MOBILE PHONE ACCESSIBILITY REVIEW

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Mobile Phone Accessibility Review

Introduction

The Georgia Institute of Technology's Center for Advanced Communications Policy (CACP) in collaboration with the Rehabilitation Engineering Research Center for Wireless Inclusive Technologies[1] (Wireless RERC**)** focuses on key issues that influence the development, implementation, and adoption of cutting-edge, advanced communications technologies. The work includes the identification of future options for innovation, articulation of a clearer vision of the ever-changing technology landscape, and assessment of policy issues with a particular emphasis on the impact on people with disabilities.

The Federal Communications Commission (FCC) has a statutory obligation to evaluate the impact of their regulations that implement the *Twenty-First Century Communications and Video Accessibility Act (CVAA).* Every two-years the FCC submits a report to Congress on the state of industry compliance with the CVAA. In anticipation of the FCC's call for stakeholder input to inform their *2018 CVAA Biennial Report*, the Wireless RERC conducted a 2017 Mobile Phone Accessibility Review (Accessibility Review/Review). Mitchell et al. (2018) submitted preliminary results of the review in response to the FCC's request for "input on the state of accessibility of "mobile" or wireless services, including basic phones and feature phones (collectively referred to herein as non-smartphones), as well as smartphones" (FCC, 2018, p. 3). This report contains the full summary and comparative analyses.

Methods

The Review included mobile phone models available as of September 2017 from the top four wireless carriers, one prepaid carrier, and five Lifeline Carriers.[2] Researchers,

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[1] The Rehabilitation Engineering Research Center for Wireless Inclusive Technologies (Wireless RERC) is sponsored by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR grant number 90RE5007-01-00). NIDILRR is within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). The contents of this Review do not necessarily represent the policy of NIDILRR, ACL, HHS, and you should not assume endorsement by the Federal Government.

[2] A random number generator was used to select five of the 49 lifeline carriers for inclusion in the review.

using the providers' web pages as a reference, identified 214 mobile phones for evaluation. Two research analysts independently collected data on the presence of 26 features that impact accessibility and/or were designed to provide access to people with vision, hearing, cognitive and mobility disabilities in each phone model. Sources included the Mobile Manufacturers Forum Global Accessibility Reporting Initiative (GARI) database,[3] user manuals, and phonescoop.com. With the exception of hearing aid compatibility (HAC) rating and screen size, accessibility features were coded as either 1 = "yes," 0 = "no," or 3 = "information not available." Once the data collection phase was complete, the two databases were reconciled, and a summary and comparative analyses produced using Microsoft Excel.

Study Limitations

A limitation of the results of this Accessibility Review is that the 25 features included in the review are not an exhaustive list. Consumers use device features in novel ways to improve access. For example, timers and reminders can be used in an assistive manner for someone with cognitive disabilities, but that feature was not assessed in the study. With the exception of FM Radio and wireless emergency alerts (WEA) capable,[4] the features identified for the study include those that are used to access the phone, content displayed on the phone, or to connect to external assistive technology or other smart devices that can be controlled via the phone.

Another limitation of the results is that for many of the features, information about whether it was included in the phone could not be found using the three sources listed above. Thus, we cannot conclusively state that the features *are* or *are not* present. However, the difficulty in locating information about certain features is in itself an important result, as consumers with disabilities may experience a similar problem when comparing models and selecting a phone to purchase. While people without disabilities can compare phone models based on *preferences* alone, people with disabilities may have accessibility *requirements* for the phone to be usable by them (e.g., video calling,

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[3] The Global Accessibility Reporting Initiative (GARI) is a project of the Mobile & Wireless Forum (MWF). Some of the data referred to in this paper was sourced from the information available from the GARI website www.gari.info and used with permission of the MWF, although all views and conclusions are the authors alone.
[4] Data were collected on the presence of an FM Radio feature and WEA capability to inform ongoing mobile emergency communications research initiatives.

HAC, screen reader, assistive technology (AT) connection). If information about the features required by a user with a disability is not easily found, then the consumer may purchase a phone that is not fully accessible to them, or not purchase a phone model that would have been accessible to them. Notwithstanding the limitations of this study, the results provide a snapshot of the accessibility of a sample of mobile phone models commercially available in 2017.

Results and Implications

Phone Type, Operating Systems, and Accessibility Features
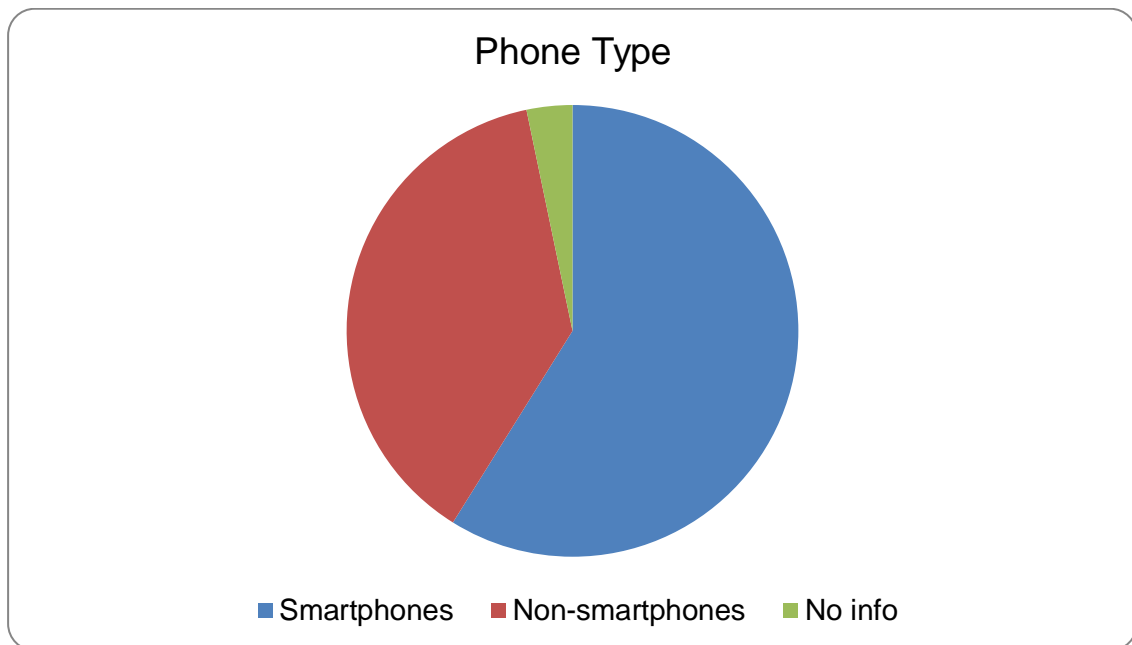

Figure 1: Phone Types

Of the 214 mobile phones included in the sample, 59% of them were smartphones, and 38% were non-smartphones (Figure 1). The remaining 3% of mobile phones were not known. After the identification of the phone type, the mobile phones were categorized by the operating system (OS). Fifty percent (50%) of the mobile phones in the sample had an Android OS, and 5% were iOS, while the remaining 32% of the phones were proprietary operating systems, Windows, and Blackberry. For 12% of the phones, information was not available (Figure 2).
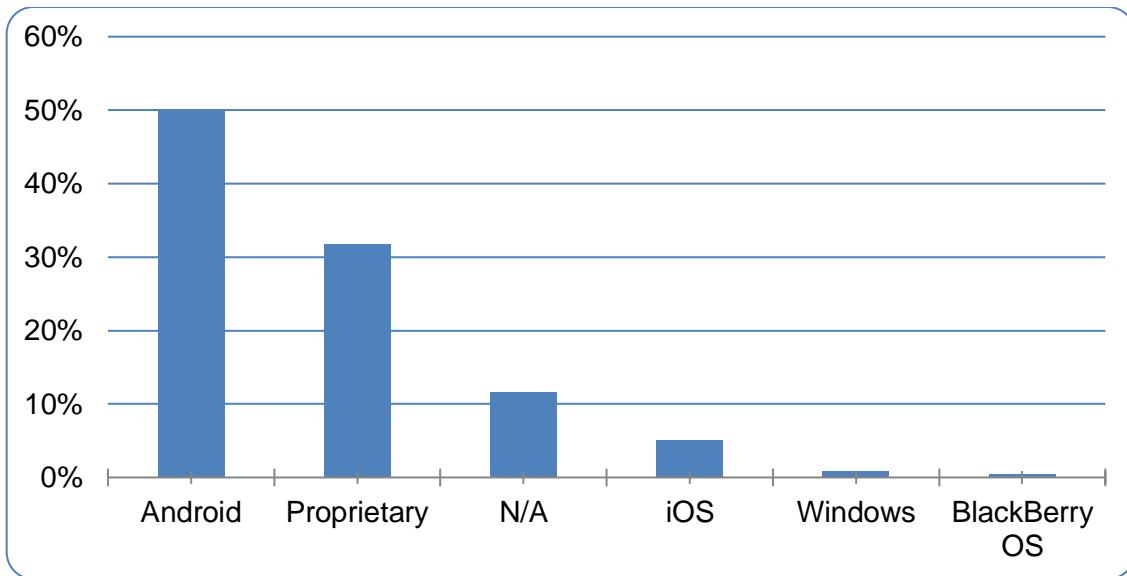
Figure 2: Operating Systems

The study collectively evaluated the accessibility features all mobile phone models available as of September 2017 from the top four wireless carriers, one prepaid carrier, and five Lifeline Carriers. Data were collected on a total of 26 features and phone characteristics. These features included: HAC rating, Screen size, Bluetooth, USB, adjust font, voice input, headphone jack, smartphone, contrast adjustment, built-in text-to-speech (TTS), two-way video, captions, FM radio, WEA-capable, simple display, vibration adjustments, full access screen reader, physical number keypad, biometric log-in, near field communications (NFC), braille access, physical QWERTY keyboard, mirror link, infrared (IR), and procure TTS. With the exception of screen size and HAC rating, Figure 3 notes the percentages of the accessibility features on all mobile phones included in the sample.
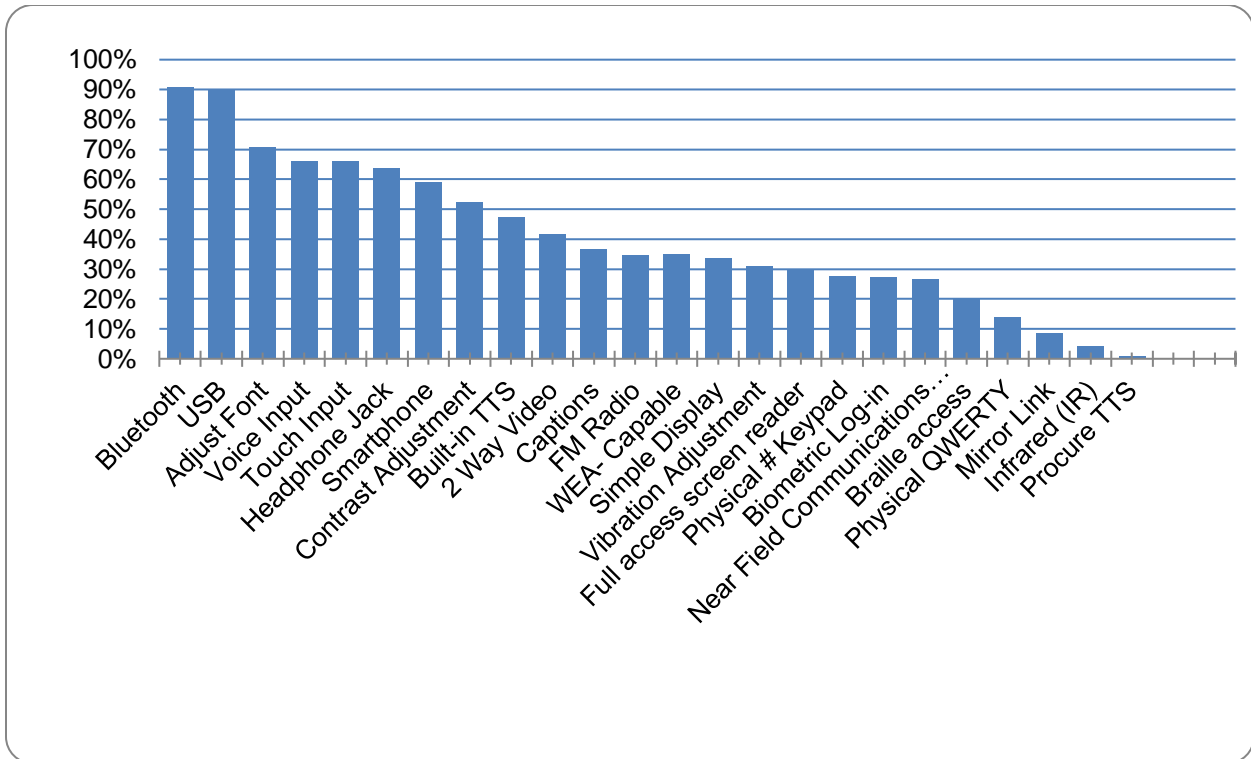
Figure 3: All Accessibility Features

Mobile phone accessibility features were evaluated by categorization: smartphone or non-smartphone (Figure 4). The results indicate that both phone types contained features that can be assistive to people who are blind, have low vision, cognitive disabilities and/or physical disabilities. However, smartphones outperformed non-smartphones in the percentage of accessibility features present, pulling higher percentages for 20 of the 24 features examined. In the smartphone subsample, the most frequently incorporated (top five) features that impact accessibility of the device were Bluetooth (100%), touch input (100%), USB (98%), voice input (82%), and headphone jack (79%). Similarly, for the non-smartphones subsample, the top five features included USB (81%), Bluetooth (79%), physical number keypad (72%),adjust font (58%), and headphone jack (43%). Noted is the steep differentials between the percentages based on phone type.
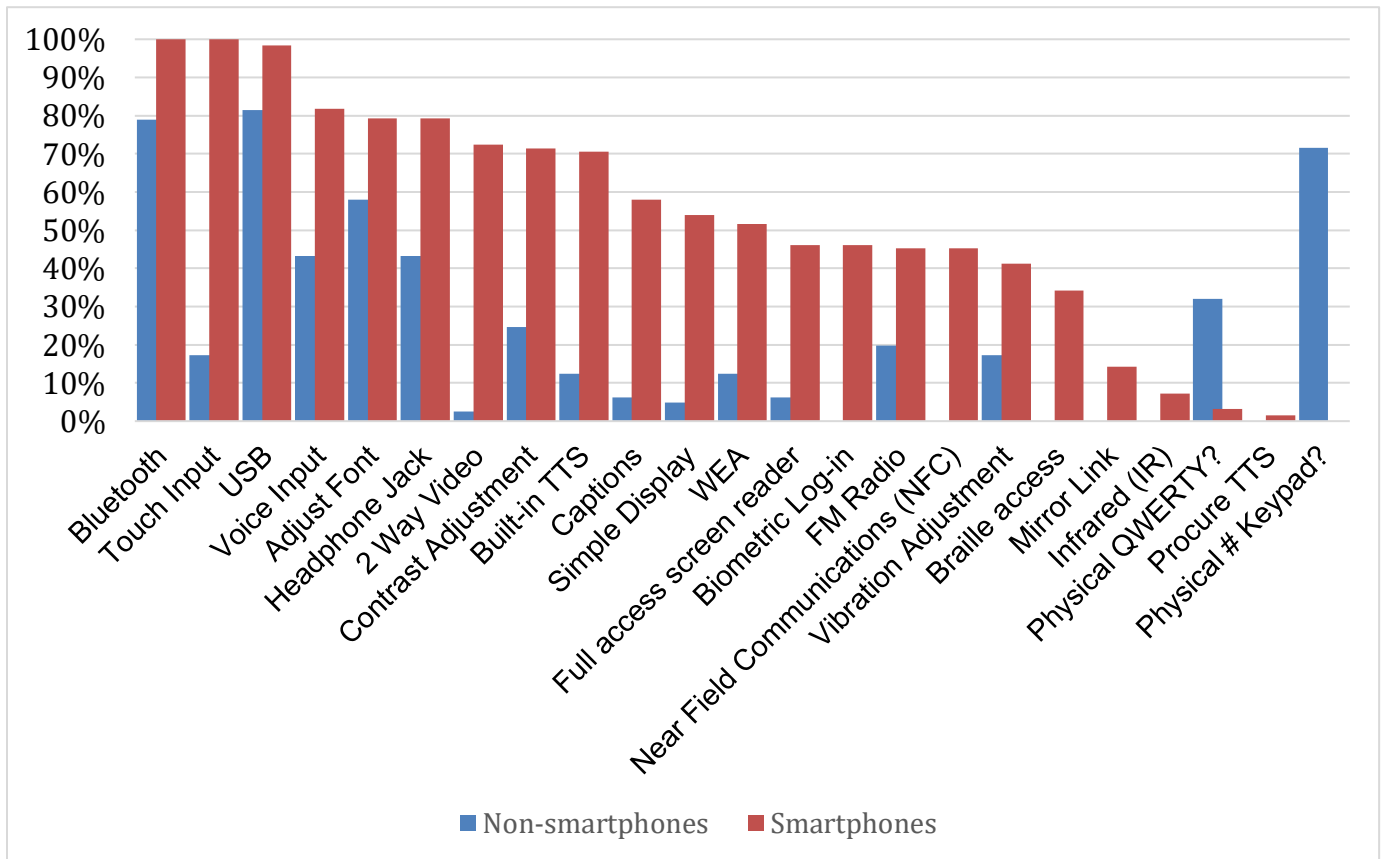
Figure 4: Comparison of Smartphone & Non-Smartphone Features

Implications

Prior studies demonstrated how integral smartphones are to people with disabilities in maneuvering through daily life (Morris, 2017). The above-detailed data bodes well for those smartphone users with disabilities, as accessibility, especially for the latest versions of iOS and Android, is better (with regard to richness of features) than in non-smartphones. Further, mobile applications (apps) can be downloaded to the device for very specific access functions. However, it is important to note that some users with disabilities, particularly the elderly, may prefer non-smartphones, so accessibility for these types of phones should not be overlooked. In focus groups of people with traumatic brain injury, participants mentioned keeping their clamshell style phones because of their durability (CACP Collaborative, 2015). While non-smartphones have fewer options, for some disability types, the physical input options present (e.g., number keypad, QWERTY keyboard) offer accessibility, but there is a tradeoff in functionality.

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The broader implication of the lower levels of accessibility features in non-smartphones is the effected demographic. Though various factors influence the decision for an individual with a disability to select a non-smartphone, socioeconomic status (SES) often has a major impact. Studies illustrate that people with disabilities comprise a significant proportion of Americans living in poverty (American Psychological Association, 2017). The American Community Survey from the American with Disabilities Act Participatory Action Research (2014) highlighted substantial disparities in the median income for those living with disabilities and those who do not. With non-smartphones having a lower price point, phone accessibility and income are linked. As this study found, non-smartphone devices' accessibility features are mostly present at lower levels, when compared to smartphone devices, or completely absent. This data is illustrative of how the economic divide contributes to an accessibility divide which effectively maintains the digital divide.

Assistive Technology Connections

The capability to connect assistive technology (AT) to each phone model was tabulated. Having multiple ways to connect a device to external AT is critical for some people with disabilities' use of a smartphone. AT connections are particularly pertinent to those that are blind who use refreshable Braille displays, those with quadriplegia, who use switch access, a feature designed to allow for hands-free navigation of a device, or individuals who utilize neck-loops to amplify sounds. Also, connectivity options such as Mirror Link, near field communications (NFC), and infrared allow users to connect to their vehicles, perform cashless transactions, and utilize a smartphone as a universal remote. As shown in Figure 5, of all mobile phones in the sample, 90% had Bluetooth and USB capabilities, while 64% had a headphone jack, 25% had NFC, and less than 10% had Mirror Link or Infrared (IR).
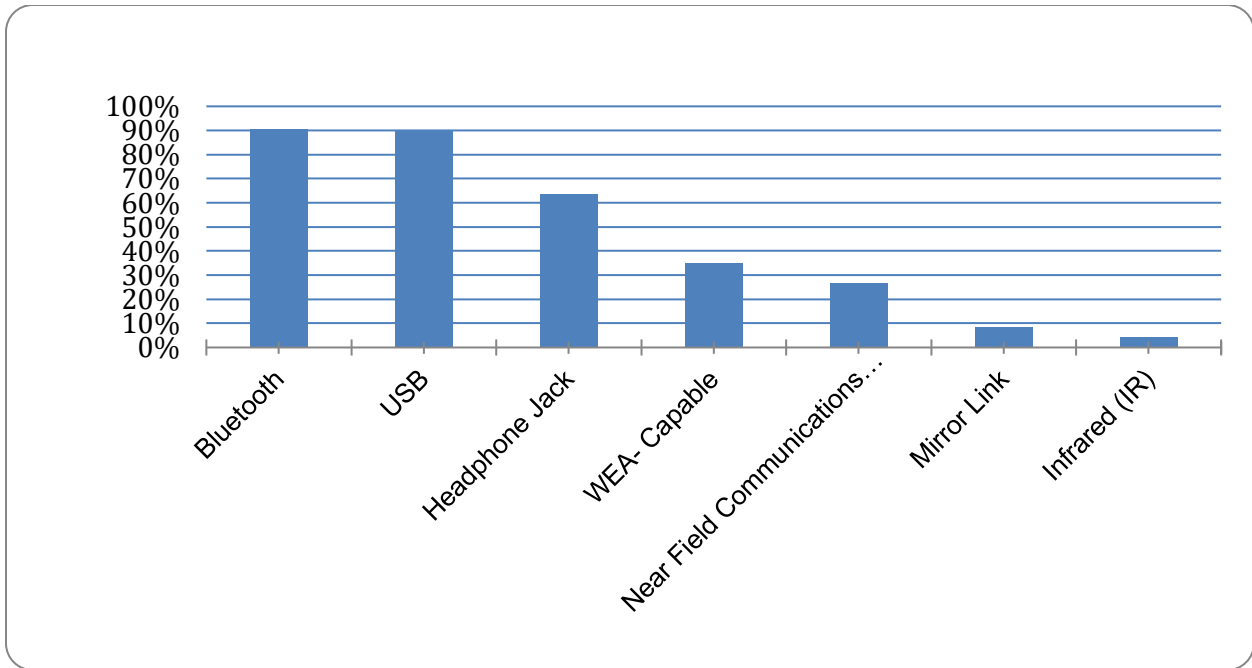
Figure 5: Assistive Technology Connection

Another assistive technology used with mobile devices are hearing aids. Researchers found HAC ratings for 30% of the sample. Without a HAC compliant device, a user with a hearing aid or cochlear implant would experience interference; typically a buzzing, humming, or whining noise. The M and T in the HAC ratings stand for microphone and telecoil. M3 or T3 is considered good and M4 or T4 is considered excellent. Thirty percent (30%) of the mobile phones in the sample had a HAC rating of M3/T3, for 21% HAC rating information could not be found (N/A), 16% had an M3/T4 rating, 13% of mobile phones had an M4/T4 rating, 12% M4/T3, 4% M3, and approximately 2% had an M4 HAC rating (Figure 6).
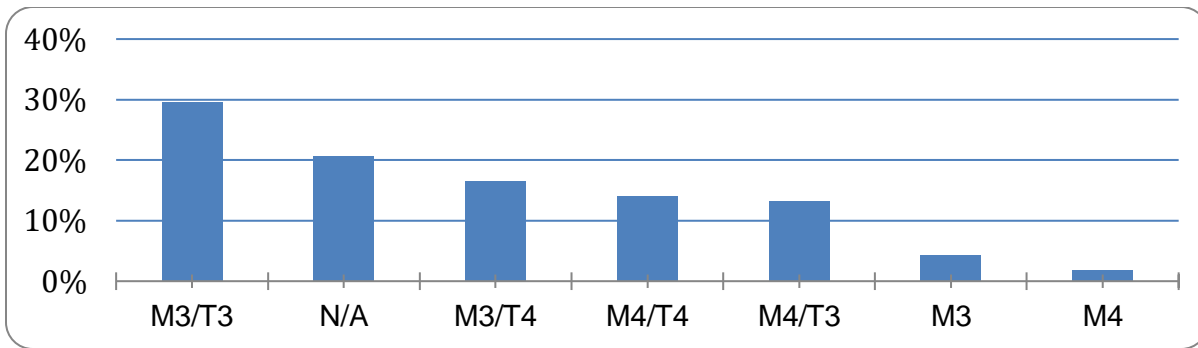
Figure 6: HAC Percent Breakdown

Implications

In the last ten years, the U.S. Department of Health & Human Services' National Institute on Deafness and Other Communication Disorders (NIDCD) have made substantial strides in developing assistive technology for hearing and commissioning research to increase the accessibility and integration of these products with mainstream devices. Mobile phones with limited pairing capabilities, constrain the utility of these devices. Also, as previously noted, no more than 30% of the surveyed phones had a "good" (M3/T3) HAC rating. This suggests an overwhelming percentage of mobile phones may lack the necessary capabilities for those that use hearing aids and limits device options. However, when M and T ratings are available for the same device, theoretically, consumers are more likely to find the appropriate device for their needs. As is shown in Figure 6, a majority of the sample consisted of phones with combined ratings.

Accessibility by Disability Type

The study examined accessibility features for four types of disability: visual, hearing, cognitive, and mobility/dexterity. When evaluating the accessibility features for visual disabilities, the study focused on the percent of phones that had individual features that improve access for people with visual disabilities (Figure 7). Sixty-six percent (66%) of phones had a voice input feature; 52% contrast adjustment feature; 47% built-in TTS; 35% FM radio; 31% vibration adjustment feature; 30% full access screen reader; 28% physical # keypad; 27%, biometric log-in; 20% braille access; 14% physical QWERTY keyboard; and 1% of phones had procure TTS.

Figure 7: Accessibility Features for Visual Disabilities

Figure 8 illustrates the accessibility features and phone characteristics (Bluetooth, two-way video, caption feature, vibration adjustment) that are important for people with hearing disabilities. Ninety-five percent (95%) of phones had the Bluetooth feature, 42% of phones had 2-way video capabilities, 36% had the caption feature, and on 31% of phones, the vibration could be adjusted.
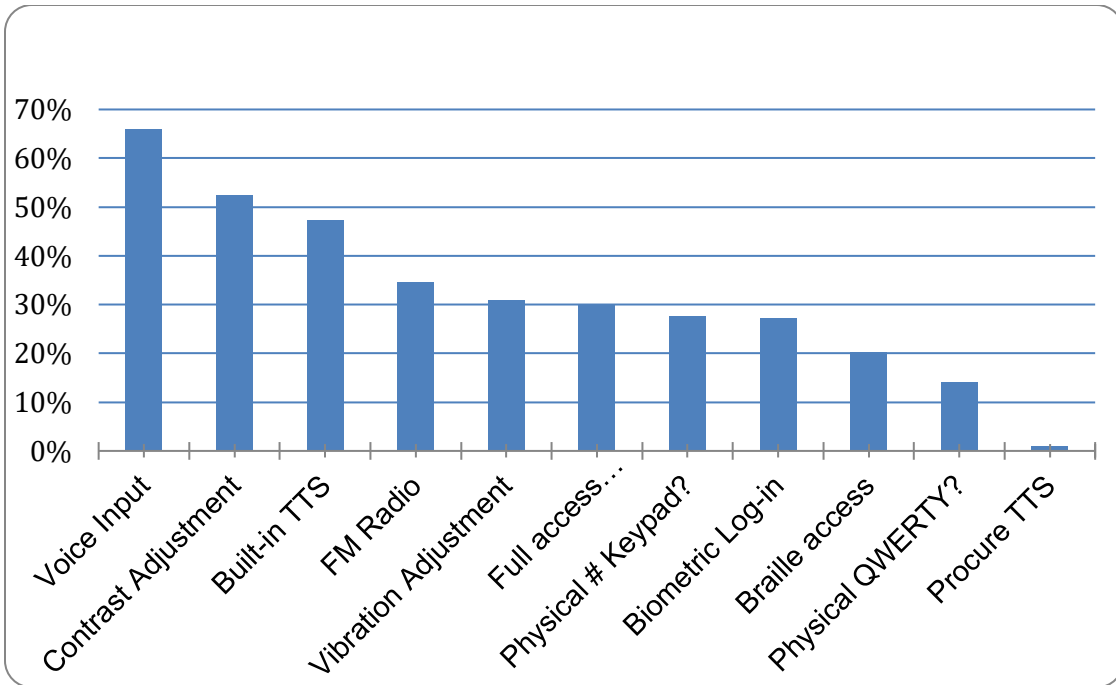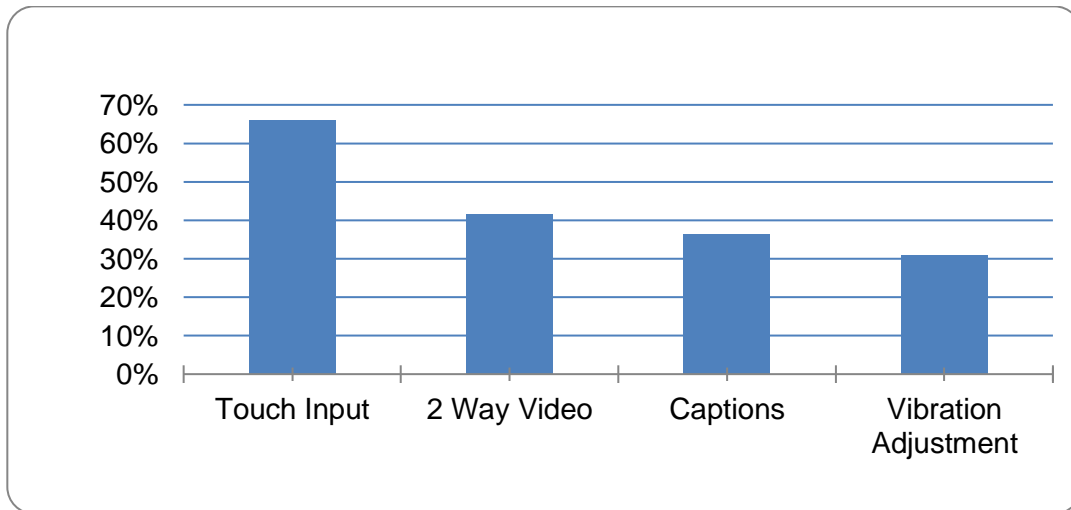

Figure 8: Accessibility Features for Hearing Disability

Figure 9 illustrates accessibility features and phone characteristics that may improve the usability of the device for people with cognitive disabilities. Of the sampled mobile phones, 66% had a voice input feature, 52% had contrast adjustment, 47% had built-in TTS, 34% had simple display feature, 30% had a full access screen reader, 27% had biometric log-in, and 1% of phones had procure TTS feature.
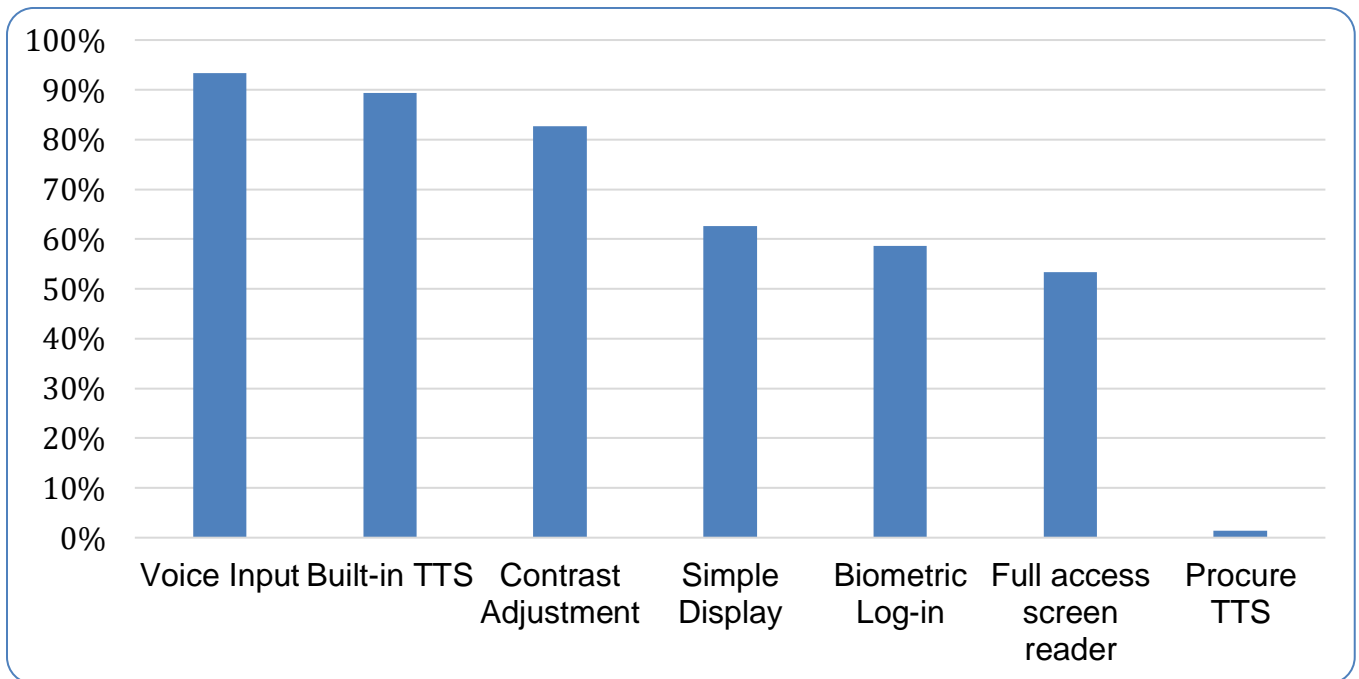
Figure 9: Accessibility Features for Cognitive Disabilities

Figure 10 illustrates accessibility features and phone characteristics that may improve the usability of the device for people with mobility and dexterity disabilities. In this study, voice input, simple display, biometric log-in, and near-field communications (NFC) are identified as features intended to aid people living with mobility/dexterity disability in unlocking, navigating the device, and interacting with external systems. Sixty-six percent (66%) of phones had voice input, 34% had a simple display option, 28% had biometric log-in, and 27% had NFC.

Figure 10: Accessibility Features for Mobility/Dexterity Disabilities

Implications

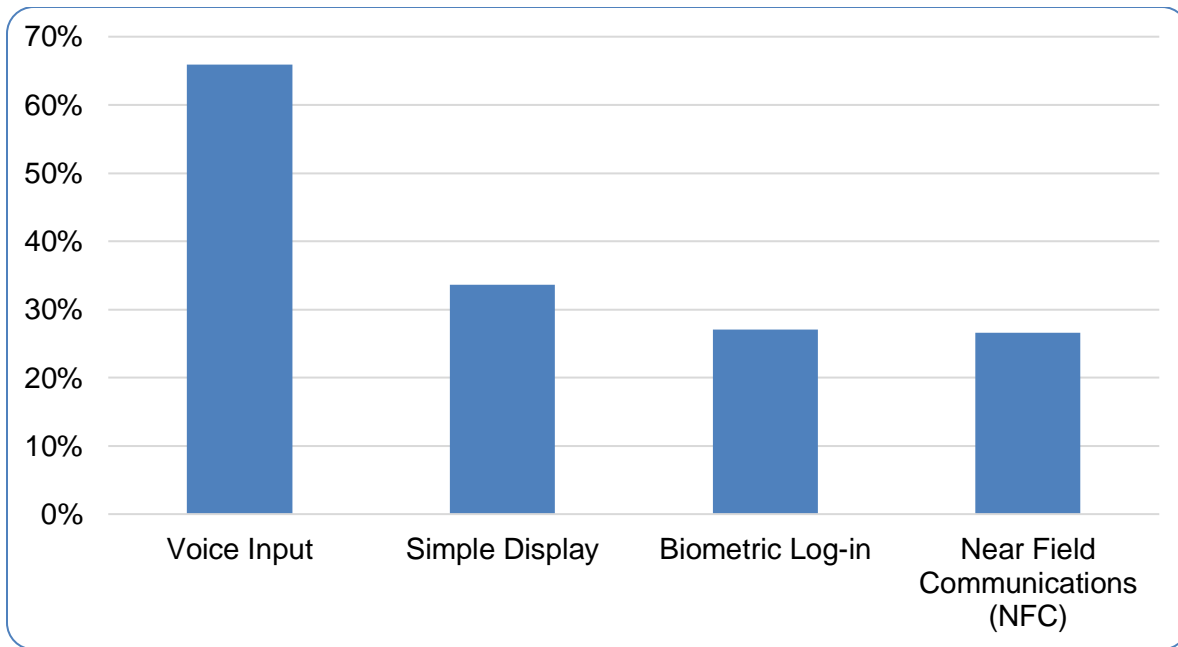Of the twenty-four features assessed, one of the accessibility characteristics for individuals with hearing and individuals with dexterity/mobility disabilities appeared in more than 50% of mobile phones in the sample. While two of the accessibility features for visual and cognitive disabilities appeared in more than 50% of mobile phones in the sample. This phenomenon is particularly notable because on average, only half, or in some cases less than half, of the accessibility features that are important for people with these types of disabilities had their needs met. As it stands now, people with disabilities have a more limited selection, and more research is required on the part of the consumer prior to purchase to determine if the device will meet their accessibility requirements. By example, 42% of the devices have accessibility features that would allow people who are deaf to place a video call and communicate in American Sign Language (ASL). For certain populations, this feature is required to make the device usable. Thus 58% of the devices in the sample may be excluded as device options for people that are deaf who primarily communicate via ASL.
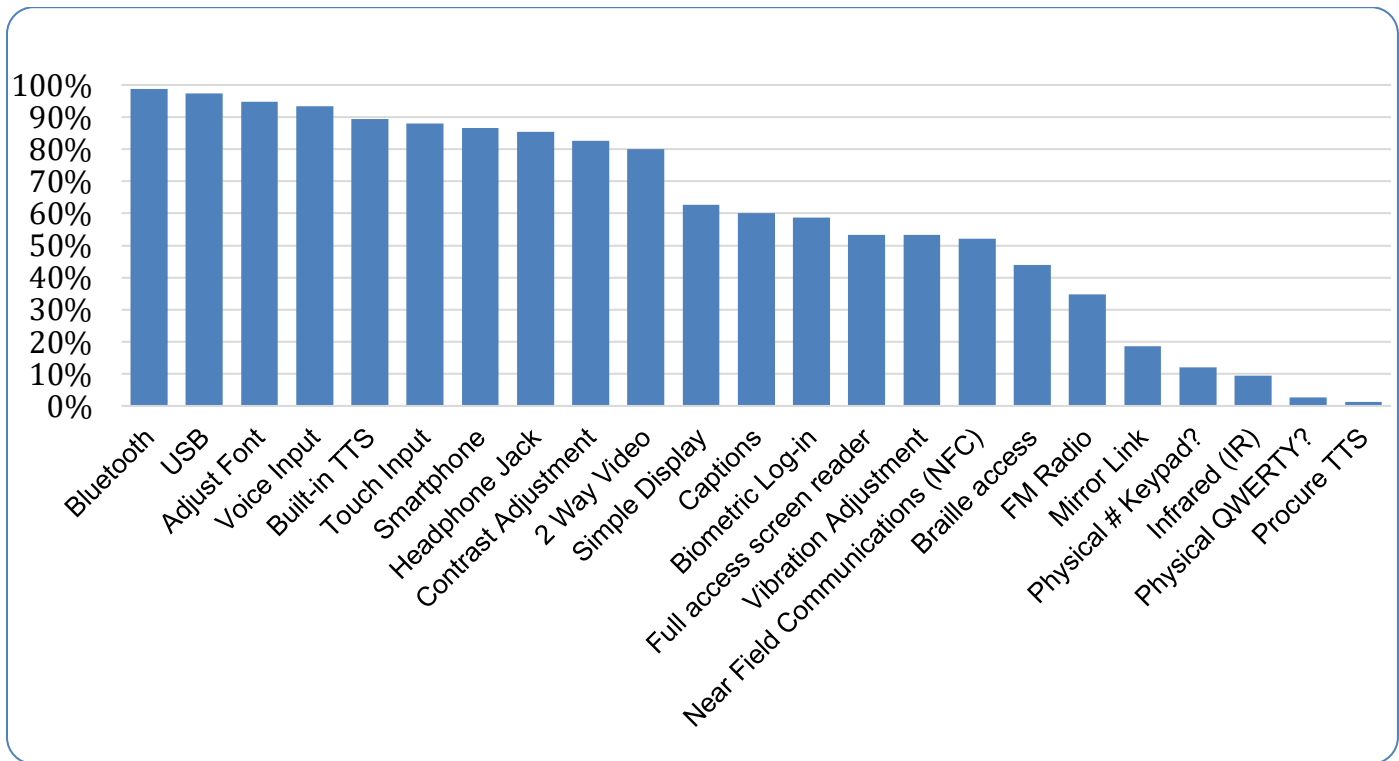
Accessibility of WEA-Capable Phones

Figure 11: 2017 WEA-Capable Phone Accessibility Features

Within the 2017 dataset, there were 72 WEA capable phones (35%). The top five features included Bluetooth (99%), USB (93%), adjust font (94%), voice input (93%), and built-in TTS (89%) (Figure 11). The bottom five features included procure TTS (1%), physical QWERTY keyboard (3%), infrared (9%), physical # keypad (12%), and mirror link (19%). Compared to the whole sample, the WEA-capable subset had greater percentages of accessibility features for 19 of the variables, sometimes by a very wide margin. For example, contrast adjustment is available on 83% of the WEA-capable subset, compared to 42% found in the whole sample; and a simple display option is available in 63% of WEA-capable devices compared to 34% of the whole sample.

Implications

These data indicate that WEA-capable devices have more accessibility options than non-WEA-capable phone models. If this trend holds, then increasing the amount of

WEA-capable handsets on the market could impact overall accessibility of levels of mobile phones.

Comparative Analyses

2015 and 2017 WEA-Capable Phones

To assess change over time in the presence of accessibility features, a subsample of WEA-capable phones from the 2017 dataset were compared to the 2015 dataset, of which all phones were WEA-capable. In 2017 additional accessibility features were tabulated, but for the sake of direct comparison, only the variables that were the same across the two datasets were included in the comparative analysis.

The 2017 WEA-capable phones had more accessibility features than were found in 2015 (Figure 12). The 2017 subsample of mobile phones outperformed the 2015 sample in ten of the thirteen variables, with the greatest difference reflected in the presence of a full access screen reader (50% compared to 3%), capability to adjust display contrast (83% compared to 35%), two-way video feature (80% compared to 40%), the capability to adjust the font (95% compared to 70%), braille access (44% compared to 27%), a simple display option (63% compared to 47%), built-in TTS (89% compared to 75%), and capability to adjust vibration (53% compared to 14%). Modest gains were made in voice features (90% compared to 88%) and touch input (88% of compared to 80%). The 2017 sample saw a decline in the presence of the physical QWERTY keyboards (3% compared to 26%), while the presence of physical number keypad remained flat.
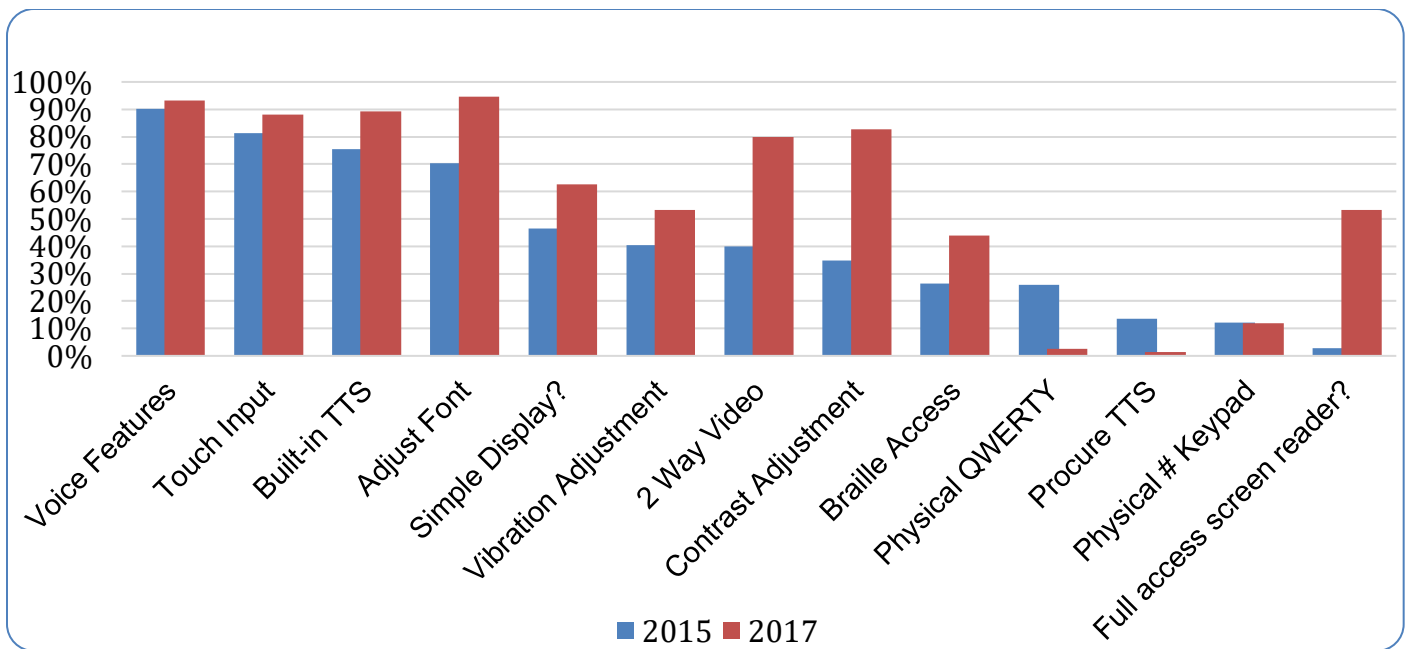
Figure 12: 2015 and 2017 Comparison of WEA Phone Features

Implications

Since wireless providers have limited control over cell phone design, many of the accessibility promises concerning WEA rely on mobile phone manufacturers enabling customizability of the device for the individual user. The data indicates that mobile phones are increasingly including built-in accessibility features, and thus, the technical accessibility of WEA-capable mobile phones, and by extension WEAs, is improving. As a result of this increased accessibility, it is anticipated that many individuals with disabilities that were formerly unable to fully access the content of the WEA message, will experience improved access. Further, the FCC's requirements for ensuring WEAs are accessible to people with disabilities are not a complete solution for accessibility, because in large part they focus on the system architecture and wireless providers as opposed to the device and mobile phone manufacturers. The developments observed in device accessibility of WEA-capable devices and the expected impact on WEA access for people with disabilities, points to the importance of each influencer along the continuum of message creation (alert originator), sending (system infrastructure), and receipt (the device).

Tier 1 Phones and Lifeline Phones

Lifeline phones are government-discounted mobile phones for consumers with low-incomes. The FCC characterized qualified recipients as individuals whose income is at or below 135% of the federal poverty guidelines. This numerical value varies with household size. Those who are eligible can use the Lifeline program for either a phone or internet service; however, there is only one discount per household. Eligible low-income subscribers can expect to pay $9.95/month. Users must connect their phone to one of the participating carriers and companies to access services. Phones provided via the Lifeline phone plan (i.e., Lifeline providers) were compared to models provided by Tier 1 providers.

Mobile phone models provided via Tier 1 providers outperformed Lifeline provider phone models on all *modern* accessibility features (Figure 13). Two phone characteristics associated with older, pre-touchscreen interface-era phones, the physical number keypad, and QWERTY keyboard, were present at greater percentages in Lifeline provider phone models. Nine percent (9%) of the Tier 1 phones had the physical number keypad compared to 39% of Lifeline models, and 1% of the Tier 1 phone models had the Physical QWERTY keyboard compared to 22% of Lifeline phones. The need to procure TTS software has been practically eliminated from both provider types, as only 1% of Lifeline phones indicated this capability (0% for Tier 1 providers), suggesting that TTS has become a standard built-in accessibility feature. For all other accessibility variables, rates of inclusion in Tier 1 phone models exceeded those of Lifeline providers, in many cases, by quite a large margin. The features and characteristics with the greatest percentage point differentials included built-in TTS (84% for Tier 1 and 26% for Lifeline), biometric log-in (65% for Tier 1 and 8% for Lifeline), two-way video (78% for Tier 1 and 22% for Lifeline), WEA-capable (72% for Tier 1 and 17% for Lifeline), and smartphone type (90% for Tier 1 and 40% for Lifeline).
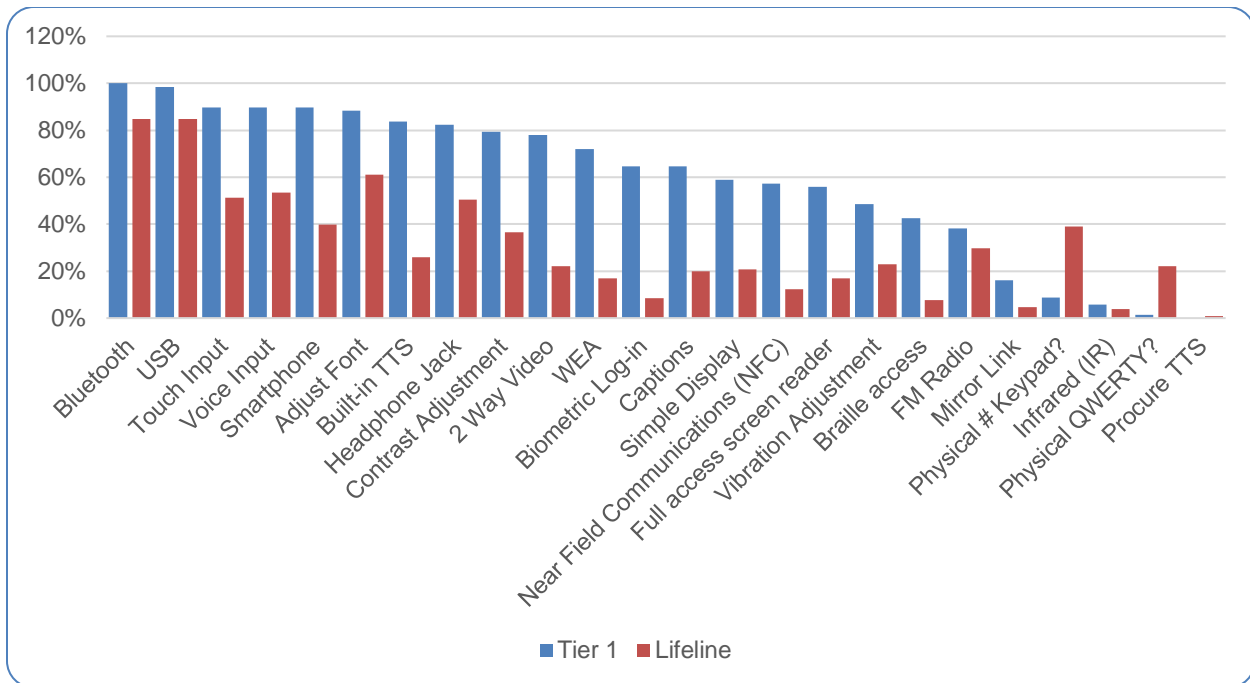
Figure 13: Comparison of Tier 1 and Lifeline Phone Features

Implications

The broader implications of these data suggest that the accessibility level of phones is diminished for people that participate in the Lifeline program, linking level of accessibility to SES. Further, the poverty percentage gap between people with disabilities and those without disabilities have reportedly been between 7.4 and 8.3 points over the past seven years (Lewis, 2017, NIDLRR). "States show an increasing poverty percentage gap between those with and without disabilities at all age groups except for people ages 65 and over" and more than one in five (21.2%) working age, Americans with disabilities were living in poverty compared to the national rate of 13.8% for their non-disabled counterparts (Lewis, 2017). These statistics suggest that people with disabilities may represent a significant proportion of Lifeline subscribers.

Ethnic minorities, those with disabilities, and people from low SES are disproportionately affected by natural disasters, and often people of low SES are unable to respond to official warnings (SAMHSA, 2017). The Lifeline program was incepted with the intention of improving access to phones and the services that are afforded by having the technology. However, the accessibility level of the devices offered is a limiting factor to achieving true access equity. Further, the impacts of the diminished

accessibility level are not encapsulated in the Lifeline program but extend to other domains. For example, though they are both government initiatives regulated by the FCC, remarkably, there is a major discrepancy between the WEA-capability on Lifeline phone models compared to Tier 1. The Lifeline program was designed to reduce the digital literacy gap and access to technology between low-income populations and higher income populations. WEAs were developed to increase access to emergency alerts for the general public; however, only 17% of Lifeline phones indicated WEA capabilities. This statistic is particularly troubling because some of the nation's populations which are most vulnerable to the effects of disasters are not receiving critical access to WEA messages.

Conclusion

Consumers with disabilities expect meaningful choices for wireless technologies that enable them to engage in employment and more fully participate in society. Data from the Wireless RERC's 2015-2016 Survey of User Needs (SUN) found that 83% of respondents owned a wireless phone, with 71% indicating ownership of a smartphone (Morris & Sweatman, 2016). These results suggest that the considerable capabilities and functionality offered by smart devices have a strong appeal and address important access and assistive technology needs of people with disabilities as a group. Anecdotal evidence suggests that alternative interface functionality provided by wireless devices and apps, such as wayfinding in the community using GPS and maps with audio output, empower people with vision disabilities to travel independently in their communities. Similarly, video calling/chats have helped individuals with hearing loss communicate without the help of a relay service or other mediating technology.

However, this Review found some potential gaps in the accessibility experience based on disability type, provider type and WEA-capability. On average, only half, or in some cases less than half, of the accessibility features that are important for people with dexterity/mobility, hearing, vision, and cognitive disabilities were found when the data were parsed by accessibility features based on disability type. Also, Lifeline provider phones in the sample had diminished levels of accessibility and WEA-capability compared to Tier 1 phones. Extra attention should be paid to Lifeline providers regarding their compliance with the CVAA. Furthermore, to ensure that people with

disabilities that participate in the Lifeline program can receive WEA messages it is essential that the Lifeline providers participate in WEA and that their devices be accessible. The FCC should consider extending WEA support to all Lifeline phones that have the requisite hardware to accept the alerts, officially aligning already complementary government programs/systems, and furthering the goals of both the FCC and the FEMA to (a) to bolster access to accessible and affordable advanced communications technologies,[5] and (b) to maximize availability of WEA to the whole community, including people with disabilities, the elderly, and the economically disadvantaged (IPAWS, 2014).

In the aggregate, the accessibility of mobile communications technologies is improving. More accessibility features are available, and many of these features are customizable (e.g., the rate of speech for voice output, vibration adjustment, font adjustment, and more). These are much-appreciated gains, but accessibility features are not uniformly available in all phone models. This may be especially frustrating for those who use several accessibility features to gain access to the device. For example, individuals who experience dual sensory loss and have complications with hearing and vision may require a HAC compliant phone and rely on a touch interface, haptic feedback, and screen reader technologies. A more inclusive mobile market would allow individuals with disabilities to select from the full range of commercially available devices. As it stands now, people with disabilities have a more limited selection, and more research is required on the part of the consumer prior to purchase to determine if the device will meet their accessibility requirements.

Nonetheless, if the trend identified in this Review of ever-increasing accessibility continues, then the mobile phone market is headed towards universal access. This is especially true for smartphones, as accessibility, especially for the latest versions of iOS and Android, is better (with regard to richness of features) than in non-smartphones. Another advancement observed is a majority of the sample consisted of phones with combined when M and T HAC ratings. When both the microphone (M) and telecoil (T) options are available for the same device, theoretically, consumers are more likely to

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[5] As evidenced through Commission proceedings concerning the CVAA and the Lifeline Program.

find the appropriate device for their needs. Finally, the data indicate that WEA-capable devices have more accessibility options than non-WEA-capable phone models. If this trend holds, then increasing the amount of WEA-capable handsets on the market could impact overall accessibility of levels of mobile phones.

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