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INSIGHTS

An Evolving Digital Divide: Measuring and Understanding Mobile-Dependent Households (MDH)

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Author

Roberto Gallardo, Ph.D.

PURDUE UNIVERSITY | Center for Regional Development

ABSTRACT

Despite unprecedented broadband investment, the share of U.S. households relying solely on cellular data and mobile devices or mobile-dependent households (MDH) increased from 11.9 to 14.1 percent between 2019 and 2024. This report introduces the MDH concept, which captures the "double whammy" of limited data and limited screen size, and examines its determinants before and after the COVID-19 pandemic using Census tract-level data. Results indicate that the share of the population with any disability, households with a lack of internet access, income, educational attainment, and homeownership are among the strongest factors associated with mobile dependence, with several associations shifting in strength post-pandemic. As communities implement BEAD-funded broadband projects, these findings suggest that connecting households is insufficient if that connectivity comes through the most constrained pathway available.

BACKGROUND

The digital divide, a concept that emerged in the mid-1990s, has been researched from many angles. Initially, the issue was understood as a binary, yes/no access to the internet as well as devices. Over time, understanding the digital divide evolved into two additional levels, adoption and use and social, personal, and economic outcomes (Wei, Teo, Chan, and Tan, 2011). This resulted in a better understanding of the sequential barriers around motivation, material, skills, and usage (van Dijk, 2020). As this landscape evolves and particularly as significant investments took place due to the COVID-19 pandemic, a new wrinkle emerges: mobile-dependent households or MDH.

According to the 5-Year American Community Survey (ACS), the share of households in the United States with no internet access decreased from 17.6 percent in 2017 to 6.5 percent in 2024, or a decline of more than 12.5 million households. On the other hand, the share of households accessing the internet solely via cellular data increased from 7.5 percent in 2017 to 11.5 percent in 2024, or an increase of close to six million households. In addition, the share of households with mobile devices only (no laptops or desktops) also increased from nine percent in 2017 to 15.2 percent in 2024, or close to nine million households. In other words, folks are increasingly connecting solely through their mobile devices and data plans. What does this mean for the digital divide?

There is an argument that mobile-only Internet users experience reduced functionality and can undermine broadband's potential. A study that coined the term "mobile Internet underclass," concluded that the mobile-only internet users experienced an "inferior" form of the technology impacting its information seeking, content creation, and development of digital skills (Napoli & Obar, 2014). Moreover, mobile access should not substitute fixed broadband, since these two technologies complement each other for browsing, video streaming, gaming and cloud services while substituting for social networking and music streaming (Quaglione, Matteucci, Furia, Marra, and Pozzi, 2020).

Smartphone dependence is mostly affected by location, broadband quality limitations, homeownership, income, educational attainment, employment type, race/ethnicity, and age groups (Dingel and Neiman, 2020; Gartland and Stegman, 2021; Olson, 2025; Perrin, 2021; Pew Research Center, 2025; Vogels, 2021). In addition, a report published by Digitunity identified who is most affected by the computer ownership gap, including older adults, less educated, and minorities among others (Mihaylova & Whitacre, 2025). Data from 2019 (pre-pandemic) and 2024 (post pandemic, latest year available) at the census tract level were used to measure and understand this "underclass." Specifically, are the socioeconomic and demographic characteristics affecting home broadband adoption affecting mobile-dependent households as well? Did these associations get stronger or weaker, pre/post the COVID-19 pandemic? The MDH incorporates the "double whammy" concept of relying on cellular data only and mobile devices only.

DATA & METHODS

Data was obtained from the 5-Year American Community Survey (ACS) dataset ending in 2019 and in 2024. The unit of analysis were Census tracts and regression analysis controlling for spatial patterns were conducted[1]. Census tracts in both years with a population of less than 50 or households were removed as were tracts in Alaska and Hawaii due to the spatial analysis[2]. Note that Census tracts change every decennial census (e.g., 2010, 2020) and these two datasets were not harmonized[3]. By comparing 2019 and 2024, we test whether the factors driving mobile dependence intensified, attenuated, or fundamentally changed because of the pandemic-era digital transformation.

The first nine variables utilized are known to affect home broadband adoption while the last two are related to broadband access and quality: 1) metro Census tracts[4]; 2) percentage of the population ages 18 to 34; 3) ages 65 or older; 4) percentage of the population White non-Hispanic; 5) percentage of the population age 25 or older with a bachelor's degree or higher; 6) percentage of the population with any disability; 7) percentage of workers age 16 or older employed in blue-collar occupations[5]; 8) median household income in nominal dollars; 9) percentage owner occupied of housing units; 10) percentage of households with no internet access; and 11) broadband quality score or BQS[6].

[1] Mobile dependence is theoretically expected to cluster spatially because broadband infrastructure, provider markets, housing stock, socioeconomic characteristics, and labor markets can operate at spatial scales larger than individual tracts. Spatial error models relying on a first-order queen contiguity weight matrix were completed.

[2] The resulting dataset was 71,500 Census tracts for 2019 and 82,551 in 2024.

[3] The intent was to show the associations across two different points in time, not a panel study.

[4] The metro dummy variable was obtained from the 2010 & 2020 Rural-Urban Commuting Area (RUCA) codes published by the Economic Research Service of the United States Department of Agriculture. Census tracts are assigned to primary and secondary codes based on commuting flows ranging from 1 to 10 where the first three refer to metro tracts. Primary codes were used since they established urban cores and the most economically integrated tracts through commuting. The first three metro-related codes were coded as metro for this analysis

[5] The ACS compiles data on six occupations; blue-collar occupations included those workers in natural resources, construction, and maintenance occupations as well as those employed in production, transportation, and material moving occupations.

[6] Data for the BQS was obtained from the Speedtest® by Ookla Global Fixed Network Performance Maps. These speed test results only include fixed broadband measurements, not mobile or cellular connections. Average download was assigned a positive 0.45 weight; average upload was assigned a positive 0.32 weight; and average latency was assigned a negative 0.23 weight based on the Vicente & Gil-de-Bernabé (2010) paper. A higher BQS denotes higher quality broadband as measured by speed tests.

The dependent variable was the mobile-dependent households or MDH calculated using the ACS questions about home internet access and device ownership. The MDH is the average of two not mutually exclusive variables (a household could have been counted in both): the percentage of households with cellular data access only and the percentage of households with smartphone only computing devices[7]. The MDH captures both limitations ot "the double whammy" in one metric. Census tracts with a higher MDH indicate a higher share of households experiencing mobile dependency.

RESULTS

Table 1 shows the statistical summary of the variables analyzed by year. The variable of interest, MDH, increased from 11.9 percent in 2019 to 14.1 percent in 2024. This number is almost identical to the "smartphone-only" or adults who say they do not use broadband at home but own a smartphone (Pew Research Center, 2025).

The share of households or the population ages 18 to 34, White non-Hispanic, employed in blue-collar occupations, and without internet access decreased. In addition to MDH, the share of households or the population age 65 or older, age 25 or older with a bachelor's or more, with any disability, owner-occupied, and the broadband quality score increased.

TABLE 1. Statistical Summary

Variables	2019 (n=71,500)				2024 (n=82,551)			
	St. Dev.	Mean	Min	Max	St. Dev.	Mean	Min	Max
% MDH	6.8	11.9	0.0	57.0	7.8	14.1	0.0	77.0
Metro	0.4	0.8	0.0	1.0	0.4	0.8	0.0	1.0
% Ages 18 to 34	9.9	23.1	0.0	99.7	10.5	22.6	0.0	99.7
% Age 65 or older	8.0	16.4	0.0	92.2	9.0	18.1	0.0	100.0
% White non-Hispanic	29.9	61.5	0.0	100.0	29.1	58.4	0.0	100.0
% Bachelor's or higher	19.3	30.7	0.0	97.0	20.0	34.3	0.0	100.0
% Any disability	5.7	13.4	0.0	60.7	6.2	14.0	0.0	69.9
% Blue-collar	11.4	23.3	0.0	100.0	11.7	22.4	0.0	100.00
Median household income	$33,443	$66,964	$2,499	$250,000	$41,170	$86,231	$2,499	$250,000
% Owner-occupied	22.8	63.5	0.0	100.0	23.8	65.2	0.0	100.0
% No internet	10.5	15.2	0.0	88.1	6.6	7.1	0.0	91.4
Broadband quality score	29.4	51.0	-151.2	191.0	45.8	159.5	-72.9	431.1

[7] MDH = (((Households with Only Cellular Data / Households) + (Households with Mobile Devices Only / Households)) / 2) * 100.

Figures 1 & 2 below show the MDH Local Moran's I (LISA) cluster maps in 2019 and 2024. These maps identify where mobile-dependent households are clustered forming statistically significant regional patterns. Census tracts are grouped into low (value is below average) or high (value is above average) clusters. The red-colored tracts indicate there is a statistically significant clustering of a tract with a high MDH value surrounded by tracts with higher MDH values (high-high). Dark blue indicates a clustering of a tract with a low MDH value surrounded by tracts with lower MDH values. These are also known as hot and cold spots.

Light blue tracts indicate tracts with a low MDH surrounded by tracts with a high MDH while pink or light red tracts indicate tracts with a high MDH surrounded by tracts with a low MDH. In other words, they show tracts increasing/decreasing their MDH despite being surrounded by tracts with low/high MDH. Gray tracts mean there was no statistically significant grouping though they may still have low or high MDH values. Notice that all tract types increased between 2019 and 2024 and that the footprint of the red tracts expanded during this period.

FIGURE 1. 2019 MDH LISA Cluster Map

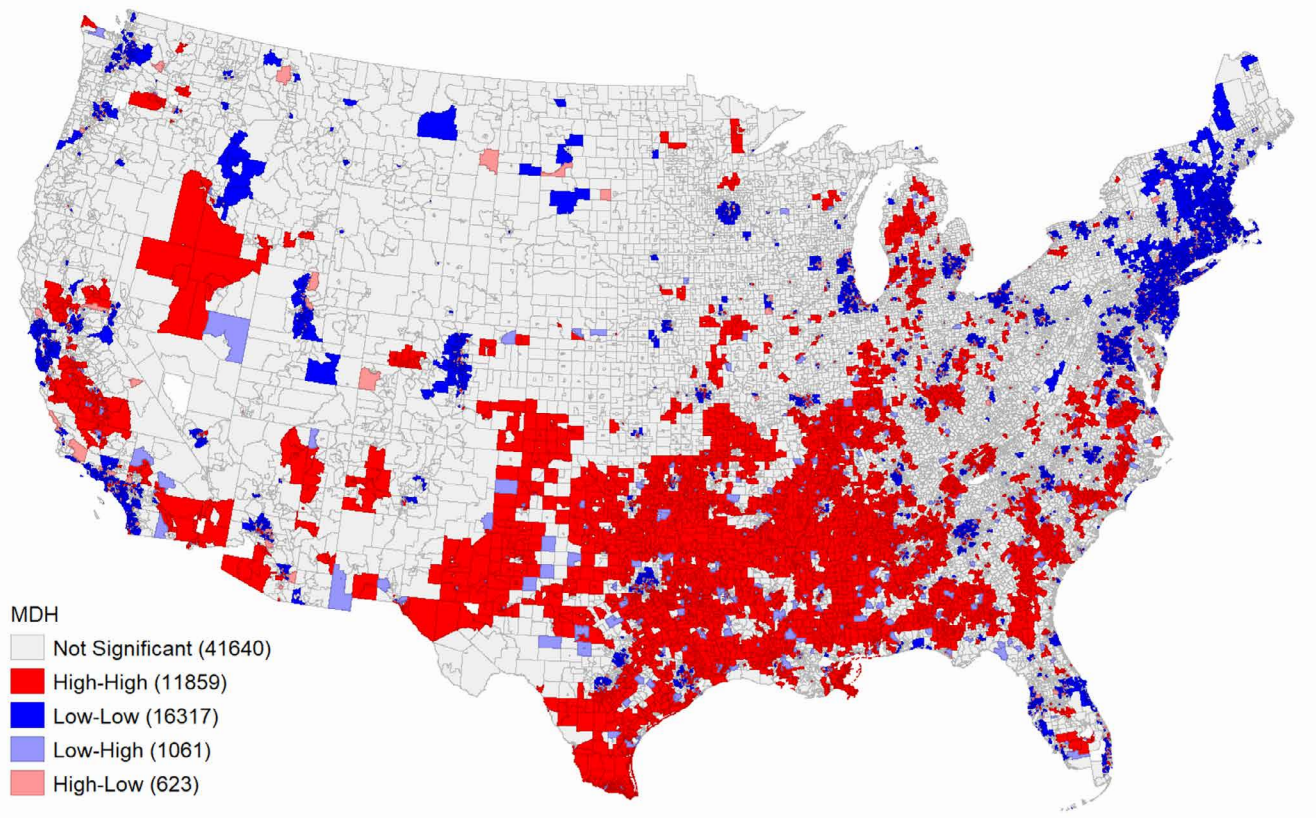

FIGURE 2. 2024 MDH LISA Cluster Map

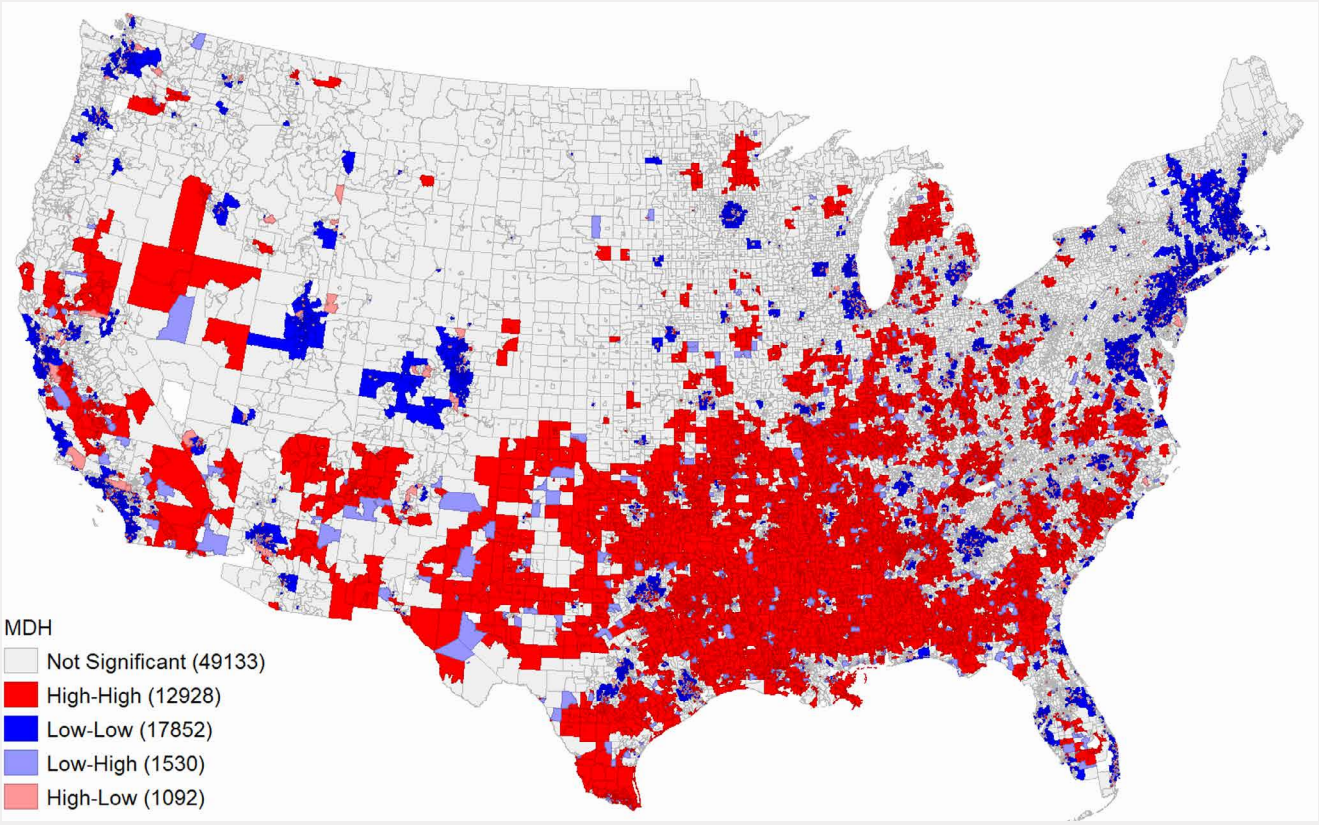

Table 2 shows the direction of the associations between the selected variables and the MDH variable[8] and whether this association changed between 2019 and 2024. The metro variable became significant in 2024 while the share of population age 65 or older became insignificant by 2024. This implies that location was not associated with MDH in 2019, but it was after COVID. Similarly, older households may have become more mobile dependent after COVID since the pre-COVID relationship was negative and significant. All other variables remained significant and with the same direction (sign).

If a Census tract was metropolitan (only in 2024), or if its share of population ages 18 to 34, White non-Hispanic, or with a bachelor's degree or more was higher as well as a higher median household income and a higher share of owner-occupied housing units, the share of mobile dependent households decreased. Likewise, if the broadband quality score improved, the share of mobile dependent households decreased. On the other hand, if the share of residents with any disability, employed in blue-collar occupations, and households with no internet access increased, so did the share of mobile dependent households.

[8] Only associations statistically significant at the $p<0.05$ level were included. Ordinary least squares (OLS) models with spatial diagnostics and spatial error tables with standardized coefficients are available upon request. VIF results for both years show no values above 5.

The direction and strength of the association between variables and MDH is summarized under the "Change" column[9]. The association with those with a bachelor's degree or more, share with any disability, median household income, and the share of households with no internet access strengthened between 2019 and 2024. Metro tracts gained significance and strength in 2024 compared to 2019. On the other hand, the association with the share of White non-Hispanic, share employed in blue-collar occupations, share of owner-occupied housing units, and broadband quality weakened during this period.

TABLE 2. Spatial Error Models Results – Direction and Significance

Variables	2019	2024	Change
Metropolitan Census tract		-	Strengthened; significant in 2024
% Pop. Ages 18 to 34	-	-	Same
% Pop. Ages 65 or older	-		Lost significance in 2024
% White non-Hispanic	-	-	Weakened
% Bachelor's or higher	-	-	Strengthened
% Any disability	+	+	Strengthened
% Blue-collar	+	+	Weakened
Median Household Income	-	-	Strengthened
% Owner-occupied	-	-	Weakened
% Household with no internet access	+	+	Strengthened
Broadband quality score	-	-	Weakened

Note: the + sign indicates that as this variable increased or decreased, so did the MDH; the – sign indicates that as this variable increased, MDH decreased and vice versa.

DISCUSSION & CONCLUSIONS

To summarize, this report introduces the concept of mobile-dependent households experiencing the "double whammy" of relying solely on cellular data and mobile devices and examines the factors associated with this growing population before and after the COVID-19 pandemic. Recalling that the share of MDH increased from 11.9 to 14.1 percent between 2019 and 2024, a period of unprecedented federal broadband investment. This growth, combined with the expanding footprint of high-high clusters shown in the LISA maps, suggests that infrastructure deployment alone does not resolve the structural conditions pushing households toward mobile-only connectivity. This is important to keep in mind as the Broadband Equity Access and Deployment (BEAD) investments across the country start to materialize and the future of the Digital Equity Act funds, which targets skills and devices is uncertain.

[9] Standardized coefficients were used to assess the change in strength. If the coefficients increased, it was labeled as strengthening. If the coefficients decreased, it was labeled as weakening.

Several post-pandemic shifts stand out: the metro-nonmetro gap widened as metro tracts gained a significant negative association with MDH by 2024; disability's association with MDH strengthened substantially, reflecting the consequences of essential services moving to digital platforms that small screens and capped data plans cannot adequately support; the no-internet association also strengthened, indicating that where fixed broadband is absent, the households that do come online are increasingly doing so through mobile; income's association strengthened as well, consistent with fixed broadband becoming more of a premium good in the post-pandemic economy; and the association with the share of the population aged 65 or older disappeared entirely, suggesting that older adults who entered the digital world during the pandemic did so disproportionately through smartphones rather than fixed broadband. Notably, blue-collar occupations, while still positively associated with MDH in both years, weakened in strength, possibly reflecting that broadband expansion reached more blue-collar communities post-pandemic even as affordability became a more dominant barrier.

These findings carry direct implications for communities planning and/or implementing digital transformation strategies. Infrastructure should be paired with demand-side interventions such as device provision, digital literacy, and affordability programs that specifically target MDH populations. The disability finding warrants particular attention: digital inclusion programs should incorporate accessible device considerations, recognizing that the double whammy is especially consequential for populations requiring assistive technologies or larger interfaces.

The strengthening association between income and MDH, alongside the weakening of broadband quality's association, suggests that the policy challenge is shifting from building infrastructure to making fixed broadband affordable enough to compete with the convenience and lower upfront cost of a mobile plan. The expiration of the Affordable Connectivity Program in June 2024 removed a critical subsidy that helped low-income households afford fixed broadband. Without affordability support, the path of least resistance for many households is a mobile plan.

Housing tenure's consistent negative association with MDH, though slightly weaker in 2024, reinforces that broadband and housing policy should be coordinated, particularly in affordable rental properties where wiring infrastructure may be absent. Communities can use the MDH measure, calculable from publicly available ACS data, to identify where mobile dependence is concentrated and tailor interventions accordingly.

This analysis has limitations worth noting. The study is cross-sectional, comparing two snapshots rather than tracking the same households over time, so the associations reported cannot establish causation. The 2019 and 2024 datasets use different Census tract geographies due to the 2020 decennial updates, meaning the two models are not estimated on identical units. While the consistency of results across years is reassuring, some differences may reflect the changed composition of the tract universe rather than true temporal shifts. The MDH variable combines two measures that are not mutually exclusive, so it captures the intensity of mobile constraint within a tract rather than a precise count of households experiencing both limitations simultaneously. And because the data are at the tract level, associations between demographic characteristics and MDH reflect area-level patterns, not individual household behavior.

Future research can delve into outlining more detailed socioeconomic and demographic characteristics of mobile dependent households. Furthermore, delving into differences, if any, among social and economic outcomes between mobile dependent households and those that subscribe to faster, higher data limits, and own more devices with greater functionality is an important next step. The consequences of this "underclass" have been theorized, but now that the MDH is introduced, more sophisticated analyses are warranted.

In moving beyond the question of whether households are linked to how they are connected, this report reveals that a growing share of American households experience a second-class form of digital participation. As Napoli and Obar (2014) warned over a decade ago, treating mobile access as equivalent to fixed broadband risks rendering this growing population invisible. The MDH concept makes them visible.

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