Water and Sanitation in Urban America, 2017–2019

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Objectives. To estimate the population lacking at least basic water and sanitation access in the urban United States.

Methods. We compared national estimates of water and sanitation access from the World Health Organization/United Nations Children's Fund Joint Monitoring Program with estimates from the US Department of Housing and Urban Development on homelessness and the American Community Survey on household water and sanitation facilities.

Results. We estimated that at least 930 000 persons in US cities lacked sustained access to at least basic sanitation and 610 000 to at least basic water access, as defined by the United Nations.

Conclusions. After accounting for those experiencing homelessness and substandard housing, our estimate of people lacking at least basic water equaled current estimates (n = 610 000)—without considering water quality—and greatly exceeded estimates of sanitation access (n = 28 000).

Public Health Implications. Methods to estimate water and sanitation access in the United States should include people experiencing homelessness and other low-income groups, and specific policies are needed to reduce disparities in urban sanitation. We recommend similar estimation efforts for other high-income countries currently reported as having near universal sanitation access. (*Am J Public Health.* 2020;110:1567–1572. doi:10.2105/AJPH.2020.305833)

People experiencing homelessness and housing instability in towns and cities in the United States may have limited or no access to safe water and sanitation. Water and sanitation are important to prevent infection by fecal–oral pathogens via well-understood pathways of transmission[1]; are necessary for handwashing, which may limit the spread of SARS-CoV-2; and are critical for maintaining public health. The number of people experiencing homelessness increased from 2016 to 2019,[2] but decreased investment in urban sanitation infrastructure has resulted in lower access to public toilets.[3] Limited sanitation access for people experiencing homelessness was linked to a nationwide outbreak of hepatitis A from 2017 to 2018.[4] People living in emergency shelters and transitional housing share sanitation facilities with others,[5] and people in unsheltered locations may not have sustained access to water and sanitation facilities, causing some in both groups to resort to open defecation.[6,7] Work by Desmond et al. on low-income housing and the eviction crisis suggested that functioning water and sanitation facilities are not universal in low-income urban housing units in the United States,[8,9] in contrast to international statistics reporting universal or near-universal access.[10,11]

The United Nations Sustainable Development Goal 6 calls for adequate and equitable sanitation, hygiene, and safe and affordable drinking water for all by 2030.[12] Under Sustainable Development Goal 6, "safely managed" sanitation is defined as the "use of improved facilities that are not shared with other households and where excreta are safely disposed of *in situ* or transported and treated offsite." Basic sanitation is defined as "use of improved facilities that are not shared with other households." Improved facilities include "flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs."[10] Safely managed drinking water is defined as "drinking water from an improved water source that is located on premises, available when needed and free from fecal and priority chemical contamination."[10]

The World Health Organization and United Nations Children's Fund (WHO/UNICEF) Joint Monitoring Program (JMP) collects and reports national-scale data on water and sanitation across countries,[10,11] but estimates are limited by the data shared by individual countries. The JMP uses the American Housing Survey (AHS) to estimate national water and sanitation access and the US Environmental Protection Agency's Safe Drinking Water Information System to assess drinking water quality.[11,13,14] These data sources exclude people experiencing homelessness, estimated to have been 570 000 in 2019, and so national statistics overestimate access to water and sanitation in the United States.

To further examine published estimates of universal or near-universal (> 99%) access to safely managed water and sanitation in urban areas of the United States,[10,11] we conducted a scoping study to (1) identify sources of nationally representative data on access to water and sanitation in the United States and (2) estimate the number of people without

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access to basic water and sanitation in the United States, inclusive of housing instability.

METHODS

We accessed publicly available data representing people living in urban areas of the United States who may have insufficient access to water and sanitation facilities compiled by representative agencies through downloadable Excel (Microsoft, Redmond, WA) files and interactive online tables.

The 2017 AHS produced nationally representative estimates that included a question regarding sanitation access (question: public sewer), but only reported data for the 15 largest metropolitan areas (representing 39% of the total urban population) and select states.[15,16]

Inaugurated in 2005, the American Community Survey (ACS) is an annual survey by the US Census Bureau with a typical participation of 3.5 million households per year.[17] The ACS is mailed to specific addresses, and participants can choose to respond via a paper form or the Internet. The ACS contains 1 question about the presence of a complete bathroom, which it defines as the presence of hot and cold running water, a flush toilet, and a bathtub or shower. In addition, it asks about the presence of a complete kitchen, which it defines as the presence of an installed sink with tap water, a mechanical refrigerator, and a stove or range oven with built-in burners. The 2013 to 2017 ACS 5-year estimates included data for all 382 US metropolitan areas[17] (urban clusters with populations ≥ 50 000) representing an additional 150 million urban US residents compared with the 15 largest metropolitan areas assessed by the AHS; therefore, we used the more comprehensive ACS to estimate urban water and sanitation access.[17]

The ACS relies on a ratio estimation procedure to transform survey response data into nationally representative estimates. Weights are assigned to each sample person record (to produce person estimates) or to each housing unit record (to producing housing unit estimates), and are used to compensate for differences in sampling rates across areas, between the full sample and the interviewed sample, and between the sample and independent estimates of basic demographic characteristics.[18] We accessed the ACS 2017 5-year estimates public-use microdata set by using the Integrated Public Use Microdata Series,[19] filtering out responses not in a metropolitan area or if the metropolitan status could not be assessed, and used the ACS "person weight" option to access national population estimates.[20] To account for the high nonresponse rate (42%) to the ACS question on the presence of a flush toilet, we applied the same response distribution from people who did respond to those who did not respond. The nonresponse rate for other questions was small (< 3%), and no adjustment was used.

We accessed publicly available data[21] on homelessness from the 2019 Department of Housing and Urban Development's (HUD's) Point-in-Time (PIT) count.[2] The PIT count is an annual survey conducted each January in which volunteers physically count people experiencing homelessness in housed and unhoused locations across the United States.[2] The 2019 PIT count was conducted in 397 Continuums of Care across all 50 states; Washington, DC; and US territories.[21] Counted persons are categorized as living in an unsheltered or a sheltered location. Unsheltered locations are considered unsuitable for human habitation, such as under an overpass, or in a car or abandoned building, or urban camping. Sheltered locations may include emergency shelters or transitional housing programs. The PIT count represents a conservative estimate of homelessness; it is cross-sectional, and volunteers only count people physically located during the count.[22] We matched estimates from ACS 2017 with PIT count data by state to generate national estimates of water and sanitation access (Tables A and B, available as supplements to the online version of this article at http://www.ajph.org).

RESULTS

In the 2019 WHO/UNICEF JMP report, basic sanitation access for urban persons in the United States was estimated to be greater than 99%, while limited sanitation, unimproved sanitation, and open defecation were each less than 1%.[10] Data available online from the JMP estimated that 96% (n = 250 000 000) of urban persons in the United States used safely managed sanitation, 4.5% (12 000 000) used basic sanitation, and less than 0.01% (n = 28 000) used unimproved sanitation in 2017.[11] Limited sanitation and open defecation were reported as nonexistent.[11] Analyzed by facility type, the JMP reported 93% (n = 250 000 000) of urban persons in the United States had a sewer connection, 6.5% (n = 17 000 000) relied on a septic tank, and no urban persons in the United States used a latrine or other form of sanitation.[11]

The ACS estimated that in 2017 there were 100 000 000 occupied housing units in the 382 metropolitan areas of the US Census, totaling 250 000 000 housed urban people.[17] A small proportion (0.30%; n = 750 000) of housed urban residents lacked a complete bathroom, defined as hot and cold running water, a bathtub or shower, and a flush toilet.[17] Hot and cold running water was most commonly absent from incomplete bathrooms (0.21%; n = 540 000), followed by lack of a flush toilet (0.19%; n = 470 000)—which we adjusted for nonresponses—and the absence of a bathtub or shower (0.18%; n = 460 000).[17]

Very-low-income households were most likely to report lack of access to a flush toilet; 0.37% (n = 150 000) of people in households with incomes less than 100% of the national poverty threshold, as defined by the Social Security Administration, lacked a flush toilet, compared with 0.21% (n = 90 000) of households with incomes between 100% and 200% of the poverty threshold, and 0.14% (n = 235 000) of households with incomes above 200% of the poverty threshold (Table C, available as a supplement to the online version of this article at http://www.ajph.org). In addition, a greater prevalence of people in renting households (0.26%; n = 220 000) lacked a flush toilet than respondents who reported owning their unit (0.14%; n = 230 000; Table C).[17] The ACS did not capture the number of flush toilets per household or what alternatives existed in the absence of a flush toilet.

Water

The data reported by the ACS and JMP are not directly comparable because of methodological limitations. To generate national estimates of water access, the JMP used data on water access and water quality, but the ACS only included data on water access.

The 2019 JMP report estimated that more than 99% of urban persons in the United States had safely managed piped drinking water into their home, and less than 1% had nonpiped water access.[10] Data from 2017 estimated that more than 99% (n = 270 000 000) of urban persons in the United States had a safely managed drinking water service, 0.11% (n = 280 000) had basic service, 0.24% (n = 610 000) had unimproved drinking water, and limited service or use of surface water was nonexistent.[11] By facility type, JMP estimated that greater than 99% (n = 270 000 000) of urban persons in the United States had access to improved piped water, and 0.18% (n = 460 000) had access to improved nonpiped water, with no other service types reported.[11]

According to the ACS, a similar number of urban persons in the United States lacked a sink with tap water (0.18%; n = 440 000) compared with those lacking a flush toilet. The lowest-income households were most likely to lack an installed sink with tap; 0.29% (n = 120 000) of people in households making less than 100% of the federal poverty threshold did not have a tap, decreasing to 0.23% (n = 97 000) of people in households at 100% to 200% of the poverty threshold, and an estimated 0.14% (n = 230 000) of people in households with incomes greater than 200% of the poverty threshold.[17] In addition, the lack of a tap was more prevalent among renters (0.26%; n = 240 000) compared with homeowners (0.13%; n = 210 000; Table D, available as a supplement to the online version of this article at http://www.ajph.org).[17] The ACS did not capture what households used for drinking water in the absence of a sink with a tap.

Homelessness

On a single night in January 2019, the PIT count recorded 570 000 people in the United States as experiencing homelessness.[2] Most (n = 330 000) persons in the United States experiencing homelessness were counted in urban areas; almost two thirds (n = 210 000) in urban areas were counted in sheltered locations, and the remaining one third were counted in unsheltered locations (n = 120 000).[2] In addition, about one quarter (140 000) of people experiencing homelessness were counted in suburban areas, which included people up to 10 miles from urbanized areas.[2] Similarly, two thirds (n = 89 000) of the suburban homeless were counted in sheltered locations and one third (n = 46 000) in unsheltered locations.[2] The 2019 PIT count did not capture data on water and sanitation access for people experiencing homelessness.

Combined Data

Because people experiencing homelessness in unsheltered urban locations do not have a bathroom when and where it is needed,[6,16] and those in sheltered locations generally use shared sanitation,[5] we estimated that at least 0.29% of residents (n = 930 000) lacked access to at least basic sanitation in the urban United States. This estimate is substantially greater than the 0.01% of urban persons in the United States (n = 28 000) that JMP reported as having limited sanitation, having unimproved sanitation, or resorting to open defecation (Table 1).

Assuming people experiencing homelessness in sheltered urban locations have access to drinking water from an improved source for which the collection time is 30 minutes or less, then those in sheltered locations should be considered to have basic drinking water access. Those experiencing homelessness in unsheltered locations, however, may not have consistent access to an improved water source or their collection time may exceed 30 minutes; people experiencing homelessness and residing in unsheltered locations should therefore be considered to have limited or worse access to drinking water. When we combined data on homelessness with ACS data, we estimated that 610 000 (0.24%) of urban persons in the United States lacked basic water access, without considering water quality.

The combined ACS and PIT count estimated that urban residents did not have access to at least basic water and sanitation in every state except Wyoming (Table 2; Figures A and B, available as supplements to the online version of this article at http://www.ajph.org). Half of estimated urban residents without at least basic water (56%; n = 340 000) and sanitation (50%; n = 470 000) resided in 4 states: California, Florida, New York, and Texas. Although California comprises 12% of the total US population, 19% of all urban residents without at least basic water and 23% without at least basic sanitation resided in California.

DISCUSSION

Access to water and sanitation is reported as near universal in the urban United States, but the human rights to water,[23] sanitation,[23] and housing[24] remain unmet for people experiencing homelessness and those living in homes without adequate water and sanitation. The JMP reports that 28 000 people in the urban United States lack access to at least basic sanitation; however, when we accounted for residents experiencing homelessness and residents in substandard housing, we found that at least 630 000 are without sustained access to a flush toilet and a further 300 000 rely on shared sanitation. The 930 000 people without access to at least basic sanitation services in the urban United States —while a low overall percentage—is a large absolute number in a high-income country where resources exist to address the issue.

In the urban United States, the human right to improved water and sanitation may be best advanced through the lens of adequate housing as a human right[24]; universal water

TABLE 1—Estimated Persons Lacking at Least Basic Access to Water and Sanitation Services in Urban United States: 2017–2019

	WHO/UNICEF JMP 2019 Estimates, No. (%)	Combined ACS and PIT Count Estimate (2017–2019), No. (%)	2017 5-y ACS Estimates, No. (%)	2019 PIT Count,[a] No. (%)
Lack at least basic water	610 000 (0.24)	610 000 (0.24)	440 000 (0.18)	170 000 (0.07)
Lack at least basic sanitation	28 000 (0.01)	930 000 (0.37)	470 000 (0.19)	460 000 (0.18)

Note. ACS = American Community Survey; JMP = Joint Monitoring Program; PIT = Point-in-Time; UNICEF = United Nations Children's Fund; WHO = World Health Organization.

[a]Includes people counted in both urban and suburban (< 10 miles from urban) Continuums of Care.

TABLE 2—Estimates of Inadequate Access to Water and Sanitation by State: United States, 2017–2019

State	Population (%) Lacking Access	
	Basic Sanitation	Basic Water
AK	1 609 (0.54)	1 130 (0.38)
AL	4 644 (0.15)	3 522 (0.11)
AR	14 624 (0.24)	14 206 (0.23)
AZ	12 587 (0.92)	7 699 (0.56)
CA	214 930 (0.57)	174 803 (0.46)
CO	14 128 (0.34)	5 917 (0.14)
CT	8 296 (0.24)	6 080 (0.18)
DC	8 181 (1.22)	1 462 (0.22)
DE	2 430 (0.26)	2 049 (0.22)
FL	51 103 (0.27)	42 704 (0.23)
GA	22 170 (0.31)	15 457 (0.21)
HI	7 517 (0.76)	5 688 (0.57)
IA	3 573 (0.42)	1 881 (0.22)
ID	18 237 (0.17)	15 059 (0.14)
IL	15 960 (0.35)	6 879 (0.15)
IN	3 305 (0.25)	2 385 (0.18)
KS	4 217 (0.27)	2 013 (0.13)
KY	4 582 (0.25)	3 138 (0.17)
LA	7 209 (0.23)	5 912 (0.19)
MA	11 100 (0.19)	10 072 (0.17)
MD	15 815 (0.29)	10 286 (0.19)
ME	20 243 (2.58)	2 046 (0.26)
MI	17 293 (0.24)	10 434 (0.14)
MN	10 189 (0.29)	6 261 (0.18)
MO	6 704 (0.65)	2 486 (0.24)
MS	11 532 (0.28)	9 713 (0.23)
MT	65 (0.06)	19 (0.02)
NC	15 770 (0.23)	10 852 (0.16)
ND	114 (0.07)	64 (0.04)
NE	3 375 (0.33)	2 039 (0.20)
NH	2 100 (0.38)	1 100 (0.20)
NJ	24 668 (0.28)	19 863 (0.23)
NM	6 760 (0.50)	4 229 (0.31)
NV	11 630 (0.45)	9 634 (0.38)
NY	131 218 (0.74)	43 848 (0.25)
OH	23 889 (0.27)	17 266 (0.19)
OK	5 420 (0.26)	2 917 (0.14)
OR	16 580 (0.58)	8 463 (0.3)
PA	30 261 (0.29)	19 127 (0.18)
RI	2 770 (0.26)	1 549 (0.15)
SC	9 969 (0.26)	6 891 (0.18)
SD	397 (0.23)	333 (0.20)
TN	10 003 (0.24)	6 482 (0.16)
TX	68 666 (0.3)	49 384 (0.21)
UT	6 328 (0.26)	4 638 (0.19)
VA	4 704 (2.16)	866 (0.40)
VT	10 159 (0.17)	9 393 (0.16)
WA	25 367 (0.42)	15 083 (0.25)
WI	2 075 (0.62)	685 (0.20)
WV	7 311 (0.19)	6 178 (0.16)
WY	0 (0)	0 (0)

and sanitation likely will only be achieved when universal affordable housing and rapid rehousing exist. Investments in public sanitation are crucial for public health—especially given the reduction in public sanitation in recent decades[3]—and public sanitation is used by both housed and unhoused people. However, affordable and adequate housing is likely the best option to end open defecation and improve water and sanitation access in the urban United States. Acknowledging that the US Census, ACS, and AHS consistently undercount people experiencing homelessness, the US Census Bureau could incorporate PIT count data to improve national estimates of water and sanitation access, which are subsequently shared with the JMP.

The 2013 AHS—which asked about household sewage disposal—estimated that a very small proportion (0.0037%) of the urban population in the largest US metro areas did not have public sewer access or use a septic tank, cesspool, or chemical toilet.[15] This suggests that most urban persons in the United States who reported the absence of a flush toilet in the 2017 5-year ACS likely relied on an outhouse or did not have sustained access to a functioning flush toilet at home. If safely covered and abandoned, or emptied and treated, outhouses can constitute safely managed sanitation. Without sustained access to a flush toilet, some households may use a neighbor's facilities or public facilities (e.g., at work or at a gym), or may resort to open defecation.[6,7]

The WHO/UNICEF JMP estimates of water access are not directly comparable to ACS and HUD data. JMP data consider the use of a water source and the quality of the water, and allow for communal water facilities to be considered a basic drinking water service. However, data from the ACS and HUD only consider the presence of a water source. Therefore, the HUD and ACS estimate of people without a tap is a conservative baseline of drinking water access in the urban United States and suggests that the WHO/UNICEF estimate of people with limited water or worse is likely insufficient. Well-publicized lead contamination of drinking water in Flint, Michigan, and Newark, New Jersey, are examples that piped water into the home does not necessarily guarantee safety. The US government could report water quality data along with HUD housing data to the JMP to improve future estimates of urban safe drinking water access.

Some households may have piped water and a flush toilet, but these facilities may fall into disrepair, and landlords may take weeks or months to provide the necessary repairs.[9] Intermittent water supply—prevalent in low- and middle-income countries—has been linked to elevated risk of waterborne illness.[25] Strengthening laws that protect tenants may be helpful to empower renters to obtain necessary repairs. For low-income homeowners, increasing awareness about and expanding funds disbursed by government housing repair programs (e.g., the Very Low-Income Housing Repair Program) may be useful to achieve universal access.

The JMP is limited by what official government data it receives and the need to apply a consistent methodology across countries. Some countries have explicitly included transient groups such as refugees (e.g., Palestinian and Syrian refugees in Lebanon) or nomadic groups (e.g., in Ethiopia) in survey data collection.[14] However, people experiencing homelessness are undercounted in national surveys based on household units and not explicitly included in any national estimate of water and sanitation access. Without housing, it is likely impossible to have consistent access to a flush toilet and piped water when and where they are needed.[16,26] More than 90% of open defecation sites in urban

Atlanta, Georgia, were less than 400 meters from shelters and soup kitchens.[6] UN Special Rapporteurs to water, sanitation, and housing have repeatedly compared the squalid living conditions for people experiencing homelessness in the United States to some of the worst settlements in low-income countries.[27,28] Analogous to people experiencing homelessness in the United States, residents of informal urban settlements globally may also be excluded from data reported to the JMP.[29]

Without sustained access, people experiencing homelessness in unsheltered locations should be classified as "unimproved" on the JMP service ladder for drinking water and "open defecation" for sanitation. Because of the shared nature of water and sanitation facilities in emergency shelters and transitional housing, water for people experiencing homelessness in sheltered locations should be considered "basic" and sanitation considered "limited." Safely managed sanitation also requires adequate treatment of fecal wastes. In some rural US communities, direct discharge of raw sewage into the household yard—referred to as "straight-pipe"—is common.[30] In urban and rural areas, failing septic tanks and sewer overflows are common.[31] The US Environmental Protection Agency estimates that 850 billion gallons of untreated wastewater and stormwater are released as combined sewer overflows each year.[31] Adequate access to sanitation accompanied by sequestration and treatment of fecal wastes remain important to achieving universal safely managed sanitation across the United States.

Access to relatively worse water and sanitation facilities was more prevalent among low-income households. More detailed data about water and sanitation facilities would be useful but overlap significantly with housing status; future ACS surveys will not include the question on flush toilets because of the high nonresponse rate and its perception as invasive.[32] Our results suggest that the ACS should reintroduce the question regarding the presence of a flush toilet. Without comprehensive data on flush toilets, other metrics may also be useful.

Nearly 1 million households were evicted in the United States in 2016,[9] leaving their short-term access to water, sanitation, and housing unclear. After an eviction, some may experience homelessness such as doubling up with friends or family, staying in an emergency shelter, or sleeping in an unsheltered location.[9] More than half a million people were counted in the PIT count, but the count did not attempt an annual estimate of homelessness. The methods used excluded people staying with friends or family and those in hospitals or jails.[22] In 2017, after considering people in county jails who had experienced homelessness at the time of their arrest, Houston, Texas, estimated their actual number of people experiencing homelessness was 57% greater than they reported in the PIT count (from 3605 to 5651).[33] A 2001 study estimated that annual rates of homelessness in the United States are 2.5 to 10.2 times greater than the cross-sectional PIT count estimate.[34] In high-income countries where housing instability and homelessness are drivers of inadequate water and sanitation conditions, national estimates derived from household data are insufficient to accurately estimate water and sanitation access. Future estimates could consider or be reported alongside housing data (e.g., evictions or worst-case housing)[2,9,35] to ensure low-income households and people experiencing homelessness are accounted for.

Limitations

Our analysis had several limitations. Embarrassment may have caused households lacking a flush toilet to respond less often about their sanitation status than households with a flush toilet, suggesting that our estimates may be biased downward. Water and sanitation access for people experiencing homelessness in sheltered locations varies depending on accommodation: some may share facilities with others, may lack access to the facilities during daytime hours, may lose access temporarily as a punishment, or may have consistent private access in some cases. The heterogeneity in access may bias our estimate of people sharing sanitation.

Current data received by the JMP from the US government exclude large groups in the urban United States because of methodological limitations and data availability. The absence of a question regarding flush toilets in future ACS surveys suggests that the JMP should continue using the AHS, include HUD data on people experiencing homelessness, and consider other metrics of housing instability as proxies for water and sanitation access in the United States. Including people experiencing homelessness, a group often invisible to policymakers, in the data reported to the JMP will enable the United States to improve national estimates of water and sanitation, increase awareness of the issue, and allocate funding for investments in public toilets, which could come from existing programs to improve stormwater quality.

Public Health Implications

Access to safely managed water and sanitation are human rights,[23] and, without these basic services, people are at increased risk of infection by fecal–oral pathogens and SARS-CoV-2.[1] The absolute number of people excluded from basic water and sanitation access is higher than available international statistics suggest. Estimates that account for housing instability reveal disparities that require action. Our methods for estimating water and sanitation access may be applicable to other high-income countries. AJPH

CONTRIBUTORS

D. Capone and J. Brown originated the study. D. Capone wrote the first draft. All authors contributed to data analysis and drafting the final article.

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The authors have no conflicts of interest to disclose.

HUMAN PARTICIPANT PROTECTION

Human participant protection was not required because no human participants were involved in this study.

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