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Considerations for equitable distribution of digital healthcare for people who use drugs

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Abstract

Background Telehealth holds the potential to expand healthcare access for people who use drugs (PWUD). However, limited data exist on their digital infrastructure access, a prerequisite for telehealth participation. We studied digital healthcare accessibility among PWUD.

Methods We employed respondent-driven sampling to recruit 162 PWUD in Athens, Greece to assess current internet and computer access and telemedicine experience via a structured questionnaire. Participants were at least 18 years with an injection drug use (IDU) history. We utilized logistic regression to evaluate sociodemographic associations.

Results Participants' mean (SD) age was 45.9 (8.8) years, 84.0% were male, 90.1% Greek, 77.8% reported IDU within the past year, 85.2% were not linked to opioid treatment, and 50.0% were experiencing homelessness. Only 1.9% had telemedicine experience. Internet and computer access were reported by 66.0% and 31.5%, respectively. Most (77.9%) used mobile phones for internet access. Compared to participants with secure housing, those experiencing homelessness reported decreased internet (50.6% vs. 81.5%, $p<0.001$) and computer access (11.1% vs. 51.9%, $p<0.001$). Multivariable analyses revealed that older age (per 1-year increase: OR = 0.94, 95% CI [0.89, 0.99], $p=0.03$)), IDU within the past year (0.29 [0.10, 0.88], $p=0.03$), and homelessness (0.29, [0.13, 0.65], $p=0.003$) were associated with lower odds of internet access.

Conclusions Two-thirds of PWUD accessed the internet, mainly via mobile phones, while only one-third gained access through a computer. Very few PWUD used telemedicine. Homelessness, recent IDU, and older age may further limit digital infrastructure access and should be considered when designing equitable digital healthcare solutions for PWUD.

Trial registration Registered on ClinicalTrials.gov (ID: NCT05794984, Protocol: STUDY00007088, Date: 2023-04-03)

Keywords Digital healthcare, Telehealth, Telemedicine, People who use drugs, Healthcare access, Health equity

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Background

People who use drugs (PWUD) are an underserved population facing health disparities, including reduced healthcare access and discrimination within conventional medical settings [1]. They frequently report unmet healthcare needs and predominately utilize emergency services when their health conditions deteriorate significantly [2, 3]. Healthcare inequalities for PWUD are largely driven by stigma in medical settings and other barriers, including provider mistrust, economic challenges, chaotic lifestyles, and competing priorities [4–6]. Consequently, PWUD experience excess mortality, up to 16 times higher than the general population [7]. Much of this excess mortality is attributed to preventable causes, such as infectious diseases, including HIV and hepatitis C virus (HCV) infections, which impose substantial burden on PWUD [8]. Limited access to HIV and HCV treatment can greatly increase the risk of complications from these infections [9–11]. Addressing health disparities and expanding access to medical services for PWUD are essential for improving PWUDs' health outcomes [12].

Digital healthcare offers a relatively innovative approach to improving healthcare access by reducing geographical and temporal barriers [13, 14]. However, the digital divide is a critical consideration for the engagement of underserved populations in digital healthcare [15, 16]. The digital divide refers to persisting healthcare disparities in digital healthcare access due largely to the influence of social determinants of health [17]. Thus, PWUD may continue to have poor health outcomes due to reduced access to digital healthcare, mirroring the barriers to accessing healthcare in conventional health systems [18]. While digital healthcare opens avenues for more accessible and inclusive healthcare, ensuring equitable distribution of digital healthcare is crucial when seeking to engage underserved populations.

Telehealth solutions are increasingly being investigated to provide medical and behavioral support for PWUD, particularly in the areas of HIV, HCV, substance use treatment, and mental health [19–23]. Research indicates that telehealth interventions among PWUD have shown considerable effectiveness and high levels of patient satisfaction [24–30]. There is a reasonable expectation that healthcare access for PWUD could be enhanced through telehealth, extending to primary care and chronic condition management, potentially addressing other preventable causes of excess morbidity and mortality. However, limited access to the internet and the requisite digital infrastructure for telehealth contribute to the digital divide for PWUD [31]. Low digital and healthcare literacy are also important considerations for PWUD in accessing digital healthcare services [32]. To date, there is limited research on digital healthcare accessibility among PWUD. Investigating the population's internet and digital infrastructure access and identifying potentially influential factors are essential for tailoring digital healthcare interventions specifically for PWUD.

We aimed to explore digital healthcare accessibility among PWUD and to potentially identify factors contributing to the digital divide. Specifically, we sought to answer what are the current levels of internet and computer access, as well as prior experiences with telemedicine, among PWUD in Athens, Greece. Recent studies highlight PWUD in Greece as a population with rapidly increasing mortality rates, underscoring the urgent need for improved healthcare access [33]. Since universal healthcare systems seek to provide equitable healthcare access to all individuals, especially the underserved, and due to a lack of relevant data, we pursued this investigation in Greece [34, 35]. These findings intend to inform policy and guide the development of strategies to ensure equitable digital healthcare distribution for PWUD and other underserved populations.

Methods

Between June and July 2023, we conducted a cross-sectional study to assess digital healthcare accessibility, including internet and digital infrastructure access, as well as experience with telemedicine among PWUD in Athens, Greece. The study protocol was approved by the Institutional Review Boards of the Hellenic Scientific Society for the Study of AIDS, Sexually Transmitted and Emerging Diseases and the University at Buffalo. The study adhered to the Helsinki Declaration principles. We received and archived written informed consent from all study participants prior to their participation. We assessed, using an eligibility screener, whether participants met the inclusion criteria of being at least 18 years old, having a history of injection drug use (IDU), Greek verbal fluency, and the ability to provide informed consent. We defined PWUD as participants who had ever engaged in IDU. No participants were excluded due to a lack of Greek verbal fluency.

Questionnaire development

Three experienced interviewers (Z.P., E.D., V.T.) administered a structured questionnaire that included sections on sociodemographic characteristics, drug use history, utilization of conventional medical care, internet and digital infrastructure access, as well as experience with telemedicine. The questionnaire employed in this study was specifically developed for this investigation, with select elements adapted from existing instruments and tailored to ensure relevance for the study population. The questionnaire has not been published elsewhere, and the full English version can be found in Additional file 1. We based the sections on sociodemographic characteristics

and history of drug use on an instrument used in a large study among PWUD in Greece [36]. The instrument was based on the National HIV Behavioral Surveillance System for PWUD, implemented throughout the United States, and modified for relevance to Greek PWUD. We adapted the remaining questionnaire sections and questions from publications of the European Patients' Forum and the Eurostat Model questionnaires as well as from those used in prior studies [37–39]. Before deploying the questionnaire, we performed cognitive testing by administering the questionnaire to five study-eligible individuals. Based upon the testing results, we slightly modified the questionnaire to ensure clarity and comprehension for the study population.

Recruitment of participants

We recruited participants through respondent-driven sampling (RDS), a chain referral methodology used to reach "hidden" or difficult-to-reach populations, in which research participation involves illegal or stigmatized behaviors [40]. In RDS, respondents recruit their peers. Its implementation begins with a limited number of initial recruits or "seeds" [41]. Each seed receives three coupons and is asked to recruit three additional PWUD. If the recruits are study-eligible and agree to participate, they subsequently can become recruiters, with the process continuing until the desired sample size is achieved [42]. To select initial seeds, the research team collaborated with colleagues from community organizations, including the "Prometheus" Hellenic Liver Patient Association, the "My Athens" shelter for PWUD experiencing homelessness, the "Positive Voice" association of people living with HIV, and the "Network of Peer Users of Psychoactive Substances". These organizations shared study information within their networks, facilitating a warm hand-off process through which potential participants connected with the research project manager (Z.P.). Subsequently, the research team provided detailed information about the study. Individuals who expressed interest and met the eligibility criteria were enrolled as seeds. Recruits received a primary incentive of 10 euro for study participation followed by secondary incentives of up to 15 euro for subsequent recruitment activities.

Questionnaire administration

The interviews were conducted on the premises of the Hellenic Liver Patients Association "Prometheus" in downtown Athens, in a quiet and private setting, with only the interviewers and participants present. The questionnaire administration had a maximum duration of 60 min, and the mean time to complete the questionnaire was 23.7 min (SD = 9.2). During the interview, participants sat in front of a computer displaying the questions, allowing them to read independently, while interviewers sat beside them, reading the questions out loud and offering clarification or assistance with comprehension as needed. The interviewers directly entered participants' responses into a password-encrypted, secure computer database. All responses provided were participants' self-reports. Interviewers determined participants' housing status by asking them if they were currently living on the street, in abandoned buildings, or in shelters. Participants who responded affirmatively were grouped as participants who were currently experiencing homelessness.

Study outcomes

The main study outcomes included digital infrastructure access, defined as current internet and computer access, as well as experience with telemedicine. We assessed the main study outcomes based on participants' self-reported responses on the corresponding sections of the questionnaire. Secondary study outcomes included exploration of PWUDs' perceptions about telemedicine, including perceived benefits, limitations, and willingness to engage in a telemedicine encounter.

Statistical methods

We initially described participants' characteristics and questionnaire responses using mean values and standard deviation (SD) or counts and percentages, as appropriate. We obtained crude and RDS-weighted (RDS-II) estimates of the main outcomes along with the corresponding 95% confidence intervals (CIs) [43]. For the 95% CIs of the weighted estimates, we used bootstrap with 1,000 replications [44]. Since 50% of our sample was experiencing homelessness, we assessed recruitment homophily for PWUD experiencing homelessness, i.e., whether seeds more frequently recruited peers experiencing homelessness. Homophily values ranged from −1 to +1 (where +1 corresponds to always recruiting from one's own group [people experiencing homelessness]) and 0 corresponds to random recruitment. We compared the responses of participants experiencing homelessness versus those with secure housing using t-tests and chi-squared tests, as appropriate. In addition, we performed univariable and multivariable analyses on the factors associated with the main study outcomes of current internet and computer access, using logistic regression, to identify factors associated with digital access. Statistical calculations were performed using Stata (Stata Corp LLC. 2023. Stata Statistical Software: Release 18. College Station, TX), and $p < 0.05$ was considered the cutoff for statistical significance.

Results

Sociodemographic characteristics and injection drug use

In total, 162 PWUD participated in the study (of these, 7 were RDS seeds and 155 recruits) (Table 1). One seed

Table 1 Sociodemographic characteristics, injecting drug use history, and participation in substance use treatment programs among people who use drugs (*N* = 162) recruited in Athens, Greece, according to housing status

Characteristic	Total (*N* = 162)	According to housing status		*p*
		Not experiencing homelessness (*N* = 81)	Experiencing homelessness (*N* = 81)	
A. Socio-demographic characteristics				
Age (years), mean (SD)	45.9 (8.8)	45.6 (8.1)	46.2 (9.6)	0.65
Sex, n (%)				0.20
Men	136 (84.0)	65 (80.3)	71 (87.7)	
Women	25 (15.4)	16 (19.8)	9 (11.1)	
Transgender	1 (0.6)	0 (0.0)	1 (1.2)	
Reside in Athens, Greece n (%)	157 (96.9)	77 (95.1)	80 (98.8)	0.08
Ethnicity, n (%)				0.23
Greek	146 (90.1)	76 (93.8)	70 (86.4)	
Other	15 (9.3)	5 (6.2)	10 (12.3)	
Refused to answer/ don't know	1 (0.6)	0 (0.0)	1 (1.2)	
Employment status, n (%)				0.16
Employed/Student/Retired	17 (10.5)	12 (14.8)	5 (6.2)	
Unemployed/Unable to work	142 (87.7)	67 (82.7)	75 (92.6)	
Other	3 (1.9)	2 (2.5)	1 (1.2)	
Monthly household income[a], n (%)				< 0.001
Up to 350€	116 (71.6)	45 (55.6)	71 (87.7)	
351–700€	19 (11.7)	17 (21.0)	2 (2.5)	
More than 701€	24 (14.8)	18 (22.2)	6 (7.4)	
Refused to answer/ don't know	3 (1.9)	1 (1.2)	2 (2.5)	
Marital status, n (%)				0.01
Single	88 (54.3)	38 (46.9)	50 (61.7)	
Partnered /Married	33 (20.4)	24 (29.6)	9 (11.1)	
Divorced/Separated/Widowed	41 (25.3)	19 (23.5)	22 (27.2)	
Highest education level, n (%)				0.45
Graduated primary school	38 (23.5)	17 (21.0)	21 (25.9)	
Graduated high school	82 (50.6)	40 (49.4)	42 (51.9)	
Graduated college/university/Master/PhD	41 (25.3)	24 (29.6)	17 (21.0)	
Refused to answer/ don't know	1 (0.6)	0 (0.0)	1 (1.2)	
B. IDU history				
IDU in the past 12 months, n (%)	126 (77.8)	64 (79.0)	62 (76.5)	0.71
Frequency of IDU in the past 12 months, n (%)				0.87
At least daily	95 (58.6)	48 (59.3)	47 (58.0)	
Less than daily	67 (41.4)	33 (40.7)	34 (42.0)	
At least daily IDU in past 12 months of the following, n (%)				
Heroine/Thai	123 (75.9)	63 (77.8)	60 (74.1)	0.95
Cocaine	59 (36.4)	13 (16.0)	11 (13.6)	0.42
Buprenorphine	18 (11.1)	8 (9.9)	10 (12.3)	0.60
Hallucinogens (i.e., LSD)	2 (1.2)	2 (2.5)	0 (0)	0.01
Sisa/Methamphetamine	19 (11.7)	8 (9.9)	11 (13.6)	0.45
Speedball	53 (32.7)	28 (34.6)	25 (30.9)	0.87
Sharing syringes in the past 12 months, n (%)				0.28
No	137 (84.6)	71 (87.7)	66 (81.5)	
Yes	25 (15.4)	10 (12.4)	15 (18.5)	
C. Participation in substance use treatment programs				
Ever participated in a substance use treatment program, n (%)	140 (86.4)	71 (87.7)	69 (85.2)	0.65
Ever participated in an OTP, n (%)	98 (60.5)	50 (61.7)	48 (59.3)	0.75
Currently participating in an OTP, n (%)	24 (14.8)	12 (14.8)	12 (14.8)	0.91

Abbreviations: *SD* standard deviation, *IDU* injection drug use, *LSD* Lysergic acid diethylamide, *OTP* opioid treatment program

[a]For participants currently experiencing homelessness, household income was measured as if they lived alone

did not recruit any participants; out of the six remaining seeds, 3 (50.0%) were currently experiencing homelessness. PWUD currently experiencing homelessness tended to recruit other peers experiencing homelessness (homophily equal to 0.38).

The mean (SD) age of participants was 45.9 (8.8) years, 84.0% (136/162) were male and 90.1% (146/162) were of Greek origin. In the past 12 months, 77.8% (126/162) reported IDU, and 50.0% (81/162) identified as currently experiencing homelessness. Approximately 58.6% (95/162) of participants had engaged in IDU at least daily in the past 12 months including injecting heroin (75.9%, 123/162), cocaine (36.4%, 59/162), and speedball (32.7%, 53/162). Additionally, 86.4% (140/162) of participants had previously attended a substance use treatment program and 60.5% (98/162) had participated in an opioid treatment program (OTP). However, only 14.8% (24/162) currently attended an OTP.

Conventional medical care

PWUD most frequently obtained healthcare at public hospitals (86.4%, 140/162) (Table 2). Only 54.3% (88/162) of participants indicated that they were currently under medical care. Approximately one-third (28.4%, 46/162) of participants disclosed difficulty in accessing healthcare within the past year. 43% (70/162) of participants reported geographical barriers that required travel to another city, region, or country for healthcare. Furthermore, 56.8% (92/162) disclosed prior negative interactions with healthcare staff largely (88.0%, 81/92) attributed to previous substance use and associated stigma. Undesirable interactions included negative healthcare staff attitudes (88.0%, 81/92), refusal to administer treatment (39.1%, 36/92), and use of inappropriate language (38.0%, 35/92).

Digital infrastructure access

The majority (89.5%, 145/162) of study participants had previously accessed the internet, primarily through

Table 2 Access to conventional medical care and healthcare barriers among people who use drugs ($N=162$) recruited in Athens, Greece, according to housing status

Characteristic	Total ($N=162$)	According to housing status		*p*
		Not experiencing homelessness ($N=81$)	Experiencing homelessness ($N=81$)	
A. Conventional medical care access				
Participants currently under care for their healthcare conditions, n (%)	88 (54.3)	43 (53.1)	45 (55.6)	0.75
Participants who had visited a healthcare provider within the past 3 months, n (%)	85 (52.5)	37 (45.7)	48 (59.3)	0.08
Participant rating of level of difficulty in obtaining healthcare services within the past 12 months, n (%)				0.04
Easy or very easy	79 (48.8)	39 (48.2)	40 (49.4)	
Moderate	25 (15.4)	16 (19.8)	9 (11.1)	
Difficult or very difficult	46 (28.4)	17 (21.0)	29 (35.8)	
I did not seek healthcare services within the past 12 months	12 (7.4)	9 (11.1)	3 (3.7)	
Where participants last accessed a healthcare provider, n (%)				0.02
At a public hospital	140 (86.4)	64 (79.0)	76 (93.8)	
At private medical practice	12 (7.4)	11 (13.6)	1 (1.2)	
At a health center	5 (3.1)	3 (3.7)	2 (2.5)	
Other	5 (3.1)	3 (3.7)	2 (2.5)	
B. Healthcare barriers				
Participants who reported geographical obstacles[a], n (%)	70 (43.2)	37 (45.7)	33 (40.5)	0.53
Participants who reported a negative experience when accessing healthcare, n (%)	92 (56.8)	41 (50.6)	51 (63.0)	0.11
Participants attributed the negative experience to, n (%)				
Drug use history[b]	81 (88.0)	36 (87.8)	45 (88.2)	0.95
Income/social status[b]	20 (21.7)	6 (14.6)	14 (27.4)	0.14
Participants reported the following types of negative experiences, n (%)				
Attitude of healthcare staff[b]	81 (88.0)	37 (90.2)	44 (86.3)	0.56
Refusal to provide me with treatment[b]	36 (39.1)	13 (31.7)	23 (45.1)	0.19
Inappropriate language[b]	35 (38.0)	22 (53.7)	13 (25.5)	0.006
Denial of my rights[b]	16 (17.4)	6 (14.6)	10 (19.6)	0.53

[a]Defined as the need to travel to another region, city, or country for healthcare

[b]Calculated as the proportion of participants ($N=92$) who reported negative experiences when accessing healthcare

mobile phones (77.9%, 113/145) or through computers (20.0%, 29/145) (Table 3). Participants most frequently used broadband as opposed to narrowband connections. Among participants who previously accessed the internet, most reported use within the past 3 months (77.2%, 112/145) with the majority reporting daily use (67.9%, 76/145).

Among all participants, approximately two-thirds (66.0%, 107/162, 95% CI [58.2–73.3]) reported current internet access (RDS-weighted prevalence: 68.7%, 95% CI [53.7–81.3]). Compared to participants with secure housing, we observed significantly lower current internet access among those currently experiencing homelessness (81.5%, 66/81 vs. 50.6%, 41/81, $p<0.001$). In multivariable analysis, we observed that current homelessness (0.29, 95% CI: [0.13, 0.65], $p=0.003$), increasing age (per 1-year increase: 0.94, 95% CI: [0.89, 0.99], $p=0.03$) and IDU within the past 12 months (0.29, 95% CI: [0.10, 0.88], $p=0.03$) were associated with decreased odds of current internet access (Table 4).

Overall, 31.5% (51/162) of participants reported current computer access. Compared to participants with secure housing, we observed significantly lower current computer access among those experiencing homelessness (51.9%, 42/81 vs. 11.1%, 9/81, $p<0.001$). In multivariate analysis, we observed that current homelessness (0.17 [0.07, 0.41], $p<0.001$) was associated with decreased odds of current computer access (Table 4). Overall, the majority of participants (77.9%, 113/162) had used mobile phones to access the internet, with no statistically significant differences between those experiencing homelessness and those with secure housing (78.6%, 55/81 vs. 77.3%, 58/81, $p=0.608$). Multivariable analyses revealed that older age (per 1-year increase: OR = 0.91, 95% CI [0.87, 0.96], $p=0.001$)) and IDU within the past year (0.29 [0.10, 0.84], $p=0.023$) were associated with lower odds of internet access through mobile phones.

Experience with telemedicine

Very few participants had ever used (1.9%, 3/162), and less than half (46.3%, 75/162) had familiarity with telemedicine (see Additional file 2). Initially, most (71.0%, 115/162) participants indicated their preference to participate in telemedicine encounters in their homes. When provided the choice of participating in a telemedicine encounter in an OTP, most (136/162, 84.0%) participants endorsed receiving care through telemedicine in that setting.

Participants perceived telemedicine to be of high value due to its time-saving nature by eliminating the need to travel to an appointment (87.0%, 141/162), the convenience of being able to participate from anywhere (84.6%, 137/162), reduced provider wait times (84.0%, 136/162), and reduced infection exposure risk by avoiding

Table 3 Digital infrastructure access among people who use drugs ($N=162$) recruited in Athens, Greece, according to housing status

Characteristic	Total ($N=162$)	According to housing status		p
		Not experiencing homelessness ($N=81$)	Experiencing homelessness ($N=81$)	
Participants who had ever accessed the internet, n (%)	145 (89.5)	75 (92.6)	70 (86.4)	0.20
Participants' most frequently used device to access the internet[a], n (%)				0.63
Mobile phone	113 (77.9)	58 (77.3)	55 (78.6)	
Computer	29 (20.0)	15 (20.0)	14 (20.0)	
Participants' use of the following types of internet connections[a], n (%)				
Broadband connections e.g., ADSL, VDSL, public Wi-Fi connections, mobile phone	82 (56.5)	56 (74.6)	26 (37.1)	< 0.001
Narrowband connection e.g., via mobile phone network less than 3G	55 (37.9)	34 (45.3)	21 (30.0)	0.03
Participants last used the internet[a], n (%)				0.03
Within the last 3 months	112 (77.2)	64 (85.3)	48 (68.6)	
Between 3 months and one year ago	18 (12.4)	4 (5.3)	14 (20.0)	
More than 1 year ago	14 (9.6)	6 (8.0)	8 (11.4)	
Participants average use of the internet within the last 3 months[b], n (%)				0.66
Every day or almost every day	76 (67.9)	45 (70.3)	31 (64.6)	
At least once a week (but not every day)	26 (23.2)	14 (21.9)	12 (25.0)	
Less than once a week	9 (8.0)	4 (6.2)	5 (10.4)	
Participants who have current internet access, n (%)	107 (66.0)	66 (81.5)	41 (50.6)	< 0.001
Participants who have current computer access, n (%)	51 (31.5)	42 (51.9)	9 (11.1)	< 0.001

Abbreviations: *ADSL* asymmetric digital subscriber line, *VDSL* very high-speed digital subscriber line, *3G* third generation mobile telephone

[a]Calculated as the proportion of participants ($N=145$) who reported ever accessing the internet

[b]Calculated as the proportion of participants ($N=112$) who reported last use of the internet within the past 3 months

Table 4 Logistic regression results to identify factors associated with current internet, computer, and mobile access among people who use drugs ($N=162$) recruited in Athens, Greece

	Odds Ratio	95% CI	*p*
A. Current internet access			
Age	0.94	[0.89, 0.99]	0.03
In the past 12 months, did you use intravenous drugs other than those prescribed to you for medical reasons?			
No	1.00		
Yes	0.29	[0.10, 0.88]	0.03
Are you currently experiencing homelessness?[a]			
No	1.00		
Yes	0.29	[0.13, 0.65]	0.003
How many years have you attended school?	1.13	[0.96, 1.33]	0.15
What is your ethnicity?			
Greek	1.00		
Non Greek	1.23	[0.31, 4.81]	0.77
What best describes your employment status?			
Employed/Student/Retired	1.00		
Unemployed/Unable to work	0.63	[0.17, 2.33]	0.49
Marital status			
Single	1.00		
Relationship/Married	1.38	[0.50, 3.86]	0.54
Divorced/Separated/Widowed	1.59	[0.60, 4.21]	0.35
B. Current computer access			
Age	0.94	[0.88, 1.00]	0.05
In the past 12 months, did you use intravenous drugs other than those prescribed to you for medical reasons?			
No	1.00		
Yes	1.90	[0.60, 6.07]	0.28
Are you currently experiencing homelessness?[a]			
No	1.00		
Yes	0.17	[0.07, 0.41]	< 0.001
How many years have you attended school?	1.10	[0.90, 1.35]	0.36
What is your ethnicity?			
Greek	1.00		
Non Greek	0.42	[0.08, 2.28]	0.32
What best describes your employment status?			
Employed/Student/Retired	1.00		
Unemployed/Unable to work	0.25	[0.07, 0.98]	0.05
Marital status			
Single	1.00		
Relationship/Married	1.79	[0.68, 4.76]	0.24
Divorced/Separated/Widowed	0.77	[0.25, 2.33]	0.64
C. Mobile phone usage for internet access			
Age	0.91	[0.87, 0.96]	0.001
In the past 12 months, did you use intravenous drugs other than those prescribed to you for medical reasons?			
No	1.00		
Yes	0.29	[0.10, 0.84]	0.023
Are you currently experiencing homelessness?[a]			
No	1.00		
Yes	0.74	[0.34, 1.63]	0.452
How many years have you attended school?	0.97	[0.82, 1.14]	0.682
What is your ethnicity?			
Greek	1.00		
Non Greek	1.11	[0.28, 4.39]	0.886
What best describes your employment status?			
Employed/Student/Retired	1.00		

Table 4 (continued)

	Odds Ratio	95% CI	*p*
Unemployed/Unable to work	0.78	[0.20, 3.00]	0.720
Marital status			
Single	1.00		
Relationship/Married	0.98	[0.39, 2.48]	0.962
Divorced/Separated/Widowed	2.91	[1.05, 8.06]	0.040

Abbreviations: *CI* Confidence internal

[a]Currently experiencing homelessness defined as currently living on the street, in abandoned buildings, or in shelters

in-person visits (79.0%, 128/162) (see Additional files 3 and 4). Most participants (76.5%, 124/162) perceived the inability to perform a physical examination as telemedicine's leading limitation. Other perceived limitations of telemedicine included the lack of direct personal contact (69.8%, 113/162), the need to use digital infrastructure for telemedicine participation (64.2%, 104/162), and potential technical issues (61.1%, 99/162). Difficulty trusting the doctor (39.5%, 64/162) and substandard patient-doctor relationships (35.8%, 58/162) were the least frequently perceived telemedicine limitations (see Additional files 5 and 6).

Discussion

We pursued this investigation to evaluate digital healthcare accessibility among PWUD in Athens, Greece. We found that the vast majority of study participants lacked experience with telemedicine, consistent with results obtained from most European countries [45]. When we investigated digital infrastructure accessibility, we found that two-thirds of participants reported currently connecting to the internet, while one-third reported current computer access. In multivariate analysis, we identified that current homelessness, older age, and IDU within the past 12 months were associated with significantly reduced internet and/or computer access among PWUD. These findings highlight important considerations for the expansion of digital health among underserved populations. Figure 1 describes several considerations for utilizing digital approaches to distribute healthcare equitably to underserved populations.

One third of participants reported difficulty accessing healthcare within the past year and only approximately half indicated that they were under medical care at the time of the questionnaire administration. Geographic barriers and stigma were frequently cited as obstacles to healthcare access in conventional healthcare venues, consistent with prior studies [46–48]. When asked about their perceptions of telemedicine compared to conventional healthcare, most participants (54.9%, 89/162) considered healthcare in conventional settings as superior, while approximately 20% perceived no differences between the two modalities. Interestingly, despite limited prior experience with telemedicine, around 18% considered telemedicine to be superior to conventional care. This preference may stem from the barriers PWUD disclosed in accessing healthcare, such as transportation challenges and stigma, leading to distrust in the current system and a search for alternative healthcare modalities. However, the findings related to telemedicine should be interpreted with caution, as participants generally lacked formal experience with telemedicine. When asked about the potential benefits and drawbacks of telemedicine, participants were more concerned with digital infrastructural challenges rather than with the expression of empathy through telemedicine. These perceptions align with findings from both a staff-facilitated telemedicine model for HCV care integrated into OTPs and a peer-facilitated telehealth model for HIV care conducted in syringe services programs. In both interventions, participants highly valued empathy, trust, and telehealth's destigmatizing approach [27, 49].

Considering that stigma is a significant barrier to healthcare access for PWUD, engendering trust and empathy are key for effective healthcare delivery, including through digital approaches [5, 27, 50]. With a separate group of PWUD in Athens Greece, we conducted focus groups for an indepth understanding of barriers and facilitators of their digital health use. Focus group participants suggested that an initial in-person appointment, eye contact during telehealth encounters, partnerships with PWUD-supportive community organizations, and patient education could enhance trust in telehealth [51]. Our current investigation also identified the need to enhance patient education on telehealth and digital literacy, as direct telemedicine experience was nearly nonexistent (1.9%).

Internet access and digital infrastructure are absolute requirements for digital health participation, yet limited data exist on digital infrastructure access among PWUD. A previous survey of 204 PWUD in Greece revealed that over 90.0% had internet access [52]. Participants in that study were recruited from substance use treatment programs, which may not represent the real-world experiences of PWUD outside those supportive environments. In contrast, only 14.8% (24/162) of participants in our study were enrolled in an OTP. Since IDU is a potential transmission route for HCV and HIV, tailored telehealth

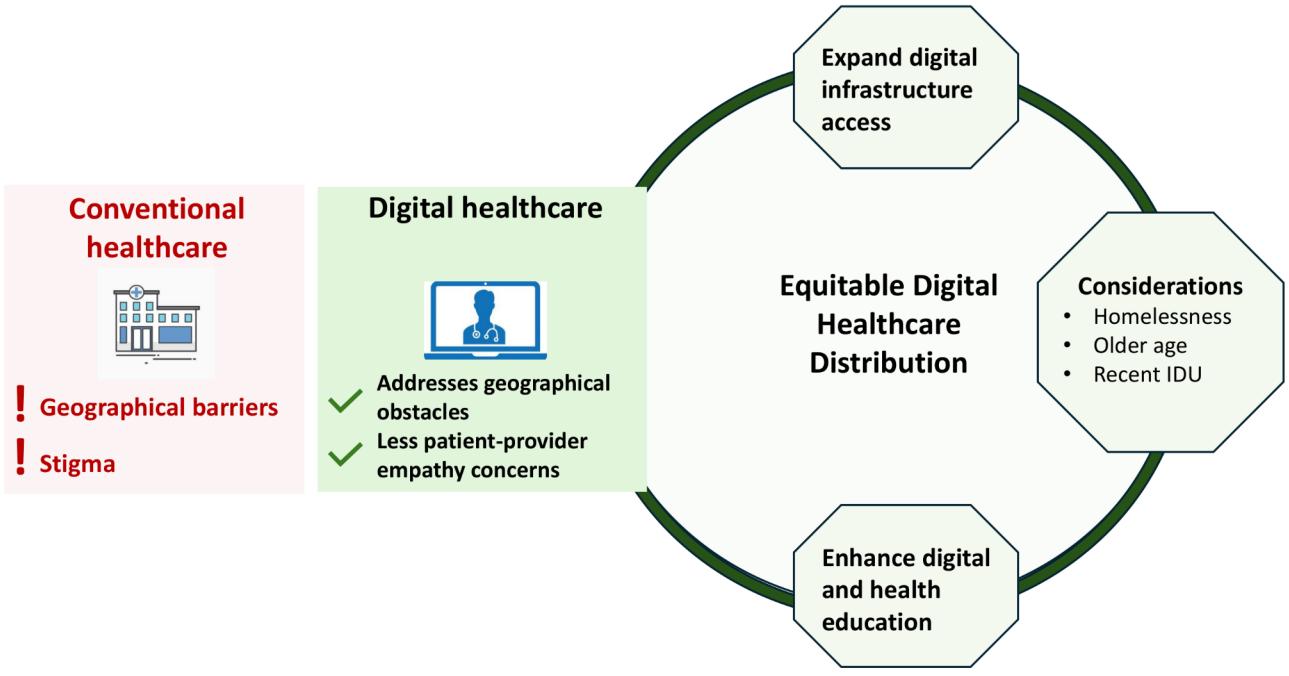

Fig. 1 Promotion of equitable digital healthcare distribution. Legend: People who use drugs (PWUD) are a medically underserved population who reported encountering geographical obstacles and stigma in accessing healthcare in conventional settings. Digital healthcare simultaneously overcomes geographical obstacles accompanied by a few empathy concerns. Therefore, the equitable distribution of digital healthcare services to PWUD is critical to avoid worsening future healthcare access. In our investigation, we found that homelessness, increasing age, and injection drug use within the past 12 months were associated with reduced internet and digital infrastructure access. We also identified gaps in digital literacy. To promote equitable distribution of digital healthcare, thereby ensuring health equity, requires expansion of internet and digital infrastructure access for underserved populations and addressing digital literacy gaps. Abbreviations: IDU, injection drug use.

interventions should be directed toward PWUD [53]. Our study sample, of whom the majority (77.8%, 126/162) disclosed IDU within the past 12 months, is representative of the PWUD population that should be prioritized in subsequent telehealth interventions.

Our study participants indicated that they predominately used mobile phones (77.9%) to access the internet. Our findings align with a previous study in which over 75% of participants used mobile phones to access the internet [54]. In that study, most PWUD participants received mobile phones through a government-supported program for low-income individuals, highlighting the government's central role in facilitating digital healthcare access for underserved populations. However, the frequent turnover of mobile devices due to theft or resale among PWUD is an important consideration when evaluating their suitability for digital healthcare access [54]. This concern was further highlighted in our previous investigation, where we conducted focus groups with PWUD in Athens, Greece [51]. In that study, participants often sold their phones, making mobile-based internet access unreliable, whereas computers were generally retained and safeguarded. While mobile internet access among PWUD may not be a reliable modality for establishing a sustainable telehealth program, our present study indicates that computer access is also limited, with only one-third of participants reporting access. Additionally, other sociodemographic factors, such as older age, IDU, and unemployment, may further impact PWUDs' ability to utilize digital healthcare resources [30, 55, 56].

A potential solution to bridging the digital divide for healthcare delivery to underserved populations is the expansion of the facilitated telemedicine model. This approach integrates digital healthcare services into settings already familiar and accessible to PWUD, such as OTPs, where digital infrastructure is embedded within the program and telemedicine participation is supported by case managers [25, 27]. While most study participants (84%) expressed a willingness to receive telemedicine care in an OTP, only 14.8% were currently enrolled in such programs. The potential interest in telemedicine may be partially attributed to prior positive experiences with OTPs, as approximately 60% of study participants had previously participated in such programs. Additionally, the reported barriers to accessing conventional

healthcare may explain, at least in part, the high willingness to receive telemedicine care in the OTP.

Our study sample included a substantial proportion currently experiencing homelessness (50.0%), a difficult population to enroll in research [57]. The homeless percentage was higher than in other studies among a similar Athenian population, where rates of homelessness ranged from 23.1 to 25.6% [36, 57]. The inclusion of PWUD experiencing homelessness as seeds (i.e., three of six actively recruiting study seeds), the moderate homophily among participants experiencing homelessness and the small sample size account for the over-representation of this population subgroup. Nonetheless, the recruitment of many participants experiencing homelessness enabled us to investigate their digital healthcare accessibility and insights into telemedicine for the first time. As expected, we found that homelessness is associated with reduced access to both conventional and digital healthcare.

Of the study limitations, potential selection bias may arise from recruiting PWUD from downtown Athens using RDS. As such, our sample may not be fully representative of PWUD populations in other geographical areas. Our study population was predominantly male and exclusively Greek speaking. Male predominance is commonly observed among the PWUD population and has similarly been reported in other studies involving PWUD in Greece [36, 58]. As a result, the generalizability of our findings may be limited to other groups, such as women, migrants, and non-Greek-speaking individuals. These populations often face additional challenges, such as childcare responsibilities, that limit healthcare visits, financial and insurance restrictions, concerns related to immigration status, and cultural and language barriers [59]. Additionally, the limited telehealth experience among participants (only 1.9%) presents a significant limitation in interpreting their perceptions of telehealth, which should be considered with caution. Participants' responses, including the prevalence of HCV and HIV, were self-reported, introducing potential ascertainment bias [60]. Furthermore, individuals experiencing homelessness are more susceptible to acquiring HIV and HCV, which may have resulted in the high self-reported prevalences observed in our study population [61]. The ethical implications of using incentives in the RDS framework have been debated. While some argue that incentives may impose undue influence, existing research does not support this claim [62]. Incentives play a key role in encouraging participation and facilitating peer recruitment, which is fundamental to RDS, as it relies on social networks for referral-based enrollment. Studies indicate that incentives are particularly effective in engaging hard-to-reach populations, where leveraging social connections is essential for recruitment [63]. Furthermore, while the questionnaire was adapted from well-established sources, it was not formally validated. Lastly, our sample size was determined by practical constraints of recruiting this hard-to-reach population while balancing the need for adequate statistical power. Thus, the sample size was calculated using as a primary endpoint the estimation of the proportion of PWUD willing to use telemedicine with a desired precision. The impact of participants' characteristics on the outcomes studied may vary depending on their housing status. However, the sample size of the study did not allow us to study this more thoroughly. For our multivariable logistic regression analyses, we limited the number of predictors to ensure a minimum of 10 events per variable. Consequently, for small effect sizes, our study may have been underpowered. Our findings regarding factors associated with the outcomes studied should be considered exploratory and warrant confirmation in larger studies.

Conclusions

Experience with telemedicine is nearly absent among PWUD in Athens, Greece. Although two-thirds reported having internet access, sociodemographic factors such as homelessness, older age, and recent IDU were associated with a lower odds of internet access, contributing to the digital divide. Mobile phones were the primary means of internet access; however, prior studies highlighting their frequent sale or theft raise concerns about their reliability for telehealth interventions. Additionally, fewer than one-third of participants had access to a computer. These findings suggest that a patient-level telemedicine model, in which the individual operates the telemedicine equipment themselves, may not be a sustainable or equitable long-term solution for PWUD. Equitable telehealth strategies for PWUD in Greece may require partnerships with community organizations, and further research is needed to explore effective digital healthcare implementation.

Abbreviations

PWUD	People who use drugs
IDU	Intravenous drug use
HCV	Hepatitis C virus
RDS	Respondent-driven sampling
CI	Confidence interval
SD	Standard deviation
OTP	Opioid treatment program

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-12619-7.

Additional file 1. Questionnaire, full English version.

Additional file 2. Telemedicine experience and perceptions among people who use drugs (***N*** = 162) recruited in Athens, Greece, according to housing status.pdf.

Additional file 3. Potential benefits of telemedicine, as identified by people who use drugs (***N*** = 162) recruited in Athens, Greece, and according to housing status. Participants were allowed to choose more than one response.pdf.

Additional file 4. Rating on a scale from 1-5 (where 1 = minimum and 5 = maximum) of every potential benefit of telemedicine chosen in the previous question, according to the importance to them, among people who use drugs (***N*** = 162) recruited in Athens, Greece, and according to housing status.

Additional file 5. Potential limitations of telemedicine, as identified by people who use drugs (***N*** = 162) recruited in Athens, Greece, and according to housing status. Participants were allowed to choose more than one response.

Additional file 6. Rating on a scale from 1-5 (where 1 = minimum and 5 = maximum) of every potential limitation of telemedicine chosen in the previous question, according to the importance to them, among people who use drugs (***N*** = 162) recruited in Athens, Greece, and according to housing status.

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Authors' contributions
Z.P.: writing – original draft, project administration (lead); investigation (lead); supervision (lead); visualization (lead). S.R.: formal analysis (equal); software (lead); writing – review and editing (equal). E.D.: resources (equal); writing – review and editing (supporting). V.T.: resources (equal); writing – review and editing (supporting). G.K.: resources (equal); writing – review and editing (supporting). A.D.: writing – review and editing (supporting). V.S.: formal analysis (equal); software (supporting); writing – review and editing (supporting). A.H.: investigation (lead); methodology (lead); supervision (lead); visualization (lead); writing – review and editing (supporting). A.H.T.: investigation (lead); methodology (lead); supervision (lead); visualization (lead); funding acquisition; writing – review and editing (equal). All authors approved the final version of the manuscript.

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Data availability
Data is provided within the manuscript and supplementary files.

Declarations

Ethics approval and consent to participate
The study protocol was approved by the Institutional Review Boards of the Hellenic Scientific Society for the Study of AIDS, Sexually Transmitted and Emerging Diseases and the University at Buffalo. The study adhered to the Helsinki Declaration principles. We obtained written informed consent from all study eligible participants prior to their participation.

Consent for publication
Not applicable.

Competing interests
A.H.T. received grants from Merck, Gilead, and Abbott Laboratories and has served as an advisor at Gilead, Novo Nordisk, and AbbVie. VS has received grants from Gilead and AbbVie paid to affiliated institutions, and she has served as a lecturer for Gilead and AbbVie. The remaining authors declare that they have no competing interests.

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References

1. Austin EJ, Tsui JI, Barry MP, Tung E, Glick SN, Ninburg M, et al. Health care-seeking experiences for people who inject drugs with hepatitis C: qualitative explorations of stigma. J Subst Abuse Treat. 2022;137:108684.
2. Lewer D, Freer J, King E, Larney S, Degenhardt L, Tweed EJ, et al. Frequency of health-care utilization by adults who use illicit drugs: a systematic review and meta-analysis. Addiction. 2020;115(6):1011–23.
3. Dasgupta S, Tie Y, Lemons-Lyn A, Broz D, Buchacz K, Shouse RL. HIV-positive persons who inject drugs experience poor health outcomes and unmet needs for care services. AIDS Care. 2021;33(9):1146–54.
4. Lewis R, Baugher AR, Finlayson T, Wejnert C, Sionean C, National HIV Behavioral Surveillance (NHBS) Study Group. Healthcare access and utilization among persons who inject drugs in medicaid expansion and nonexpansion States: 22 United States cities, 2018. J Infect Dis. 2020;222(Suppl 5):S420–8.
5. Biancarelli DL, Biello KB, Childs E, Drainoni M, Salhaney P, Edeza A, et al. Strategies used by people who inject drugs to avoid stigma in healthcare settings. Drug Alcohol Depend. 2019;198:80–6.
6. Zeremski M, Zibbell JE, Martinez AD, Kritz S, Smith BD, Talal AH. Hepatitis C virus control among persons who inject drugs requires overcoming barriers to care. World J Gastroenterol. 2013;19(44):7846–51.
7. Larney S, Tran LT, Leung J, Santo T Jr., Santomauro D, Hickman M, et al. All-cause and cause-specific mortality among people using extra-medical opioids: a systematic review and meta-analysis. JAMA Psychiatry. 2020;77(5):493–502.
8. Artenie A, Stone J, Fraser H, Stewart D, Arum C, Lim AG, et al. Incidence of HIV and hepatitis C virus among people who inject drugs, and associations with age and sex or gender: a global systematic review and meta-analysis. Lancet Gastroenterol Hepatol. 2023;8(6):533–52.
9. Popping S, Kall M, Nichols BE, Stempher E, Versteegh L, van de Vijver D, et al. Quality of life among people living with HIV in England and the Netherlands: a population-based study. Lancet Reg Health Eur. 2021;8:100177.
10. Sandmann L, Schulte B, Manns MP, Maasoumy B. Treatment of chronic hepatitis C: efficacy, side effects and complications. Visc Med. 2019;35(3):161–70.
11. Nagot N, D'Ottavi M, Quillet C, Debellefontaine A, Castellani J, Langendorfer N, et al. Reaching hard-to-reach people who use drugs: a community-based strategy for the elimination of hepatitis C. Open Forum Infect Dis. 2022;9(6):ofac181.
12. Woodward EN, Matthieu MM, Uchendu US, Rogal S, Kirchner JE. The health equity implementation framework: proposal and preliminary study of hepatitis C virus treatment. Implement Sci. 2019;14(1):26.
13. Barbosa W, Zhou K, Waddell E, Myers T, Dorsey ER. Improving access to care: telemedicine across medical domains. Annu Rev Public Health. 2021;42:463–81.
14. Zhang Y, Peña MT, Lal LS, Lin Y-Y, Summers RL, Chandra S, et al. Telemental health services usage and association with health care utilization and expenditures among vulnerable medicare beneficiaries in 2019: a comparative study using propensity score matching. Telemed E Health. 2024;30(7):1848–56.
15. Baudier P, Kondrateva G, Ammi C, Chang V, Schiavone F. Digital transformation of healthcare during the COVID-19 pandemic: patients' teleconsultation acceptance and trusting beliefs. Technovation. 2023;120:102547.
16. Sivakumar A, Madden L, DiDomizio E, Eller A, Villanueva M, Altice FL. Treatment of hepatitis C virus among people who inject drugs at a syringe service program during the COVID-19 response: the potential role of telehealth, medications for opioid use disorder and minimal demands on patients. Int J Drug Policy. 2022;101:103570.
17. Saeed SA, Masters RM. Disparities in health care and the digital divide. Curr Psychiatry Rep. 2021;23(9):61.
18. Haimi M. The tragic Paradoxical effect of telemedicine on healthcare disparities—a time for redemption: a narrative review. BMC Med Inf Decis Mak. 2023;23(1):95.
19. Bartholomew TS, Tookes HE, Chueng TA, Bluthenthal RN, Wenger LD, Kral AH, et al. Availability of telehealth-based services at syringe services programs under the COVID-19 public health emergency. Harm Reduct J. 2023;20(1):122.
20. Suarez E Jr., Bartholomew TS, Plesons M, Ciraldo K, Ostrer L, Serota DP, et al. Adaptation of the tele-harm reduction intervention to promote initiation and retention in buprenorphine treatment among people who inject drugs: a retrospective cohort study. Ann Med. 2023;55(1):733–43.
21. Tookes HE, Bartholomew TS, Suarez E, Ekowo E, Ginoza M, Forrest DW, et al. Acceptability, feasibility, and pilot results of the tele-harm reduction intervention for rapid initiation of antiretrovirals among people who inject drugs. Drug Alcohol Depend. 2021;229:109124.
22. Cooper CL, Hatashita H, Corsi DJ, Parmar P, Corrin R, Garber G. Direct-Acting antiviral therapy outcomes in Canadian chronic hepatitis C telemedicine patients. Ann Hepatol. 2017;16(6):874–80.

23. Health Resources and Services, Administration H. How do I use telehealth for behavioral health care? 2025. Available from: https://telehealth.hhs.gov/patients/additional-resources/telehealth-and-behavioral-health#:~:text=Telehealth%20can%20be%20used%20to,Medication%2Dassisted%20treatment.
24. Talal AH, Andrews P, McLeod A, Chen Y, Sylvester C, Markatou M, et al. Integrated, co-located, telemedicine-based treatment approaches for hepatitis C virus management in opioid use disorder patients on methadone. Clin Infect Dis. 2019;69(2):323–31.
25. Talal AH, Markatou M, Liu A, Perumalswami PV, Dinani AM, Tobin JN, et al. Integrated hepatitis C–opioid use disorder care through facilitated telemedicine: a randomized trial. JAMA. 2024;331(16):1369–78.
26. Talal AH, McLeod A, Andrews P, Nieves-McGrath H, Chen Y, Reynolds A, et al. Patient reaction to telemedicine for clinical management of hepatitis C virus integrated into an opioid treatment program. Telemed J E Health. 2019;25(9):791–801.
27. Talal AH, Sofikitou EM, Wang K, Dickerson S, Jaanimägi U, Markatou M. High satisfaction with patient-centered telemedicine for hepatitis C virus delivered to substance users: a mixed-methods study. Telemed J E Health. 2023;29(3):395–407.
28. Wang L, Weiss J, Ryan EB, Waldman J, Rubin S, Griffin JL. Telemedicine increases access to buprenorphine initiation during the COVID-19 pandemic. J Subst Abuse Treat. 2021;124:108272.
29. Lai JT, Chapman BP, Carreiro SP, Costigan AD, Rodriguez-Perez KM, Gonzalez G, et al. A pilot study of a telemedicine-based substance use disorder evaluation to enhance access to treatment following near-fatal opioid overdose. Proc Annu Hawaii Int Conf Syst Sci. 2020;2020:3488–96.
30. Adams CS, Player MS, Berini CR, Perkins S, Fay J, Walker L, et al. A telehealth initiative to overcome health care barriers for people experiencing homelessness. Telemed J E Health. 2021;27(8):851–8.
31. Ftouni R, AlJardali B, Hamdanieh M, Ftouni L, Salem N. Challenges of telemedicine during the COVID-19 pandemic: a systematic review. BMC Med Inf Decis Mak. 2022;22(1):207.
32. Delisle-Reda S, Bruneau J, Martel-Laferrière V. Telehealth for people who inject drugs: an acceptable method of treatment but challenging to access. J Addict Dis. 2022;40(4):514–7.
33. Roussos S, Angelopoulos T, Cholongitas E, Savvanis S, Papadopoulos N, Kapatais A, et al. High levels of all-cause mortality among people who inject drugs from 2018 to 2022. Int J Drug Policy. 2024;126:104356.
34. World Health Organization. Universal health coverage. 2023. Available from: https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc)#:~:text=Overview,products%2C%20and%20enjoying%20decent%20work.
35. Myloneros T, Sakellariou D. The effectiveness of primary health care reforms in Greece towards achieving universal health coverage: a scoping review. BMC Health Serv Res. 2021;21(1):628.
36. Hatzakis A, Sypsa V, Paraskevis D, Nikolopoulos G, Tsiara C, Micha K, et al. Design and baseline findings of a large-scale rapid response to an HIV outbreak in people who inject drugs in Athens, Greece: the ARISTOTLE programme. Addiction. 2015;110(9):1453–67.
37. Talal AH, Markatou M, Sofikitou EM, Brown LS, Perumalswami P, Dinani A, et al. Patient-centered HCV care via telemedicine for individuals on medication for opioid use disorder: telemedicine for evaluation, adherence and medication for hepatitis C (TEAM-C). Contemp Clin Trials. 2022;112:106632.
38. Eurostat. Digital economy and society statistics - households and individuals. 2023. Available from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Digital_economy_and_society_statistics_-_households_and_individuals.
39. European Patients Forum. Access to healthcare. EPF's survey-final report. 2016. Available from: https://www.eu-patient.eu/globalassets/policy/access/final-access-survey-report_16-dec.pdf.
40. Heckathorn DD. Respondent-driven sampling: a new approach to the study of hidden populations. Soc Probl. 1997;44(2):174–99.
41. Heckathorn DD. Respondent-driven sampling II: deriving valid population estimates from chain-referral samples of hidden populations. Soc Probl. 2014;49(1):11–34.
42. Kapadia SN, Katzman C, Fong C, Eckhardt BJ, Guarino H, Mateu-Gelabert P. Hepatitis C testing and treatment uptake among young people who use opioids in new York City: a cross-sectional study. J Viral Hepat. 2021;28(2):326–33.
43. Volz E, Heckathorn DD. Probability-based estimation theory for respondent-driven sampling. J Off Stat. 2008;24(1):79.
44. Schonlau M, Liebau E. Respondent-driven sampling. Stata J. 2012;12(1):72–93.
45. Powell RE, Henstenburg JM, Cooper G, Hollander JE, Rising KL. Patient perceptions of telehealth primary care video visits. Ann Fam Med. 2017;15(3):225–9.
46. Motavalli D, Taylor JL, Childs E, Valente PK, Salhaney P, Olson J, et al. "Health is on the back burner:" multilevel barriers and facilitators to primary care among people who inject drugs. J Gen Intern Med. 2021;36(1):129–37.
47. Sagrestano LM, Clay J, Finerman R, Gooch J, Rapino M. Transportation vulnerability as a barrier to service utilization for HIV-positive individuals. AIDS Care. 2014;26(3):314–9.
48. Amiri S, Lutz R, Socías ME, McDonell MG, Roll JM, Amram O. Increased distance was associated with lower daily attendance to an opioid treatment program in Spokane County, Washington. J Subst Abuse Treat. 2018;93:26–30.
49. Scaramutti C, Hervera B, Rivera Y, Chueng TA, Forrest DW, Suarez E, et al. Improving access to HIV care among people who inject drugs through teleharm reduction: a qualitative analysis of perceived discrimination and stigma. Harm Reduct J. 2024;21(1):50.
50. Abadie R, Goldenberg S, Welch-Lazoritz M, Fisher CB. Establishing trust in HIV/HCV research among people who inject drugs (PWID): insights from empirical research. PLoS ONE. 2018;13(12):e0208410.
51. Papalamprakopoulou Z, Ntagianta E, Triantafyllou V, Kalamitsis G, Dharia A, Dickerson SS, et al. Telehealth to increase healthcare access: perspectives of people who use drugs. BMC Med Inf Decis Mak. 2024;24(1):306.
52. Mimigiannis C, Gallos P, Mantas J. The drug addicts' usage of information and communication technologies. Stud Health Technol Inf. 2020;275:236–7.
53. Novak SP, Kral AH. Comparing injection and non-injection routes of administration for heroin, methamphetamine, and cocaine users in the united States. J Addict Dis. 2011;30(3):248–57.
54. Ozga JE, Paquette C, Syvertsen JL, Pollini RA. Mobile phone and internet use among people who inject drugs: implications for mobile health interventions. Subst Abus. 2022;43(1):592–7.
55. Patanwala MY, Garcia CM, Kushel M. Health care for people experiencing homelessness. JAMA. 2024;2024;332(1):70–71.
56. Collins KM, Armenta RF, Cuevas-Mota J, Liu L, Strathdee SA, Garfein RS. Factors associated with patterns of mobile technology use among persons who inject drugs. Subst Abus. 2016;37(4):606–12.
57. Roussos S, Paraskevis D, Psichogiou M, Kostaki EG, Flountzi E, Angelopoulos T, et al. Ongoing HIV transmission following a large outbreak among people who inject drugs in Athens, Greece (2014–20). Addiction. 2022;117(6):1670-82.
58. Center for Behavioral Health Statistics and Quality. 2016 national survey on drug use and health: detailed tables. Rockville: Subst Abuse Ment Health Serv Adm. 2017.
59. Hacker K, Anies M, Folb BL, Zallman L. Barriers to health care for undocumented immigrants: a literature review. Risk Manag Healthc Policy. 2015;8:175–83.
60. Althubaiti A. Information bias in health research: definition, pitfalls, and adjustment methods. J Multidiscip Healthc. 2016;9:211–7.
61. Arum C, Fraser H, Artenie AA, Bivegete S, Trickey A, Alary M, et al. Homelessness, unstable housing, and risk of HIV and hepatitis C virus acquisition among people who inject drugs: a systematic review and meta-analysis. Lancet Public Health. 2021;6(5):e309-23.
62. Halpern SD, Chowdhury M, Bayes B, Cooney E, Hitsman BL, Schnoll RA, et al. Effectiveness and ethics of incentives for research participation: 2 randomized clinical trials. JAMA Intern Med. 2021;181(11):1479–88.
63. Abdul-Quader AS, Heckathorn DD, McKnight C, Bramson H, Nemeth C, Sabin K, et al. Effectiveness of respondent-driven sampling for recruiting drug users in New York City: findings from a pilot study. J Urban Health. 2006;83(3):459–76.

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