) for medical visit days compared to non-OSGM. Frailty mediated the association between OSGM status and medical visit days as we observed, if all participants were "not frail" the controlled direct aRR was, 1.03 (95% CI: 0.87, 1.22) (Table 3). For MH visit days neither the total effect aRR 1.27 (95% CI: 0.72, 1.99) nor the controlled direct effect aRR 0.37 (95% CI: 0.06, 1.47) were statistically significant.

Delays

OSGM adults had higher MH visit days in the past 12 months; the adjusted total effect aRR was 1.85 (95% CI: 1.07, 2.91) compared to non-OSGM. Delays mediated the association between OSGM status and MH visit days as we observed, if all participants had "no delays" the controlled direct effect aRR was 2.27 (95% CI: 1.15, 3.76) (Table 3). Delays did not mediate the association between OSGM status and medical visit days the total effect aRR was 1.08 (95% CI: 0.99, 1.18) and the controlled direct effect aRR was 1.06 (95% CI: 0.97, 1.17).

Discussion

The aim of this study was to assess frailty and delays as mediators between OSGM status and healthcare utilization. Our results were consistent with our hypotheses. We report that improving frailty reduces the disparity of medical visits between OSGM and non-OSGM adults. In contrast reducing delays increases the disparity of MH visits between OSGM and non-OSGM adults.

This finding suggests that interventions aimed at mitigating frailty may reduce healthcare utilization among OSGM adults. The *All of Us* Frailty Index is a deficit accumulation frailty index that assesses 7 domains of health,[3] however the comprehensive measure makes tailoring interventions difficult. Understanding clinically difference subgroups[22] of OSGM adults and health domains[23] driving frailty would further define potential targets for frailty interventions. Furthermore, considering that OSGM adults have a higher burden of frailty beginning at younger ages,[3] the cumulative healthcare utilization across the lifespan compared to non-OSGM is likely higher than our estimates emphasizing the need assess and monitor frailty at earlier ages among OSGM populations.

Our results also demonstrate that healthcare delays reduce timely access to MH care among OSGM adults. Also, findings were consistent with prior literature demonstrating that sexual minority older adults are twice as likely to report MH care compared to heterosexual older adults.[9] We extend this line of work by demonstrating that accounting for delays results in a 40% increase in the difference of MH visits between OSGM and non-OSGM adults. It follows that healthcare delays disproportionally impact timely access of MH care among OSGM adults; a population with higher MH conditions and needs at baseline.[9,24,25] Therefore, further characterizing healthcare delays specific to OSGM adults represents a vital next step to ensure appropriate MH care.

In general, we saw OSGM adults had higher healthcare utilization, with 12% higher rate of medical visit days and almost twice as many MH visit days compared to non-OSGM adults. Objective healthcare utilization research similar to our study has been limited to transgender and gender diverse people identified using an administrative claims algorithm (TGD-algorithm).[11,26–28] In Medicare beneficiaries ≥65 years, TGD individuals had higher outpatient primary care and MH visits, emergency department visits, and hospitalizations.[11,26,28] The TGD-algorithm has also been applied to EHR data[29] however investigations of healthcare utilization was limited to visits prior to a suicide attempt.[30] Our

Table 3. Older sexual and gender minority status, frailty, and healthcare utilization: mediation analysis with marginal structural model.

		Total effect rate ratio[a]		Controlled direct effect rate ratio[a]	
Mediator	Outcome	Rte	95% CI	Rcde	95% CI
Frailty	Medical visits	1.14	1.03, 1.24[b]	1.03	0.87, 1.22
	Mental health visits	1.27	0.72, 1.99	0.37	0.06, 1.47
Delays	Medical visits	1.08	0.99, 1.18	1.06	0.97, 1.17
	Mental health visits	1.85	1.07, 2.91[b]	2.27	1.15, 3.78[b]

[a] Adjusted for age, race and ethnicity, income, HIV status, and marital status, as well as general mental health only for mental health visits.
[b] *P* value <.05.
Abbreviations: CI, confidence interval; OSGM, older sexual and gender minority; Rte, total effect rate ratio; Rcde, controlled direct effect rate ratio.

study replicates findings in a broader OSGM cohort supporting higher EHR-based healthcare utilization of outpatient medical and MH visit days.

Limitations

There are some key limitations of the *All of Us* Research Program data with respect to this study. The *All of Us* Research Program is a convenience sample, which may introduce sampling bias, however it represents one of the largest samples of OSGM adults available for research. Moreover, the follow up time of our study overlaps with the Coronavirus Disease 2019 Pandemic, a world-wide event that impacted all people and likely resulted in reduced healthcare utilization. As such, this would bias our findings toward the null suggesting that our results may be underestimated, however it should be noted that this is assuming similar impact from the pandemic in both groups. Specific to the EHR data, the provider and care site fields are suppressed which may result in misclassification of visits. In our study, we aimed to capture outpatient primary care visits, however without provider information we were unable to differentiate between primary care and specialty visits which resulted in our outcome of medical visits. Understanding patterns of primary versus specialty care among OSGM populations may inform how best to target healthcare utilization disparities among OSGM adults. Additionally, care site information may provide insight of how to create a welcoming, inclusive, and safe environment for OSGM adults. However, while there are benefits to having provider and care site information this needs to be balanced with protecting participant privacy. Next, in this study we assumed follow up time of 12 months from index date; with EHR data it is difficult to determine lost to follow up which may be represented by no further visits or transition of care to a site that does not contribute EHR data to the *All of Us* Research Program. Further refining methods of EHR observation time would be helpful to reduce assumptions of follow up time. Lastly, there is likely missing EHR data because participants may seek healthcare from various sites, and not all healthcare sites contribute EHR data to the *All of Us* Research Program. This results in incomplete EHR data, especially for participants that may have primary care at a small private practice and specialty care at an academic medical center. This may skew the representation of tertiary care sites compared to smaller healthcare sites as well as specialty versus primary care data. The missing data may result in lower estimates of the actual healthcare utilization and may bias EHR data to those who are "sicker" and require healthcare at tertiary care sites.

Despite these limitations the major strength of our study includes the integration of EHR data with SOGI data from health surveys to assess links between OSGM status, objective healthcare utilization, frailty, and healthcare delays. This study represents an essential advancement in OSGM health research by capitalizing on multiple data sources, including EHR data, within the *All of Us* Research Program.

Conclusion

Here, we provide value to the broader community by using the *All of Us* Research Program to assess health disparities among OSGM populations—an underrepresented group in biomedical research—and by advancing the integration of SOGI information with EHR data. We found that both frailty and healthcare delays mediate the association between OSGM status and specific types of outpatient healthcare utilization. Our findings generate several lines of future investigation. First the need to identify targets to mitigate frailty to reduce the disparity in medical visit days between OSGM and non-OSGM adults. Second, our findings emphasize the impact of healthcare delays on timely MH care access and the critical need for OSGM-specific MH care. Lastly, applying this conceptual framework to emergency department visits and hospitalizations will further our understanding of the causal associations between OSGM status, healthcare utilization, frailty, and healthcare delays.

Author contributions

All authors provided substantial contributions to the conception and design of the work as well as the analysis and interpretation of the data for this work. Chelsea N. Wong created the draft manuscript and all authors provided critical revisions for important intellectual content. All authors provided final approval of the revision to be published. All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Supplementary material

Supplementary material is available at *Journal of the American Medical Informatics Association* online.

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Conflicts of interest

None declared.

Data availability

Data used for this study is available to approved researchers following a 3-step process that includes registration, completion of ethics training, and attestation of a data use agreement through the *All of Us* Research Workbench platform (available at https://workbench.researchallofus.org/).

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Research and Applications