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Disparities in Technology and Broadband Internet Access across Rurality: Implications for Health and Education

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Abstract

Background: Amidst the COVID-19 pandemic, interest in using telehealth to increase access to health and mental health care has grown, and school transitions to remote learning have heightened awareness of broadband inequities. The purpose of this study was to examine access and barriers to technology and broadband Internet service (“broadband”) among rural and urban youth.

Methods: Washington State public school districts were surveyed about youth’s access to technology (i.e., a device adequate for online learning) and broadband availability in spring 2020. Availability of and barriers to broadband (i.e., geography, affordability, and smartphone-only connectivity) were assessed across rurality.

Results: Among responding districts, 64.2% (n=172) were rural and 35.8% (n=96) were urban. Rural districts reported significantly fewer students with access to an Internet-enabled device adequate for online learning (80.0% vs. 90.1%,$p<0.01$). Access to reliable broadband varied significantly across geography ($p<0.01$).

Conclusions: Compared to their urban peers, rural youth face more challenges in accessing the technology and connectivity needed for remote learning and telehealth. Given that inadequate broadband infrastructure is a critical barrier to the provision of telehealth services and remote learning in rural areas, efforts to improve policies and advance technology must consider geographical disparities to ensure health and education equity.

Keywords

telehealth; education; access; rural; youth

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Access to broadband Internet service ("broadband") has recently been identified as a social determinant of health, alongside access to health care, economic stability, education, and community and social context, among others.[1,2] The coronavirus disease (COVID-19) pandemic has underscored the necessity of reliable broadband access for both health care and education needs.[3] Indeed, telehealth has been used increasingly in lieu of in-person health care visits during the pandemic, and there is growing speculation that telehealth will play a more central role in the health care system moving forward.[3] The transition to online learning in the wake of school closures and the expansion of telehealth has revealed that certain populations, lack the digital resources needed to shift their educational and health care needs online.[4,5] This "digital divide" has been linked to built-environment barriers, such as lack of broadband availability and other social determinants of health.[4] These barriers have the potential to accelerate the growing digital divide between urban and rural residents of the United States (US) and to negatively impact health and education outcomes.

The COVID-19 pandemic has also heightened the importance of health care access for youth in the US, particularly access to mental health care. Loneliness and psychological distress due to social isolation are often cited pandemic-related concerns,[6,7] and shelter-in-place mandates have generated alarm about increased exposure to unsafe home environments (e.g., child maltreatment, family violence).[6,8] These concerns are exacerbated for rural youth who are at an increased risk of suicide,[9,10] face challenges accessing health and mental health care providers,[11] have limited school mental health services,[11] and experience greater stigma related to mental health and help-seeking relative to their urban peers.[12] Addressing the mental health needs and barriers that rural youth encounter will persist even when US communities eventually transition into the post-COVID-19 era.

Telehealth, especially technologies involving synchronous patient-provider interaction, have been leveraged to address increasing mental health needs, particularly since the COVID-19 pandemic was declared.[6,8,13] Evidence points to the effectiveness of telehealth for increasing access to youth mental health services.[14–16] While telehealth services can be delivered in real-time via telephone or even text messaging, those approaches may be suboptimal for mental health care. Video-based encounters, which often require broadband, can facilitate rapport building, enhance the patient-provider relationship, and enable clinicians to visually observe key indicators (e.g., facial expressions, energy level, intoxication[17]) critical for health assessment.

Inadequate broadband infrastructure is a critical barrier to provision of telehealth services and remote learning in rural areas, particularly for approaches that involve synchronous video communication between provider and recipient.[18,19] This barrier can be compounded by lack of technology to utilize these services and costs to obtain them. Although ownership of desktop computers, tablets, and smartphones has increased dramatically in the US over the last 20 years, rural residents lag behind suburban and urban residents in ownership of these devices.[20,21] Rural residents more often lack adequate cellular coverage to reliably access video telehealth services and remote learning through mobile technologies, such as smartphones. Furthermore, for telehealth services and remote learning that require high bandwidth for real-time videoconferencing services, expensive data plans may be prohibitive for families with limited incomes. Finally, owning a device capable of accessing the Internet may be insufficient for using telehealth services and remote learning if that device is outdated or unable to process data swiftly.

Existing data to examine technology and broadband access among children and adolescents in the US are limited. The US Census Bureau provides detailed estimates of the proportion of households with technology (e.g., desktop/laptop, smartphone or tablet) and broadband subscriptions and indicate rural-urban disparities in access to both, with nonmetropolitan (i.e., small towns or rural) households being less likely to report these resources than urban households.[22] However, Census data do not provide information about broadband geographic *availability* nor residents' reasons for not having broadband. Also, households that do not have Internet are more likely to be undercounted in the Census.[21] The US Federal Communications Commission (FCC) provides Census block-level broadband deployment data that are self-reported by Internet service providers. These data have been criticized for being inaccurate and for overestimating broadband access, particularly in rural areas.[23]

In Washington State, over 1.1 million children and adolescents (92%) receive education through the public school system.[24] After closure of public schools in March 2020 due to COVID-19, the Washington State Office of the Superintendent of Public Instruction (OSPI) surveyed school districts about students' needs, including technology and broadband access, in an effort to identify challenges to delivering online educational content to students and to strategize solutions to enable equitable access to education. By understanding variations in technology and broadband access, outreach and policy efforts can more efficiently address access inequities. The objectives of this study were to use OPSI data to characterize rural-urban differences in (1) access to Internet-enabled technology and broadband, and (2) perceived barriers to accessing broadband service across among public school students in Washington State.

METHODS

This cross-sectional study utilized data about student technology access and perceived barriers reported by Washington State public school districts in spring 2020. District-level data were linked to geographic information to examine rural-urban differences in technology access and perceived barriers to broadband access. This study involved use of publicly available data about school districts and is not characterized as human subjects research.

Data Sources

After closure of public elementary, middle, and high schools on March 13, 2020, the Washington State OSPI began collecting data from each school district, including existing needs and available student support services related to technology, meals, and childcare.[25] Weekly electronic surveys from OSPI were distributed to school administration through spring 2020; surveys that included technology-related questions were administered April 12 and May 17, 2020. To answer survey questions, school districts summarized student-level data that were obtained by classroom teachers familiar with students' needs, equipment tracking/records, or by directly surveying families when information was not readily available. Only district-level aggregated data were reported to OSPI; identifiable student information was not disclosed. Data were collected and cleaned by OSPI.

School district locale codes were obtained from National Center for Education Statistics (NCES) and were used to classify rurality (see “Rurality measure” below). Average daily attendance data were also obtained from the NCES to generate district-level survey weights.

Measures

Access to technology.—In the OSPI survey, school districts reported the estimated percentage of students who had at-home access to either an Internet-enabled desktop/laptop computer or a tablet or smartphone. Districts also reported the percentage of students with a device “adequate for online learning” at home, either provided by the district or owned by the student. Adequacy was not specifically defined, and this device could be a desktop/laptop or tablet/smartphone. The verbatim questions related to technology needs and survey dates are provided in Figure 1.

Access to broadband.—School districts reported estimated percentage of students with reliable broadband connectivity adequate to support synchronous (real-time) video (Figure 1). This definition of broadband connectivity refers specifically to broadband speeds that would be most appropriate for remote education and telehealth.

Barriers.—Districts reported barriers faced by students who lacked broadband access. Response options included geography (living in a geographical area without broadband or smartphone data access), affordability (unable to afford broadband access), phone-only connectivity (broadband connection to the Internet available through smartphone data plan only), or other (write-in). Districts indicated whether or not their students were affected by each barrier and the percentage of students affected by each, if applicable.

Rurality.—The geographic status of each school district (also termed “local education agency”) was categorized using NCES locale codes, a 12-level classification scheme ranging from large city to rural.[26] In accordance with the dichotomization scheme used to designate rural schools for federal funding, districts with schools assigned NCES codes 32 (town, distant territory), 33 (town, remote territory), 41 (rural, fringe), 42 (rural, distant), or 43 (rural, remote) were classified as rural; other districts were classified as urban.

Analysis

Sample weights, based on district-level daily average attendance, were used to account for differing sizes of school districts across the state. All analyses were conducted using survey weights; unweighted data were examined as a sensitivity analysis. Wald tests were used to compare the mean percentage of students in rural and urban districts with access to Internet-enabled technology and broadband access. To examine barriers to accessing broadband across rurality, chi-squared (χ^2) tests were used to compare the percentage of rural vs. urban districts with students who reported barriers due to geography, affordability, or connectivity. The mean percentage of students affected by each barrier was summarized and compared across urban and rural districts using Wald tests. Responses to the write-in “other” option for barriers were grouped by topic and summarized. Statistical analyses were conducted using Stata/MP v15.1; the level of significance was set at $\alpha = 0.05$ (two-tailed). We used ESRI ArcGIS version 10.5.1 to map the geographic distribution of school districts and the mean percentage of students with access to Internet-enabled technology and broadband at home.

RESULTS

Among the 283 districts that responded to the OSPI surveys (response rate 91.0%), 268 were matched to the NCES list of the 295 geographically defined public school districts in Washington State. Among responding districts, 64.2% (n = 172) were rural and 35.8% (n = 96) were urban (Figure 2). There was no rural-urban difference in districts that completed OSPI surveys compared to those that did not (χ^2 test, p = 0.52). Slightly fewer than half of responding districts surveyed families directly about technology (43.3%, n = 116); remaining districts (56.7%, n = 152) relied on classroom teacher reports or other internal sources of data. Significantly more rural than urban districts surveyed families directly (49.4% vs. 32.3%, p = 0.01).

Table 1 presents the mean percent of students with access to Internet-enabled technology and broadband by rurality. On average, Washington State school districts reported that 73.9% of students had access to an Internet-enabled desktop/laptop computer at home. There was no rural-urban difference in students' access to a desktop/laptop computer. Statewide, access to an Internet-enabled tablet/smartphone at home was less common (59.0%) than access to a desktop/laptop computer; this did not vary significantly by geography. Districts indicated that 88.0% of students had access to an Internet-enabled device "adequate for online learning," with rural districts reporting a significantly lower mean percentage than urban school districts (80.0% vs. 90.1%, $p < 0.001$). Statewide, school districts reported an average of 80.7% of students with access to reliable broadband adequate to support synchronous video. Rural school districts reported a significantly lower mean percentage of students with access to broadband compared to urban districts (67.5% vs. 84.2%, $p < 0.001$). Unweighted mean percentages were consistent with these findings (see Supplemental Table 1). Geographic variation in the percentage of students in each school district with access to technology and broadband services is apparent in Figure 2 (based on unweighted mean percentages).

Table 2 presents the mean percentage of students who experience barriers to accessing broadband, as reported by school districts. A total of 132 (76.7%) rural and 56 (58.3%) urban school districts reported geography as a barrier (i.e., broadband was not available in the area) for at least some of their students. On average, rural districts reported that 18.2% of their students experienced this barrier, compared to 10.1% reported by urban districts (p = 0.005). A total of 98 (57.0%) rural and 50 (52.1%) urban districts reported access to broadband through a smartphone data plan as a barrier; overall, these schools reported that 23.7% of their students experienced this barrier, on average, with no differences observed between rural and urban school districts in the percentage of students experiencing this barrier (p = 0.63). Findings based on unweighted mean estimates were similar to weighted results (see Supplemental Table 2 for unweighted results).

Thirty-two school districts reported that their students faced “other” barriers to accessing broadband (14 rural, 18 urban; Table 2). Six districts (three rural, three urban) cited low bandwidth or weak broadband connections as a barrier, providing comments such as “broadband quality is too low for streaming” (urban district) or “connection is weak in outlying rural areas” (rural district). Family preference was also noted as a barrier to Internet access by one rural and three urban districts, who indicated that families “do not want Internet in their home.”

DISCUSSION

Evidence from this study suggests that proportionally fewer rural students have the technology needed to effectively access online, telehealth health and education services. In particular, compared to urban students, relatively fewer rural students had a device adequate for online learning or reliable broadband service to support synchronous video at home. Given telehealth has been touted as a solution for reaching rural communities in mental health and other services[6,8,13] and that remote learning is a COVID-19 mitigation strategy until the pandemic is controlled,[19] rural youth are at risk for having unmet health care and education needs. Consistent with other scholars who contend that broadband is a social determinant of health,[2] we assert that these technologies are essential for ensuring that children and adolescents have equitable access to health care and education, both of which are critical during and after the COVID-19 pandemic.

Synchronous, interactive communication between provider and patient using telehealth technology[27] closely approximates in-person mental health services.[28] However, we recognize that other technology could be employed to deliver mental health services, including mobile apps; asynchronous text, voice or video messages; games; and simulations.[16,28] While some of these approaches are “low-tech” and could be readily implemented in rural settings (assuming they are acceptable to rural populations and privacy is ensured), the barriers discussed in this article, including inadequate cellular phone coverage and costly data plans, may prove limiting. Children and adolescents living in rural areas deserve access to these services in schools or through non-school-based providers that are equitable to their urban counterparts.

Like elsewhere in the world, the US has seen substantial momentum to expand telehealth in response to the COVID-19 pandemic.[29] The federal government has eased several policy restrictions that have historically limited the provision of telehealth services. For instance, the Office for Civil Rights has issued notice that it will not impose penalties for covered entities that use certain remote communication technologies that may not be fully compliant with the Health Insurance Portability and Accountability Act (HIPAA), such as Zoom or Facebook Messenger, assuming “good faith provision of telehealth during the COVID-19 nationwide public health emergency.”[30] Other policy changes that have fostered telehealth expansion include the allowance of telehealth services to be billed as if in-person care was provided and the expansion of covered services for Federally Qualified Health Centers and Rural Health Clinics.[31] Rural health care systems are now expanding telehealth services to provide patient care, while maintaining the safety of health care staff and providers.[32] According to a national survey of US school districts in April 2020, only 22.7% school websites mentioned providing mental health counseling for children and adolescents during the COVID-19 pandemic, the majority of which were offered via suboptimal technology that enabled communication but lacked visual cues important for mental health assessment (e.g., telephone).[17,19]

In order to facilitate students' remote learning, 88% of US school districts reported distributing devices (e.g., laptops, tablets) and 50% provided access to Internet hotspots.[19] Still, these efforts do not meet all students' needs, including those in geographic areas without access to Internet service at all. Districts provided learning materials and supports through multiple modalities, including in printed form, to alleviate disparities in technology and broadband access.[19] Public television systems also provided high-quality, educational programming to support remote learning.[19] As more schools re-open due to widespread vaccination efforts and other COVID-19 mitigation strategies, remote learning concerns for rural youth are likely to diminish. However, lack of broadband in rural communities will remain a concern for certain educational activities, such as homework that are done outside of the classroom setting.

Despite efforts made to increase access to telehealth services and remote learning amidst the COVID-19 pandemic, our findings indicate that children and adolescents in rural Washington State are less likely than their urban peers to have the necessary resources to enable equitable access to health care and education. We found that approximately 18% of rural students live in a geographic area without broadband or smartphone data access, compared to only 10% of urban students. In addition, nearly 36% of rural students could not afford broadband compared to 28% of urban students. Until rural-urban inequities in broadband access and use are addressed, expansion of telehealth services and remote online learning may inadvertently perpetuate rather than alleviate health disparities among rural youth. Policies are needed urgently to improve and expand broadband access to ensure that the needs of people who reside in rural areas are not marginalized, as well as to reduce barriers to telehealth and remote learning in rural communities. As a start, recent bipartisan legislation has called for reforms in broadband deployment maps to more realistically reflect broadband coverage across the US.[33]

Simply having broadband may not eliminate the technology-related barriers that rural residents face – Internet speed matters. According to the FCC, minimum broadband download speeds for remote learning range from 5 to 25 megabits per second (Mbps); the minimum download speed for high-definition video calls and high-definition videoconferencing are 1.5 and 6 Mbps, respectively.[34] Based on these parameters, many rural residents who have broadband may lack requisite download speeds to enable telehealth services and remote learning at present. However, rural residents may also be able to access the Internet using mobile devices (some wireless carriers provide data speeds that exceed 30 Mbps), and evidence indicates there is no difference between rural and urban residents in Internet use via cellular networks.[35] Fixed wireless Internet is an additional option for some rural residents who otherwise lack broadband.

Another important consideration is whether broadband is available in certain areas but is not being used by residents. Four school districts (three urban and one rural) in this study noted that some families simply did not want Internet service in their homes. Alternatively, cost barriers may preclude broadband uptake in rural populations even if broadband is available. Many rural residents may be unable to afford broadband, which is consistent with our finding that affordability was a barrier for youth in rural school districts. Data from the 2018 American Community Survey show that the prevalence of poverty was higher in rural areas, with the most severe poverty noted in the Southeast and Native American communities.[36] If rural residents rely on a broadband connection through their smartphone, data costs and limited connectivity may preclude access to telehealth services and remote learning.

This study has several limitations. First, the information provided by school districts is based on self-report and we were not able to verify accuracy. Fewer than half of the districts collected data from families to inform their responses. It is possible that districts obtained this information prior to the OSPI surveys in spring 2020 to provide supplemental online content prior to the pandemic. Schools that distributed devices to families prior to the pandemic, which would be reflected in their inventory records, may explain why one-third of urban districts collected data from families. Second, school district data were based on self-report, and the "adequacy" of technology and broadband access for online learning may be subject to interpretation. However, perception of adequacy is a valuable indicator that may affect one's willingness to use telehealth services or remote learning. Finally, while the data reported in this study describe technology and broadband access for children and adolescents enrolled in public school districts and do not capture the situation for those who attend private schools or are home-schooled, our data do capture nearly all (92%) schools attended by children and adolescents in Washington State. Efforts to improve access to technology and broadband, as well as on- and off-line education and mental health services, should focus on all school-age youth.

Conclusions

Proportionally more students in rural school districts of Washington State experienced barriers accessing the technology and connectivity needed for remote learning and synchronous, video-based telehealth services, compared to their urban peers. These inequities have the potential to exacerbate rather than mitigate health and education disparities during COVID-19 and beyond. Efforts to improve policy and to advance technology throughout the US and globally must consider geographical disparities in access to technology and broadband as issues fundamental to education and health equity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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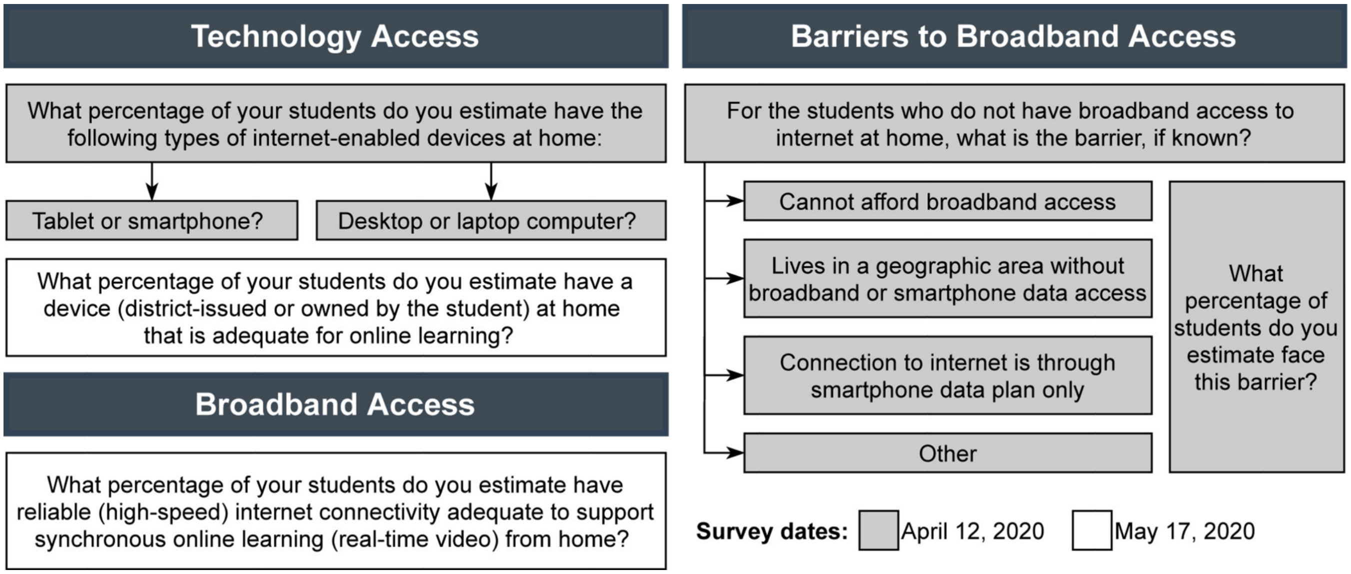

Figure 1.

Survey prompts related to technology and broadband access and barriers that were sent to public school districts by the Office of the Superintendent of Public Instruction (OPSI) in spring 2020. (Text reflects verbatim wording in OSPI survey.)

Figure 2.

Percentage of students per district with access to A) desktop/laptop computer (Internet-enabled), B) tablet or smartphone (Internet-enabled), C) Internet-enabled device that is adequate for online learning, and D) reliable broadband adequate to support synchronous (real-time) video. Percentages reflect unweighted, district-reported values.

Table 1.

Mean percent of public school students with access to Internet-enabled technology and broadband, by rurality. Washington State, 2020.

	Urban	Rural	All districts	Sig.*
	Mean (95% CI)	**Mean (95% CI)**	**Mean (95% CI)**	
Internet-enabled technology at home				
Desktop or laptop computer	76.0 (65.3–86.7)	66.0 (58.0–73.9)	73.9 (65.2–82.6)	0.14
Tablet or smartphone	59.2 (45.8–72.6)	58.3 (49.7–66.8)	59.0 (48.3–69.7)	0.91
Device that is “adequate for online learning”	90.1 (86.9–93.3)	80.0 (75.1–84.9)	88.0 (84.9–91.1)	<0.01
Reliable broadband Internet adequate to support synchronous (real-time) video	84.2 (79.6–88.8)	67.5 (61.4–73.5)	80.7 (76.4–85.0)	<0.01

Source: Author

Note: Values indicate the estimated mean (weighted) percent of students reported by school district. Sample weights based on district average daily attendance have been applied. Rurality based on school district classification of rurality NCES scheme. Item response rates varied as follows: Access to desktop/laptop computer, n=147 rural and n=84 urban districts; access to a tablet or smartphone, n=135 rural and n=72 urban districts; access to a device adequate for online learning, n=137 rural and n=65 urban; broadband, n=136 rural and n=65 urban.

Abbreviations: CI, confidence interval; NCES, National Center for Educational Statistics; SD, standard deviation

*Wald test comparing responses from urban and rural districts.

Table 2.

School district-reported percentages of students experiencing barriers to accessing broadband Internet, by rurality. Washington State, 2020.

	School districts indicating students experience barrier (% of all responding districts)		Mean percentage of students experiencing each barrier to broadband access (95% CI)			Sig.*
	Urban	Rural	Urban	Rural	All districts	
Living in a geographical area without broadband or smartphone data access	56 (58.3)	132 (76.7)	10.1 (7.2–13.1)	18.2 (13.5–22.9)	12.3 (9.7–14.9)	<0.01
Cannot afford broadband access	68 (70.8)	113 (65.7)	28.4 (19.7–37.0)	35.6 (27.0–44.2)	29.7 (22.4–37.0)	0.24
Broadband connection to Internet through smartphone data plan only	50 (52.1)	98 (57.0)	24.3 (12.3–36.4)	21.0 (14.4–27.6)	23.7 (13.9–33.4)	0.63
Other (write-in option)	18 (18.8)	14 (8.1)	5.4 (1.3–9.5)	39.0 (0.7–77.4)	7.3 (2.0–12.7)	0.09

Source: Author

Note: Values indicate the estimated mean percent of students reported by school district. Sample weights based on district average daily attendance have been applied. Rurality based on school district classification of rurality per NCES scheme.

Abbreviations: CI, confidence interval; NCES, National Center for Educational Statistics; SD, standard deviation

* Wald test comparing the mean percentage of students experiencing each barrier across urban and rural districts.