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# Telemedicine in Illinois: Ecological Explanations

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## Abstract

This paper explores the environmental correlates of telemedicine. Empirical analysis of telemedicine use in Illinois counties reveals that the service is patronized in large numbers by collectivists, people who value collective responsibility over individual rights.

## Introduction

Interest in telemedicine has increased during the Covid-19 pandemic<sup>2</sup>; a search for the title “telemedicine” in Google Scholar resulted in 2,310 publications for the period 2020-2021<sup>3</sup>. However, most of the social science research on telemedicine has focused on the characteristics of the telemedicine user; little or no research has explored the contextual factors related to telemedicine use<sup>4</sup>. Six decades ago Lewin (1951)<sup>5</sup> posited that behavior ( $B$ ) is a function of both person ( $P$ ) and environmental ( $E$ ) variables,  $B = f(P, E)$ . This paper is an attempt to explicate the  $E$  factors related to telemedicine use. Specifically, it empirically tests environmental variables such as culture for association with telemedicine use. The geographical scope of the study is Illinois and the unit of analysis is the county.

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<sup>2</sup> In the Midwest, telemedicine registered approximately 400% growth during 2019-2020 time period; see Athiyaman, A. (2021). Value of Telemedicine, *Research Brief*, 3(3), 1-25. Available online: [http://www.iira.org/wp-content/uploads/2021/02/Telemedicine\\_ResBrief3\\_Feb3\\_2021.pdf](http://www.iira.org/wp-content/uploads/2021/02/Telemedicine_ResBrief3_Feb3_2021.pdf)

<sup>3</sup> The actual search was phrased: “allintitle: telemedicine”.

<sup>4</sup> See, for example, Athiyaman, A. (2021). Who uses telemedicine? Believers or disbelievers of Covid-19, *Research Brief*, 3(2), 1-6; [http://www.iira.org/wp-content/uploads/2021/01/who\\_uses\\_telemedicine\\_v3\\_2\\_2021.pdf](http://www.iira.org/wp-content/uploads/2021/01/who_uses_telemedicine_v3_2_2021.pdf).

<sup>5</sup> Lewin, K. (1951). *Field Theory in Social Science, Selected Theoretical Papers*, New York: Harper.

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## Conceptual Framework

The framework is based on a set of four principles: adaptation principle, cycling of resources principle, interdependence, and succession principle<sup>6</sup>. These principles are discussed below and a set of propositions are deduced from them for empirical analysis.

The *adaptation principle* is about assessment of social context, described using broad economic trends and cultural beliefs surrounding the definitions of problems and their solutions. In Illinois, cultural traditions differ among counties<sup>7</sup>; citizens' voting pattern suggests that some counties could value individual rights over collective responsibilities<sup>8</sup>; for the residents of these counties, viewing telemedicine as a tool for preventing the spread of Covid-19 among members of the community may not be of appeal. Furthermore, public opinion about Covid-19 in these 'individualistic' counties could be either neutral or positive, not negative

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<sup>6</sup> Adapted from Kingery-Westergaard, C., and Kelly, J. G. (1990). A contextualist epistemology for ecological research, *Researching Community Psychology: Issues of Theory and Methods*, Washington, DC: APA.

<sup>7</sup> For an in-depth discussion of the cultural capital concept and county rankings on cultural capital, see Athiyaman, A. (2019). Cultural capital in Illinois: A county-wise analysis, *Research Brief*, 1(7), 1-13. Available online: [http://www.instituteintelligence.com/wp-content/uploads/2019/08/CulturalCapital\\_IL\\_v1\\_7.pdf](http://www.instituteintelligence.com/wp-content/uploads/2019/08/CulturalCapital_IL_v1_7.pdf)

<sup>8</sup> Republican voters tend to be individualistic; see, for example, Bourgeois, D. Y. (2002). The politics and values of individualists and collectivists: A cross-cultural comparison.

as it would be for a 'collective' culture. Thus,

P<sub>1</sub>: Telemedicine use will be higher in counties that value collective responsibilities.

P<sub>2</sub>: Telemedicine use will be higher in counties with negative opinion about Covid-19.

It has been suggested that different types of economies are associated with different kinds of behavior<sup>9</sup>. For example, societies whose economies are predominantly driven by accumulating and caring for food resources tend to stress the development of traits such as responsibility and obedience in their residents, whereas hunting and fishing societies tend to emphasize self-reliance. Telemedicine is driven by information and communications technology (ICT)<sup>10</sup>; since communities that provide ICT access (for example, broadband access) are likely to be the population centers for tech-savvy individuals<sup>11</sup>,

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<sup>9</sup> See for example, Berry, J. W., Berry, J. W., Poortinga, Y. H., Segall, M. H., & Dasen, P. R. (2002). *Cross-cultural psychology: Research and applications*. Cambridge University Press.

<sup>10</sup> Same as footnote 2.

<sup>11</sup> See Athiyaman, A. (2019). Natural capital as an economic public product: An empirical analysis of Illinois counties, *Research Brief*, 1(10), 1-13. [http://www.instituteintelligence.com/wp-content/uploads/2019/08/Nat.Cap\\_IL\\_v1\\_10.pdf](http://www.instituteintelligence.com/wp-content/uploads/2019/08/Nat.Cap_IL_v1_10.pdf)

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P<sub>3</sub>: Telemedicine use will be higher in counties with broadband access.

Also, since the manufacturing sector is a producer and user of innovation<sup>12</sup>, it is postulated that:

P<sub>4</sub>: Telemedicine use will be higher in counties with more manufacturing employment.

*Cycling of resources* principle highlights how resources in a social system are used to achieve individual and community goals. At an individual level, people with chronic illness such as heart conditions have to learn about healthcare resources that are essential for survival; access to telemedicine is one such knowledge<sup>13</sup>.

This kind of reasoning suggests that,

P<sub>5</sub>: Telemedicine use will be higher in communities with more chronically ill population.

The principle of cycling of resources also suggests that communities will think about ways in which the range of available resources can be expanded. One such tactic would be, for example, hospitals in the community to offer telemedicine services for patients<sup>14</sup>. Logically, this is

likely to happen in larger communities with a variety of healthcare services such as hospitals and medical clinics. Hence,

P<sub>6</sub>: Telemedicine use will be higher in large population centers.

The *interdependence principle* is based on the idea of system dynamics, changes to one part of a system could impact the other components of the system. Research on spread of Covid-19 in Illinois suggests that as a variable, “Covid-19 spread” explains significant amount of variability in telemedicine use<sup>15</sup>, so the proposition:

P<sub>7</sub>: Communities in which the growth rate of Covid-19 is high will witness high telemedicine use among its residents.

Related to the proposition on Covid-19 growth and use of telemedicine is the idea about social interactions of people; for example, that people may travel less to attend social functions, or eat out in restaurants, for fear of being infected by the virus. A measure of the intensity of social interaction at the county level is Google’s Mobility index; this index is expected to be lower in communities with high telemedicine use. Thus,

P<sub>8</sub>: Mobility index will be low in communities with high telemedicine use.

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<sup>12</sup> Same as footnote 11.

<sup>13</sup> See Athiyaman, A. (2021). Consumer awareness about telemedicine during the Covid-19 pandemic, *Research Brief*, 3(1), 1-6. [http://www.iira.org/wp-content/uploads/2021/01/telemedicine\\_awareness\\_v3\\_1.pdf](http://www.iira.org/wp-content/uploads/2021/01/telemedicine_awareness_v3_1.pdf).

<sup>14</sup> See, for example, Athiyaman, A. (2016). Marketing strategy

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recommendations for FQHCs. IIRA, Macomb, IL: Working paper.

<sup>15</sup> Same as footnote 4.

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An unintended consequence of telemedicine use could be loss of jobs in traditional healthcare settings, for example, in medical clinics that offer only face-to-face consultations. According to a latest healthcare industry report, healthcare providers such as primary care physicians lag in the adoption of digital services<sup>16</sup>. Thus,

P<sub>9</sub>: Higher the use of telemedicine in a community, greater is the job loss in traditional healthcare settings in the community.

Finally, the *principle of succession* suggests exploration of changes in community structure, for example, employment shifts from manufacturing to services, to understand variations in behavior among residents (for example, student enrolment in STEM courses). A structural factor that is salient for adoption of telemedicine is scarcity of medical professionals in the community<sup>17</sup>. Another factor would be investments in ICT in the community by state and federal agencies and programs. On the latter, there is evidence that disproportionately low rates of resources per capita are directed to rural residents<sup>18</sup>.

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<sup>16</sup> The BCG's digital acceleration index places healthcare at the bottom of sectoral rankings, healthcare is better only than public sector institutions; see BCG (2020). How digital divide healthcare providers.

<sup>17</sup> See IBISWorld (2020). *Industry Outlook: Telehealth Services, OD5775*, August.

<sup>18</sup> See, for example, Pruitt, L., and Bradley, E. S. (2014). Law stretched thin: Access to justice in rural America, *SD Law Review*, 59, 466.

These premises suggest that:

P<sub>10</sub>: Use of telemedicine will be higher in communities with declining rates of healthcare providers.

P<sub>11</sub>: Telemedicine use will be lower in rural counties.

## Methodology

A variety of data were used to explore the hypothesized associations between telemedicine use and county environment. The operational definitions of the predictors or the independent variables and sources of data are given in Table 1.

**Table 1: Variables, Operational Definitions, and Data Sources**

Variable	Operational Definition	Data Source
Collective culture	Proportion of vote for the Democratic candidate in the 2020 presidential election.	Scraped from Github, election data.
Individualistic culture	Proportion of vote for the Republican candidate in the 2020 presidential election.	
Sentiment about Covid-19	Twitter analysis of Covid-19 sentiments, by county.	Author's own software was deployed on Twitter platform to scrape tweets <sup>19</sup> .
Broadband access	Number of households with broadband access of any kind, for example, fiber.	ACS, 2019, 5-year estimates, Table S2801.
Manufacturing employment	Proportion employed in the manufacturing sector, by county.	ACS, 2019, 5-year estimates, Table DP02.
Chronically ill	Quality of life measure, from Behavioral Risk Factor Surveillance System.	<a href="https://www.cdc.gov/brfss/index.html">https://www.cdc.gov/brfss/index.html</a> .
Population density, per square mile	$\frac{\text{Population}}{\text{Land Mass}}$	US Census: USA Counties, Land Area data, 2011 numbers.
Covid-19 spread	Daily growth rate of the virus computed using exponential growth: $Base \times e^{rt}$	Scraped from Github, Covid-19 dataset.
Mobility of residents	Google mobility index.	<a href="http://www.google.com/covid19/mobility">www.google.com/covid19/mobility</a> .
Job loss in healthcare	Changes in healthcare employment; 2020 quarters 1 and 2 compared with 2019 quarters 1 and 2.	<a href="http://www.bls.gov/cew/">www.bls.gov/cew/</a>
Changes in healthcare provider numbers.		
Metro and nonmetro classification.	Rural-urban continuum codes, USDA, 2013.	<a href="http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx">www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx</a> .

<sup>19</sup> For details about sentiment analysis, see Athiyaman, A. (2020). Twitter conversations about Covid-19: What is going on out there in Illinois? Research Brief, 2(5), 1-7. Available online: [http://www.iira.org/wp-content/uploads/2020/04/Twitter-Conversations-about-SARS-Cov-2\\_April-2020.pdf](http://www.iira.org/wp-content/uploads/2020/04/Twitter-Conversations-about-SARS-Cov-2_April-2020.pdf).

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The criterion or dependent variable, number of telemedicine users in Illinois counties, were sourced from a research on economic value of telemedicine<sup>20</sup>. Standardized mean differences, *d* ratio, and product moment correlations were used to test the hypotheses.

The *d* ratio is the difference between the group means, for example, average number of telemedicine users in metro versus nonmetro, divided by an estimate of the population standard deviation. The norm in statistics is to interpret *ds* of 0.20, 0.5, and 0.8 as small, medium, and large, respectively<sup>21</sup>.

We express *ds* as point biserial, product-moment correlations. Hunter and Schmidt recommend its use over *d* because it can then be inserted into a correlation matrix and treated like an interval level variable<sup>22</sup>.

## Results and Discussion

The law of continuity highlights the stability of cause and effect, to understand what will happen, we have only to examine what is happening.

Telemedicine has grown exponentially during the Covid-19 pandemic; the AMA claims approximately 5000% increases in usage of the service during 2020<sup>23</sup>.

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<sup>20</sup> Same as footnote 2.

<sup>21</sup> Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. San Diego, CA: Academic Press.

<sup>22</sup> Hunter, J. E. and Schmidt, F. L. (1990). *Methods of meta-analysis: Correcting error and bias in research findings*. Newbury Park, CA: Sage.

<sup>23</sup> See [www.fairhealth.org](http://www.fairhealth.org).

Variableness in events such as telemedicine use are merely the results of new combinations of existing factors or causes; for example, the Center for Medicare Services (CMS) injected \$8bil in 2020 to encourage telemedicine use among Medicare beneficiaries<sup>24</sup>. This “incentive” and the spread of Covid-19 in the nation could have combined to propel or grow telemedicine services. Although it is not possible to predict with certainty the future of telemedicine because of the complexity of the factors involved<sup>25</sup>, it is possible to speculate or model future tendencies and possibilities for the service. Towards this end we empirically tested the environmental correlates of telemedicine use; the principles of adaptation, cycling of resources, interdependence, and succession provided the frame to deduce hypotheses about the correlates.

Table 2 shows the results of hypothesis testing; seven of the 11 hypotheses were confirmed by the empirical analysis. The adaptation principle suggests the need to consider cultural factors in telemedicine use. Based on the notion that political affiliation is an indicator of culture, we tested the hypothesis that telemedicine use will be high in counties that voted for the democratic presidential candidate in the 2020 presidential election; democratic vote is an indicator of collectivist culture<sup>26</sup>. This hypothesis gained support in statistical analysis.

Of the four disconfirmed predictions, three deal with the healthcare sector:

(1) telemedicine use is independent of

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<sup>24</sup> Same as footnote 2.

<sup>25</sup> Same as footnote 5.

<sup>26</sup> Same as footnote 8.

healthcare provider numbers in the region, (2) use of telemedicine does not reduce jobs in traditional healthcare settings such

as medical clinics, and (3) the magnitude of chronically ill population in the county does not predict telemedicine use.

**Table 2: Correlation of Predictors with the Criterion, Telemedicine Use**

Variable	Expected Association with Telemedicine Use	<i>r</i> ; (0.95 CI)	Results of Hypothesis Testing
Collective culture	+	0.88; (CI = 0.68, 0.98)	Confirmed
Individualistic culture	-	-0.55 (CI = -0.75, -0.35)	Confirmed
Sentiment about Covid-19	-	-0.6 (CI = -0.79, -0.40)	Confirmed
Broadband access	+	0.2 (CI = 0.004, 0.39)	Confirmed
Manufacturing jobs	+	-0.1 (CI = -0.29, 0.09)	Disconfirmed
Chronically ill	+	0.1 (CI = -0.1, 0.29)	Disconfirmed
Pop. Density	+	0.95 (CI = 0.78, 0.98)	Confirmed
Covid-19 Growth	+	0.43 (CI = 0.23, 0.62)	Confirmed
Mobility <sup>26</sup>	-	-0.39 (CI = -0.58, -0.19)	Confirmed
Job loss in healthcare	-	-0.03 (CI = -0.22, 0.17)	Disconfirmed
Changes in healthcare provider numbers <sup>27</sup>	-	0.11 (CI = -0.08, 0.30)	Disconfirmed
Rural region	-	-0.24 (CI = -0.44, -0.04)	Confirmed

So, what is the prediction for the future of telemedicine? Regions with high population density will continue to use telemedicine. If Covid-19 persists, telemedicine will be used; use of the service will be more in collectivist cultures.

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## Summary and Conclusion

This paper is an attempt at explaining the uptake of telemedicine in Illinois counties using the ecological principles of adaptation, cycling of resources, interdependence, and succession. Results of empirical analysis suggests that the contextual nature of telemedicine is:

a densely populated region, with collectivist culture experiencing high Covid-19 growth, and a population that harbors negative opinions about Covid-19 (for example, it is a life-threatening illness).

In conclusion, the details of the future of telemedicine is difficult to predict, but the outcomes of the general principles given in this paper may be predicted. This is what we did, showed that environment plays a very important part in diffusion of telemedicine in Illinois.