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# Environmental Impact of a Pediatric and Young Adult Virtual Medicine Program: A Lesson from the COVID-19 Pandemic

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## Abstract

**Objectives—**The Coronavirus Disease 2019 (COVID-19) pandemic led to the expansion of virtual medicine as a method to provide patient care. We aimed to determine the impact of pediatric and young adult virtual medicine use on fossil fuel consumption, greenhouse gas and non-greenhouse traffic-related air pollutant emissions.

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Declaration of Competing Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Methods—**We conducted a retrospective analysis of all virtual medicine patients at a single quaternary-care children's hospital with a geocoded address in the Commonwealth of Massachusetts prior to (3/16/2019–3/15/2020) and during the COVID-19 pandemic (3/16/2020–3/15/2021). Primary outcomes included patient travel distance, gasoline consumption, carbon dioxide and fine particulate matter emissions as well as savings in main hospital energy use.

**Results—**There were 3,846 and 307,273 virtual visits performed with valid Massachusetts geocoded addresses prior to and during the COVID-19 pandemic, respectively. During one year of the pandemic, virtual medicine services resulted in a total reduction of 620,231 gallons of fossil fuel use and $1,620,002 avoided expenditure as well as 5,492.9 metric tons of carbon dioxide and 186.3 kilograms of fine particulate matter emitted. There were 3.1 million fewer kilowatt hours used by the hospital intra-pandemic compared to the year prior. Accounting for equipment emissions, the combined intra-pandemic emission reductions are equivalent to the electricity required by 1,234 homes for one year.

**Conclusions—**Widespread pediatric institutional use of virtual medicine provided environmental benefits. The true potential of virtual medicine for decreasing the environmental footprint of healthcare lies in scaling this mode of care to patient groups across the state and nation when medically feasible.

### Keywords

COVID-19; virtual medicine; carbon dioxide emissions; fossil fuel consumption; climate change

## Introduction

The healthcare sector has added substantially to climate change and contributes close to 10% of the nation's greenhouse gas emissions. Taken in aggregate, the United States (U.S.) healthcare system would constitute the 13th largest national greenhouse gas emissions in the world.[1] Virtual medicine has emerged to decrease the environmental footprint of healthcare. With recommendations for social distancing and relaxation of virtual medicine regulations, there has been swift expansion of virtual medicine during the Coronavirus Disease (COVID-19) pandemic.

Prior to the pandemic, investigators had begun to evaluate the environmental impact of virtual medicine.[2–7] In the United Kingdom, a teleneurology clinic eliminated 2,560 kilometers of travel each year and decreased greenhouse gas emissions by 705 kilograms.[6] The University of California, Davis Health System's virtual medicine program performed 19,246 visits over 17.5 years, resulting in total carbon dioxide emissions reduction of 1,969 metric tons.[3] Additional studies highlighted the environmental impact of virtual medicine during the pandemic throughout the five University of California healthcare systems[8] and in an adult cancer center in Florida.[9] Finally, a recent two-year study within the Division of Vascular Surgery of Henry Ford Hospital showed decreases in vehicle emission of environmental pollutants and a total of 195 gallons of fuel saved.[5]

Virtual medical visits reduce greenhouse gas emissions in large part from reducing combustion of fossil fuels in transportation. One study demonstrated traffic restriction measures implemented during the COVID-19 pandemic resulted in an approximately 50% decrease in $NO_2$ concentration during lockdowns compared to pre-lockdown periods across four different cities in the United States and Spain.[10] Lesser fossil fuel combustion also reduces emission of air pollutants such as particulate matter that have profound health effects. Fine particulate matter contributes greatly to pediatric and adult disease burden. An estimated 1 in 5 children in the U.S. have asthma from breathing traffic associated air pollution, and an equal portion of annual deaths globally result from fossil fuel sourced particulate matter.[11–15]

Many investigators have demonstrated the benefits of virtual medicine for the patient and health system.[16–19] The "stay-at-home" recommendation during the COVID-19 pandemic has made some virtual medicine gains, such as the opportunity costs, harder to assess. However, the environmental impact of virtual medicine can be quantified.

Boston Children's Hospital, a quaternary-care children's hospital, initially established a virtual medicine program in December 2016. In response to the COVID-19 crisis, many in-person clinic visits were transitioned to virtual medicine visits. This widespread use of virtual medicine at our institution during the COVID-19 pandemic offers a unique opportunity to demonstrate the potential benefit that reduced patient travel has on the environment. We leveraged the opportunity to understand the impact of the pandemic on hospital energy expenditures to further guide sustainability efforts. Specifically, we aimed to estimate the reductions in fossil fuel use and traffic-related air pollutant emissions associated with widespread utilization of virtual medicine.

## Methods

We conducted a retrospective analysis of virtual medicine services provided at a single quaternary-care children's hospital to patients and families in the Commonwealth of Massachusetts between 3/16/2019 and 3/15/2020 (pre-pandemic) and 3/16/2020 and 3/15/2021 (intra-pandemic). The latter period was selected due to the widespread institutional use of virtual medicine during the COVID-19 pandemic, as compared to the year prior. Though regional established patients located out-of-state were able to receive virtual follow-up care with their providers during periods of the COVID-19 pandemic, we excluded these patients from our analysis to improve generalizability and to better estimate the population level impact. We also excluded those patients without a valid geocoded address.

The overall number of outpatient visits as well as virtual medicine appointment data was abstracted from our institutional electronic data warehouse. Virtual visits were performed using a HIPAA-compliant video conferencing platform, either SBR Health (SBR Health Inc., Cambridge, MA) or Zoom (Zoom Video Communications Inc., San Jose, CA). In a minority of cases, traditional telephonic communication was employed. We extracted data on patient demographics, including age, sex, and race. Self-reported racially minoritized groups included Black/African American, Asian, American Indian/Alaska Native and Native Hawaiian/Pacific Islander. Demographic characteristics and virtual visit type were compared between pre- and intra-pandemic study populations using Chi-squared and Fisher's exact tests, where appropriate, with significance defined as a p-value of $<0.05$. Primary study outcomes included patient travel distance, carbon dioxide and fine particulate matter emissions, and fossil fuel consumption and cost.

## Patient Travel Distance

Patient travel distance was defined as the estimated round-trip driving distance avoided by utilization of virtual medicine services. This was determined by doubling the measured kilometers in a proposed distance traveled via *road networks* between a patient's geographic home address and the institution's address.[20] Given variability in use and availability of public transportation during the COVID-19 pandemic, patients/families were more likely to travel to a clinic appointment via private vehicle.

## Environmental Impact

The U.S. Environmental Protection Agency (EPA) reports that the average model year 2018 passenger vehicle emits approximately 221 grams of carbon dioxide per kilometer driven.[21] This estimate includes data from the fourteen largest vehicle manufacturers (except for Tesla since their electric cars do not emit carbon dioxide). In our analysis, reductions of carbon dioxide emissions were quantified by multiplying the per-kilometer emission by the round-trip travel and total distance avoided. Other potential vehicle gaseous emissions including methane and nitrous oxide are more difficult to estimate. Since carbon dioxide emissions are responsible for 95–99% of the total greenhouse gas emissions from passenger vehicles[21], only carbon dioxide reductions were estimated in this study.

To further characterize the impact of reductions in carbon dioxide emissions on the environment, the EPA Greenhouse Gas Equivalencies Calculator was employed.[22] With this calculator, the estimated annual carbon dioxide emissions were converted to pounds of coal burned, homes' electricity use for one year, and the amount of carbon that would be sequestered in U.S. forests in one year.

The Bureau of Transportation Statistics at the U.S. Department of Transportation leveraged the U.S. EPA Motor Vehicle Emission Simulator (MOVES) to estimate that the average model year 2018 passenger vehicle emits approximately 0.0075 grams of particulate matter per kilometer driven.[23] Reductions of particulate matter emissions were quantified by multiplying the per-kilometer emission by the round-trip travel and total distance avoided. For non-gaseous traffic emissions, we evaluated fine particulate matter because of the substantial share of air pollution-related disease that results from particulate matter exposure.[13]

The reduction in fuel use was calculated by dividing the patient travel distance by the average fuel economy of passenger vehicles. In model year 2018, fuel economy was 10.6 kilometers per liter.[21] According to the U.S. Bureau of Labor Statistics, in December 2018, the national average was $2.46 per gallon of gasoline.[24]

The carbon dioxide emissions associated with use of virtual medicine equipment were estimated based on previously reported findings. Masino et al. observed the environmental cost of telemedicine equipment to be 0.04 kg of carbon dioxide emitted per 1-hour consultation.[4] Whetten and colleagues similarly demonstrated 0.052 kg of carbon dioxide emitted per 1-hour consultation.[25] Given that our virtual medicine services were provided by different departments with varying lengths of consultations, we assumed an average length of 30 minutes per virtual visit. Based on an average of 0.046 kg of carbon dioxide emissions per 1-hour consultation proposed in these two studies, we estimated the telemedicine equipment emissions in our analysis by multiplying the total number of virtual visits by 0.023 kg of carbon dioxide emissions for 30-minute consultation.

The power generation facility that supplies the hospital with electricity provides emissions factors associated with utility on an annual basis.[26] For the period of the study, emissions were calculated to be 274 metric tons per Gigawatt-hour of electricity (1 Gigawatt = 1,000,000 kilowatt). The total electrical use at the main hospital campus over the pre-pandemic time-period was compared to the first year of the pandemic (i.e., intra-pandemic) and the difference was calculated. We then estimated the averted metric tons of carbon dioxide emissions associated with reduced expenditure during the pandemic. This is likely due to a combination of factors, including increased virtual medicine and decreased clinic use.

This work received approval by the Boston Children's Hospital Institutional Review Board. Microsoft Excel 2019 (Microsoft Corp., Redmond, WA), R 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria) and ArcMap 10.1 (ESRI, Redlands, CA) were used for data analysis.

## Results

The institutional volume of overall outpatient visits and virtual visits performed each month during the two study periods can be visualized in Figure 1. The proportion of virtual visits increased from 0.7% during the pre-pandemic year to 53.9% during the intra-pandemic year. The in-person visit volume decreased by 60.1% during the intra-pandemic year compared to the prior year. There was an overall 15.4% decrease in the total number of outpatient visits completed during the intra-pandemic year.

### Pre-Pandemic Study Population

During the pre-pandemic study period, 44 departments provided virtual medicine services, with psychiatry/psychology (N= 1,955, 50.8%), urology (N=273, 7.1%), and cardiac surgery (N=251, 6.5%) representing the three highest users. From March 16$^{th}$, 2019 to March 15$^{th}$, 2020, a total of 5,406 virtual visits were completed at our hospital; of these 4,007 (74.1%) patients were residents of Massachusetts. From this population, 161 visits were unable to be geocoded resulting in a total study population of 3,846 (96.0%) Massachusetts visits used in the road-network analysis. Of the 3,846 total virtual visits performed: 3,844 (99.9%) were video visits and two (0.1%) were telephone encounters. Median patient age was 16 years (IQR 10 – 19), 52.1% reported sex as female, and 10.6% identified as part of a racially minoritized group (Table 1).

### Intra-Pandemic Study Population

During the intra-pandemic study period, 44 departments provided virtual medicine services, with neurology (N=33,683, 11.0%), gastroenterology (N=25,742, 8.4%), and psychiatry/psychology (N=20,584, 6.7%) representing the three highest users. Between March 16$^{th}$, 2020, and March 15$^{th}$, 2021, 355,387 virtual visits were completed at our hospital; of these 314,297 (88.4%) patients were residents of Massachusetts. From this population, 7,024 visits were unable to be geocoded resulting in a total of 307,273 (97.8%) patient visits used in the road-network analysis. The increase in virtual visits per municipality adjusted for population (2010 U.S. Census) from pre- to intra-pandemic periods is displayed in Figure 2. The largest growth in virtual visit volume was concentrated in the greater Boston metropolitan area, in close proximity to Boston Children's Hospital. Of the 307,273 total virtual visits performed: 298,669 (97.2%) were video visits and 8,604 (2.8%) were telephone encounters. Median patient age was 13 years (IQR 6 – 17), 51.2% reported sex as female, and 11.4% identified as part of a racially minoritized group. There were statistically significant differences found in all demographic groups and virtual visit type between the pre- and intra-pandemic study populations (Table 1).

### Travel Distances Averted

The average round-trip distance saved by virtual medicine in 2019–2020 was 93.4 kilometers (Table 2). For all 3,846 virtual visits during this pre-pandemic study period, the total round-trip distance avoided was 359,416 kilometers. In the first year of the COVID-19 pandemic, the average distance saved by virtual medicine was 82.1 kilometers. The total round-trip distance avoided that year was 25,246,408 kilometers.

### Emissions Saved

Prior to the pandemic, there was a total reduction of 8,957 gallons of fossil fuel use and $23,396 avoided fuel expenditure (Table 2). An average of 20.7 kilograms of carbon dioxide and 0.7 grams of fine particulate matter emissions were avoided per virtual visit. The total pre-pandemic reduction in emission of carbon dioxide was 79.4 metric tons and 2.7 kilograms of fine particulate matter.

Virtual medicine services provided during the first year of the COVID-19 pandemic resulted in a total reduction of 629,188 gallons of fossil fuel use and $1,643,398 avoided fuel expenditure. An average of 18.2 kilograms of carbon dioxide and 0.6 grams of fine particulate matter emissions were avoided per virtual visit. The total intra-pandemic reduction in vehicle emission of carbon dioxide was 5,579.5 metric tons and 189 kilograms of fine particulate matter.

### Energy Saved

We estimated that virtual visit equipment resulted in 7.1 metric tons of carbon dioxide emissions during the first year of the COVID-19 pandemic. Accounting for the use of this equipment, the delta saving based on vehicle emissions is 5,492.9 metric tons of carbon dioxide. This equates to 6,077,395 pounds of coal burned, 1,069 homes' electricity use and the amount sequestered in 6,500 acres of U.S. forests in one year.

From the pre-pandemic year to the first year of the COVID-19 pandemic, there was a 3.1-million-kilowatt hours reduction in hospital energy expenditure, representing a 4.5% decrease. There were fluctuations in hospital energy expenditure that varied by month during both periods (Figure 3). This equates to a saving of 850 metric tons of carbon dioxide emissions for hospital energy expenditure. The combined delta saving of 6,342.9 metric tons of carbon dioxide based on both vehicle and hospital energy emissions (accounting for technological equipment emissions) from the intra-pandemic year is equivalent to 7,017,843 pounds of coal burned and 1,234 homes' electricity use for one year. Additionally, this represents the amount of carbon dioxide sequestered in 7,506 acres of U.S. forests in one year.

## Discussion

Changes in reimbursement and relaxation of regulations under the emergent circumstances of the COVID-19 pandemic allowed for rapid scaling of our pediatric virtual medicine program. In the current study, we evaluated a large sample of regional patients (>300,000) who relied on virtual medicine for healthcare during the pandemic. This program resulted in a total of over 25 million kilometers of travel saved and a reduction of almost 630,000 gallons of fossil fuel use over one year. We also demonstrated a significant decrease in our hospital's environmental footprint during this period. We employed network analysis methodology that was able to account for accessibility/circuity of roadway networks in calculating the travel distance, rather than a straight-line measurement. This study is unique in that it leverages both hospital energy expenditure and vehicle emissions to better understand environmental impact with a particular focus on pediatric and young adult populations.

The environmental benefits of virtual medicine may vary by state and hospital catchment area. The Commonwealth of Massachusetts is only 304 kilometers in length. The average round-trip distance averted for a virtual medicine visit was on average 82.1 kilometers in the first year during the pandemic, compared to 93.4 kilometers in the year prior. In a large state like California (roughly 1280 kilometers long), the University of California Davis Health System patients could save 445 kilometers of round-trip travel if all in-person consultations were replaced by virtual medicine encounters.[3] Although not all hospitals have the same opportunity to leverage virtual medicine or catchment area as the quaternary-care hospital studied here, Boston Children's Hospital is one of more than 75 hospitals in Massachusetts alone and one of more than 4,000 hospitals nationwide, which illustrates the much larger scale of averted greenhouse gas and particulate matter emissions possible with broader virtual medicine use.

Avoided travel led to reductions of fine particulate matter and carbon dioxide emissions. The diminution in such traffic related emissions can benefit health of children and adults alike.[11–15, 27] Here we provided the first estimate of a virtual visit platform particulate matter reduction of almost 200 kilograms. Exposure to traffic related air particulate pollution falls most heavily on low wealth communities of color in the U.S.[28] This means that scaling virtual medicine programs may result in substantial health benefits that promote health equity. Additionally, there are potential economic advantages for rural patients, including minimizing travel expenses, missed work, and childcare arrangements.[17]

Virtual medicine may be viewed as a mainstay of healthcare delivery after the COVID-19 pandemic and can be part of strategies to mitigate healthcare's climate change footprint. Larger scale studies integrating virtual medicine will be crucial to demonstrate the potential environmental impact of this burgeoning mode of healthcare delivery. With the expansion of virtual medicine, it will be important to ensure accessibility. A recent systematic review, prepared for the Agency for Healthcare Research and Quality (AHRQ), found that patients using virtual medicine were more likely to be White and of higher socioeconomic status.[29] Similarly, virtual access screening of pediatric urology families at our institution revealed that there is a small proportion of families who lack access, and this cohort disproportionately represented underserved communities.[30]

It should also be considered that virtual medicine may be less suitable for patients with complex clinical conditions and/or those requiring a tactile physical examination. The potential exists for claims of delayed or missed diagnosis of conditions that would have been better assessed during in-person visits. Given the novelty of virtual care, this has not yet been substantiated and further investigation of the safety, quality, and efficacy of virtual visits is warranted. The AHRQ systematic review noted that virtual medicine may be comparable to in-person care across a variety of conditions.[29] Still, it is possible that a small proportion of our virtual medicine patients required a subsequent in-person clinical encounter. The travel required for that in-person encounter would be unlikely to have a substantial impact on the total averted patient travel afforded by the virtual medicine program, given the 60.1% decrease in in-person visits during the intra-pandemic year.

In fact, this study likely represents an underestimation of travel averted as we were unable to account for traffic patterns, such as stop and start traffic in our urban location, that would certainly increase the emission and gasoline consumption rates by vehicles. The emission and fossil fuel estimates may be underestimations since these calculations are based on vehicles with model year 2018. Older vehicles would have higher carbon dioxide and fine particulate matter emissions and reduced fuel economy. For example, from 2008 to 2018, light-duty vehicles have had a 48% reduction in particulate matter emissions per kilometer driven and more significant reductions in gaseous pollutants.[23] We also were unable to account for patients who would have traveled by means of public transportation. Use of public transportation probably fluctuated during the COVID-19 pandemic, due to social distancing requirements and variability in patients' preferred modes of transport. Regardless, this characterizes those patients that live near the hospital and, therefore, would not represent a sizable portion of the total distance.

Based on variability of physician licensing requirements during the pandemic, we limited our analysis to virtual visits associated with patients that were within state boundaries. This likely also significantly underrepresents the true environmental benefit of virtual medicine. Additionally, during the COVID-19 pandemic, some providers may have completed virtual visits from their home. In the current analysis, we did not consider reductions in fuel consumption or emissions due to curtailment of provider travel.

Given the healthcare sector's large footprint for greenhouse gas emissions, this study demonstrates a 4.5% reduction in hospital energy expenditure. Although this reduction is modest, it represents a savings of 850 metric tons of carbon dioxide, which is equivalent to 107 homes' electricity use for one year. These reductions were not stable throughout both study periods. In the early months of the pandemic, there were mandated changes in health utilization patterns due to decreased ability to perform elective operative procedures to minimize viral spread. In the later months of the pandemic, as the hospital returned to more of a 'normal' operation, new guidelines called for more air circulation, sanitization, and other infection, prevention and control measures that likely increased energy use despite a lower on-site population. Measuring and learning from sustainability efforts in mitigating hospital emissions is essential as we address the climate crisis.[1]

Our study must be considered in the setting of certain limitations. We focused our estimates on carbon dioxide emissions and did not include other traffic-related air pollutant estimates such as carbon monoxide, nitric oxide, and sulfur dioxide, as these contribute less than 5% of total greenhouse gas emissions from passenger vehicles.[21] Further studies are needed to evaluate this. We did not assess the appropriateness, safety, or efficacy of virtual visits. As such, we did not track in-person encounters that occurred after virtual visits, such as laboratory, radiology, and emergency department visits, and cannot account for potential associated patient travel. We also did not record the number of no-show visits or virtual visit duration. The study findings are constrained by the nature of the sample and the unique effects of the pandemic on transportation access and use. The virtual visit preferences of patients served at Boston Children's may not reflect those of other institutions. In addition, the desire of patients to avoid in-person visits due to risk of contagion spread may be a uniquely potent motivator for virtual visits. For healthcare systems and providers, changes in policy and/or payor contracts may drive shifts in virtual medicine use. We did not assess the patient or provider experience with virtual visits. Finally, we cannot completely attribute institutional electricity reductions to the uptake of virtual medicine.

## Conclusions

Widespread institutional use of virtual medicine can provide significant environmental benefits. Avoided travel results in reductions in fossil fuel use and associated fine particulate matter and carbon dioxide emissions. Such data should be considered when healthcare systems, payers and legislators decide whether to sustain the use of virtual medicine beyond the COVID-19 crisis. Further research investigating the safety, quality and efficacy of virtual visits is necessary. Employing virtual medicine, while being mindful of equity and appropriate patient selection, may provide benefits for patients, providers, and the environment.

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## Abbreviations:

| | |
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| **U.S.** | United States |
| **COVID-19** | Coronavirus Disease 2019 |
| **EPA** | Environmental Protection Agency |

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**What's New**

With widespread application during the COVID-19 pandemic, a paradigm shift toward pediatric virtual medicine program greatly reduced patient travel burden, fossil fuel use, carbon dioxide and fine particulate matter emissions, with the impact in pediatrics not previously evaluated.

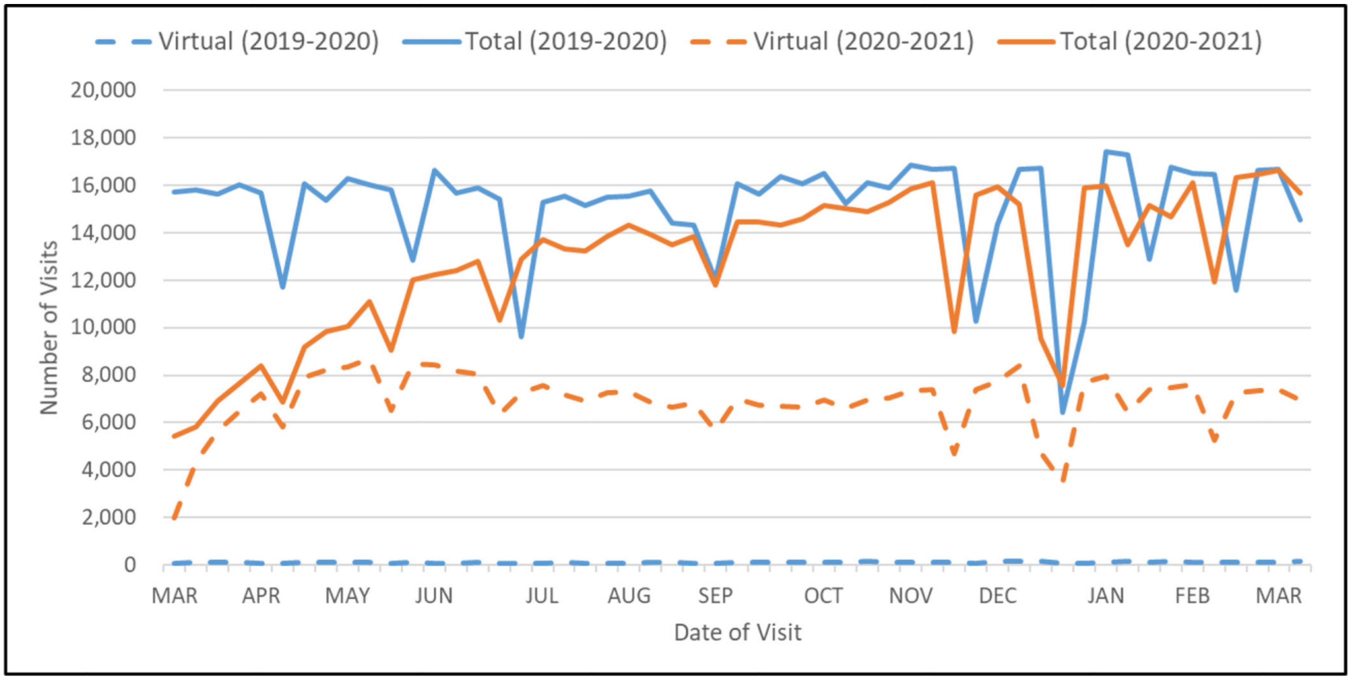


**Figure 1.**
Number of virtual and overall outpatient visits at our institution by month.

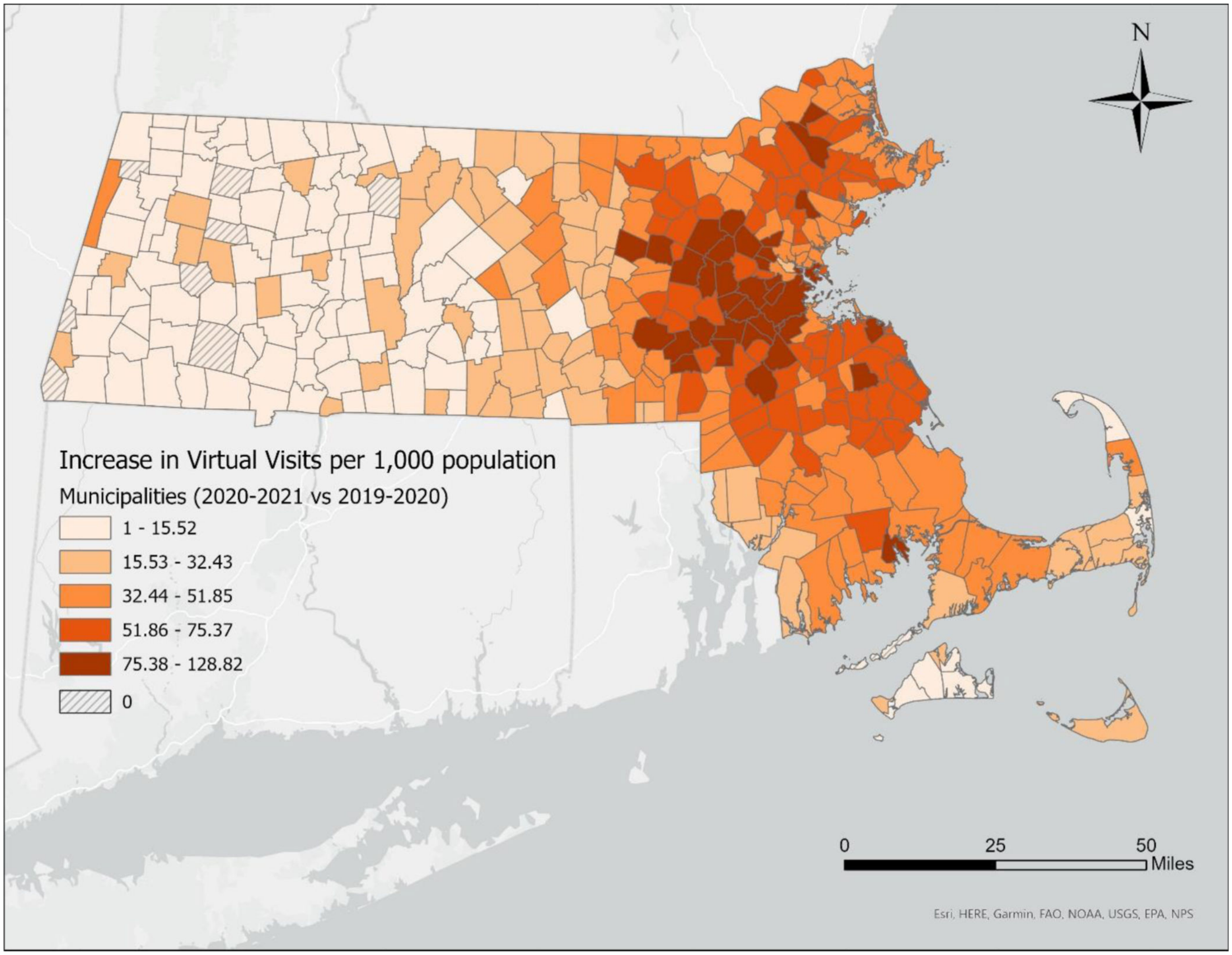


**Figure 2.**
Increase in virtual visits from pre- to intra-pandemic by municipality adjusted for population.

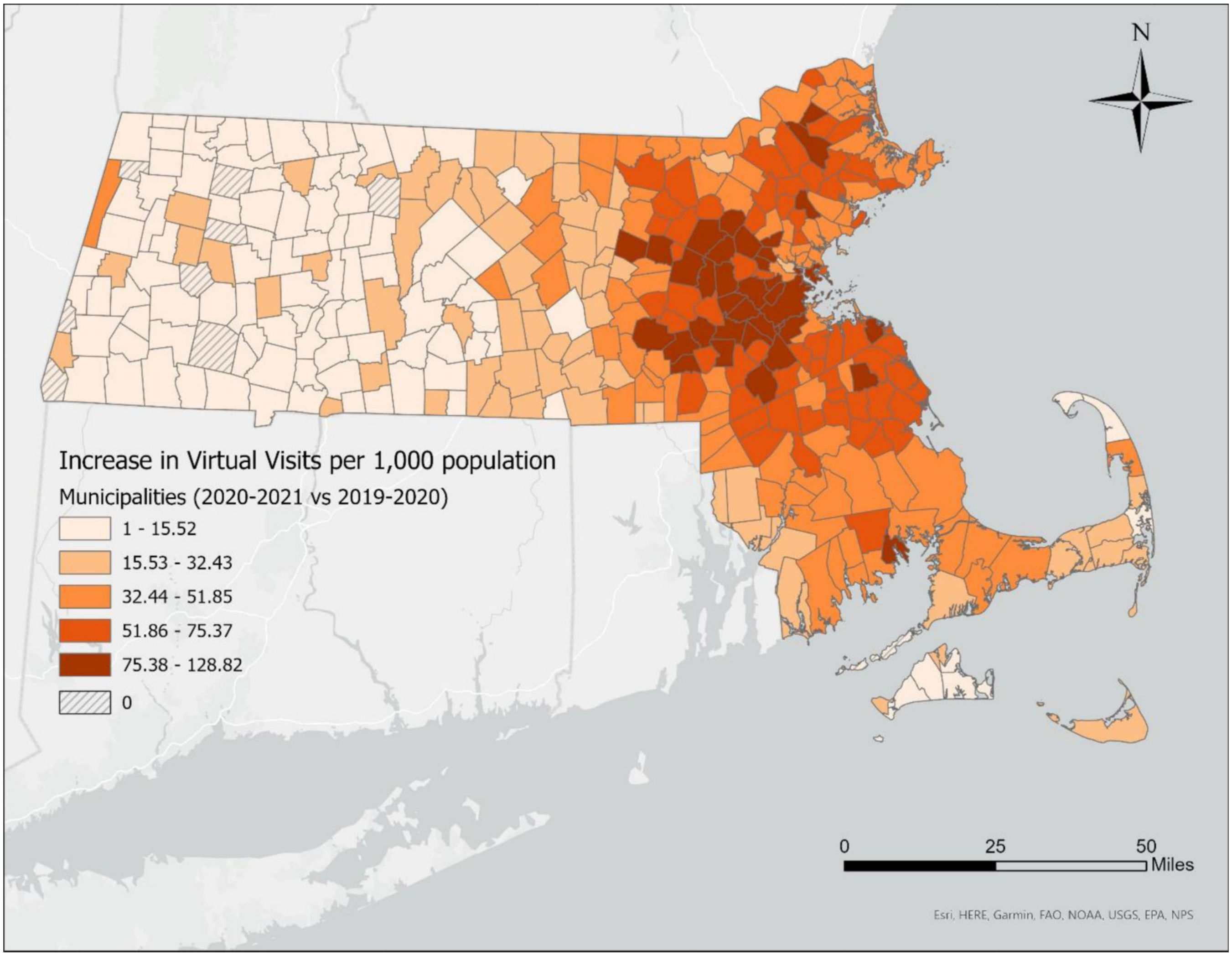


**Figure 3.**
Total energy expenditure at the main hospital by month.

**Table 1.**

Patient demographics and virtual visit type by year of encounter.

| Year | Pre-Pandemic 2019–2020 (N=3,846) | Intra-Pandemic 2020–2021 (N=307,273) | P-value |
|---|---|---|---|
| **Age by Groups** | | | <0.001 |
| 0–5 Years | 400 (10.4%) | 67,023 (21.8%) | |
| 6–10 Years | 573 (14.9%) | 56,423 (18.4%) | |
| 11–15 Years | 892 (23.2%) | 70,608 (23.0%) | |
| 16–20 Years | 1,427 (37.1%) | 79,472 (25.9%) | |
| 21–30 Years | 504 (13.1%) | 26,168 (8.5%) | |
| >30 Years | 38 (1.0%) | 6,868 (2.2%) | |
| Unknown/Missing | 12 (0.3%) | 711 (0.2%) | |
| **Sex by Visits** | | | <0.001 |
| Female | 2,003 (52.1%) | 157,286 (51.2%) | |
| Male | 1,843 (47.9%) | 149,957 (48.8%) | |
| Unknown | 0 (0.0%) | 30 (0.01%) | |
| **Race by Visits** | | | <0.001 |
| American Indian/Alaska Native | 13 (0.5%) | 705 (0.2%) | |
| Asian | 121 (3.1%) | 9,687 (3.2%) | |
| Black/African American | 273 (7.1%) | 24,578 (8.0%) | |
| Native Hawaiian/Pacific Islander | 1 (0.02%) | 184 (0.1%) | |
| Other | 543 (14.1%) | 46,741 (15.2%) | |
| Unknown/Refused | 567 (14.7%) | 55,888 (18.2%) | |
| White | 2,328 (60.5%) | 169,490 (55.2%) | |
| **Virtual Visit Type** | | | <0.001 |
| Interactive Video Visits | 3,844 (99.9%) | 298,669 (97.2%) | |
| Telephone Visit | 2 (0.1%) | 8,604 (2.8%) | |

**Table 2.**

Reductions in travel distance, gasoline and associated cost, and carbon dioxide and fine particulate matter emissions by institutional use of virtual medicine prior to and during the COVID-19 pandemic.

| Year | Pre-Pandemic 2019–2020 (N=3,846) | Intra-Pandemic 2020–2021 (N=307,273) | Percent Change (%) |
|---|---|---|---|
| **Distance** | | | |
| Average round-trip distance saved by averted patient travel | 93.4 kilometers | 82.1 kilometers | N/A |
| Total travel distance saved by averted patient travel | 359,416 kilometers | 25,246,408 kilometers | +6924.3% |
| **Fossil Fuel Consumption** | | | |
| Total gas consumption saved by averted patient travel | 8,957 gallons | 629,188 gallons | +6924.5% |
| **Gasoline Cost (USD)** | | | |
| Total cost saved by averted patient travel | $23,396 | $1,643,398 | +6924.3% |
| **Carbon Dioxide ($CO_2$)** | | | |
| Total $CO_2$ emissions saved by averted patient travel | 79.4 metric tons | 5,579.5 metric tons | +6927.1% |
| **Fine Particulate Matter ($PM_{2.5}$)** | | | |
| Total $PM_{2.5}$ emissions saved by averted patient travel | 2.7 kilograms | 189 kilograms | +6900.0% |
| **Energy Expenditure** | | | |
| Total energy use at main hospital | 69.5 million kilowatt hours | 66.4 million kilowatt hours | −4.5% |