Environmental impact of digital health

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Abstract

Digital health incorporates many efficient new solutions like tele medicine and access to digital test results and medical reports. In this retrospective study, we analyze the environmental impact of digital health activity. We evaluate the net CO₂ emissions avoided through a reduction in patient travel to surgeries and medical clinics thanks to the alternative of digital appointments or the digital access to test results and medical reports which avoid the need travel into a clinic for a face-to-face visit or to pick up printed results or reports. During 2020 a total of 640,122 digital appointments were carried out by the healthcare company, which avoided 1,957 net Tons of CO₂ emissions, while patients downloaded 3,064,646 digital medical reports through the company portal, which avoided a further 4,698 net Tons of CO₂ emissions. These two digital health solutions avoided a net total of 6,655 Tons of CO₂ emissions. The present study demonstrates that digital health, specifically digital appointments and digital reports, reduce the environmental impact of healthcare by reducing the need for patient travel, contributing both to population and planet health.

Introduction

Digital health is the use of information and telecommunication technologies to improve health. It is a big umbrella that incorporates a broad range of developments like telemedicine, mobile health and other solutions like online appointments and access to digitalised medical reports. Digital health enables innovative models of care and allows healthcare professionals to put patients at the center of medical assistance, improving efficacy and accessibility (1). It has also proven to be a powerful weapon in fighting the health system's latent crisis in resources by enabling the remote care of chronic conditions, relieving the shortage of health workers', and favouring the evolution of the patient – doctor relationship, reorientating it towards an agile and continuous attention focused on patient autonomy, participation, experience and necessities. Digital tools have the potential to simplify both administrative and healthcare processes, to improve the quality and reduce the cost of medical care and to breakdown geographical barriers. Several international organisations recommend further developing and implementing digital health strategies (2).

Digital health has been our ally during the COVID-19 crisis (3). There has been a shift from an almost exclusively analogical attention to an effective – and accepted – level of digital attention. Virtual appointments (essentially videocalls carried out by a doctor through a secure platform that is also connected with a patient's medical history record and the ability to prescribe follow-up tests, scans and pharmaceutical prescription) have proven to be an effective and safe alternative to provide patient centred care and to improve accessibility to medical assistance (4). Beyond the benefits shown in these exceptional times (5), its role should be considered in everyday life. Its advantages have become clear for patients, doctors, and health system managers.

One of the most developed areas of digital health is telemedicine. It can be defined as remote medical assistance and its aim is to improve patient's health and welfare. This kind of assistance implies the use

of information and communication technologies to boost communication both between doctors and patients and among health professionals themselves (6).

Digital consultation is the best known example of telemedicine; it comprises tele consultation (audio communication) and video consultation (audio and video communication). Its implementation has been boosted over the last few years thanks to connectivity improvements and the boom of smart phones. Video consultation is preferred over tele consultation as it allows visual contact, enables communication, and makes physical examination possible. Digital consultation improves patient experience and promotes patient's empowerment with regards to his/her own care (7). Satisfaction levels are very high (8). What users underline the most are safety, smoothness, flexibility, comfort and time and economic savings. It also avoids Carbon dioxide (CO₂) emissions in those cases when it avoids the need to travel in to a surgery for a face to face appointment, and although the digital process does lead to an increase in energy consumption, this is far outweighed by the benefits of avoided travel.

CO₂ is one of the most important greenhouse gases; it traps heat in the atmosphere and is one of the main gases responsible for Climate Change. The impact of climate change is evident in every continent and poses a risk both for human health and for nature (9). Human activities have been responsible for almost all the increase in greenhouse gases in the atmosphere in recent years. The transportation sector generates the largest share of greenhouse gas emissions, which come mainly from the burning of fossil fuels for cars, trucks, ships, trains and airplanes. Electricity production generates the second largest share of greenhouse gas emissions. Many mitigation strategies have been proposed which centre primarily on the reduction of fossil fuels and energy demand (10). Digital health could help address both issues, especially telemedicine programs due to the potential to avoid patient travel (11, 12).

In the current climate of growing interest in reducing the environmental footprint of health care activities (13), this study evaluates the environmental impact of digital health solutions, analyzing the net CO₂ emissions avoided thanks to the corresponding reduction in patient travel to medical clinics when using a digital consultation or video appointment option or when downloading medical reports instead of travelling in to request printed versions.

Results

The total number of medical appointments carried out by the healthcare company patients in 2020 was 3,015,530. Of those, 640,122 were in digital format (495,913 were video appointments and 144,209 telephone appointments), with an average of 3,700 digital appointments per day. This digital use is estimated to have avoided 1,957 net Tons of CO₂ emissions (figure 1). Similarly, in 2020 patients downloaded 3,064,646 medical reports to their digital health folder, with an estimated impact of 4,698 net Tons avoided of CO₂ emissions. These two digital health solutions together avoided 6,655 net Tons of CO₂ emissions in 2020.

Of the digital appointments, 66,510 were with a generalist practitioner (GP) and 573,612 were with a specialist. 74,7% of the video appointments were made from a mobile phone application and 25,3% were made over the web using a computer.

The average age of patients who requested a digital appointment was 39 years old, unlike those who used face-to-face consultation, which was 44 years old. The people who most used the digital appointment option during 2020 were people between 30 and 39 years old (54,812 digital appointments), followed by those between 45 and 54 (47,372 digital appointments). It is worth noting however, that, overall, this service was used by patients of all age group, with those over 70 years old making more than 18,000 video appointments during 2020.

Patient satisfaction with the use of digital appointment, measured using the Net Promoter Score (NPS) methodology, was high with an average rating of 62.1% in 2020 and 48.7% of customers repeating this communication method.

Discussion

This study showed that the 640,122 digital appointments carried out and the 3,064,646 digital medical reports downloaded by the customers in 2020 avoided an estimated 6,655 net Tons of CO₂ emissions, according to the calculations revised by the Carbon Trust. These results confirm that digital health reduces the impact of healthcare on the environment by reducing the number of car journeys for a face-to-face visit or to pick up paper medical reports, contributing to both population and planet health.

Our results are consistent with those from Vidal-Alaball et al (11) involving 9,034 teleconsultations with a reduction of 29,384 net Tons of CO₂ – representing an average 3,248 Kgs saved per journey, in line with our estimate of 3,057 Kgs in Spain. Other studies also suggest that the reduction in visits as a result of telemedicine services and the consequent reduction of pollutant emissions is significant (14, 15).

Digital consultations have risen exponentially in 2020, to enable continuity of care during the COVID-19 pandemic. During this test period it proved to be a safe and effective alternative to classical care (8). Telemedicine, beyond being considered a very useful means in exceptional situations, provides advantages that will lead us to rethink its use in the day-to-day care processes outside of the exceptionality of a pandemic. These advantages benefit both the patient and the professional and the healthcare system. In 2020, users highlighted its ease of use, flexibility, comfort and savings in time and money by reducing travel, with the consequent environmental impact achieved by avoiding CO₂ emissions, in addition to greater security by reducing the risk of contagion throughout the different COVID-19 waves. These advantages were also experienced by healthcare personnel, who reported greater work-life balance thanks to remote working, as well as considering digital tools a well accepted healthcare alternative (8). Most of those users who made virtual appointments consider that they offer quality of medical care (5) and affirmed that they intended to continue with this type of care once the pandemic is over (16) and believe that its implementation will be permanent (17). Telemedicine also

brings benefits to healthcare organizations by moving care from healthcare facilities to homes and to mobile devices. It increases the efficiency of the consultations because they are shorter, once the rapid learning process to use the new software has been overcome. It improves accessibility to services by ensuring continuity of care, reducing waiting lists and prioritizing the patients who need it most, directing them towards adequate healthcare circuits and providing the right attention to the right patient (8). At the same time, it allows agile communication between healthcare levels avoiding unnecessary referrals (18). In addition to the advantages perceived by the different users, there is evidence that telemedicine improves the health of the population (19) and reduces the costs derived from health care, especially in certain chronic diseases such as diabetes (20) or cardiovascular diseases (21).

The high satisfaction of users and the high recurrence of the use of the digital consultation in our sample, coincides with those reported in scientific literature (5). These results favor the maintenance of this level of activity once the situation has normalized. Thus, we have seen the consolidation of a new way of communication between patients and doctors that ensures equality of access to healthcare while reducing in person hospital visits and their environmental impact.

The effect of reduced travel and its decrease in CO₂ emissions has been clearly demonstrated during the pandemic. COVID-19 has meant a digital transformation in health, but it has also had an impact on human activities, and, in turn, energy use and CO₂ emissions. There was an abrupt 8,8% decrease in global CO₂ emissions (-1551 Mt) in the first half of 2020 compared to the same period in 2019. But the pandemic's effects on global emissions diminished as lockdown restrictions relaxed and some economic activities restarted (22).

The Spanish public National Health System covers the 45,207,196 inhabitants of Spain. Every year it takes care of around 234 million GP consultations and 103 million specialized medical consultations (23). Telemedicine alone cannot solve all clinical demands, but according to some studies, up to 75% of face-to-face visits can be resolved remotely (24). A profound change in the healthcare model will be necessary to reach this figure: however, if we take the digital consultation rate of 25% witnessed in our sample and extrapolate this rate to apply it to telehealth solutions across Spain, we can guess that it could have led to 84,2 million digital consultations had it been used throughout the health system. With each digital consultation avoiding 3,057 kg of net CO₂ emissions, by avoiding the need for patients to travel to an appointment, this would have meant avoiding 78,717 net Tons of CO₂ emissions in Spain. This means 0,03% of the annual production of 252,6 million tons in the country (25). Even though this figure might seem modest, with increased take up and by extending it to more and more examples, digital health has the potential to be considered a mitigation strategy for Climate Change (26). Every little step helps towards becoming a climate neutral country and having a healthier planet.

Approximately 2.5 million cases of non-communicable diseases attributable to air pollution are predicted by 2035 if the atmospheric pollutants stay at current levels, making air pollution an important public health priority (27). The concept of One Health recognizes that the health of people is closely connected to the health of animals and our shared environment. To take care of people's health, we must also take

care of the health of the planet. Therefore, the health sector must also assume the responsibility of caring for people, animal and environmental health if it truly wishes to achieve a healthy society.

The results of this study should be interpreted with caution and in the context of its limitations. The calculation of the net CO₂ emissions data has been obtained from the different modes of travel used by the population in Spain and UK, therefore, these results cannot be extrapolated to other countries with another use of means of transport. For the purposes of this study, the type of transport used has been taken to be a normal vehicle with average emissions. The use of hybrid or electric cars, or higher emissions through the use of outdated and obsolete cars, has not been taken into account. The calculation of distance travelled and the use of different means of transport is an average, based on the average distance travelled by all the healthcare company patients in 2019. It is not based on actual distances or methods used. Air pollution is a mixture of different pollutants and we have selected CO₂ as the only marker of air pollution. Although digital consultations do not always avoid a face-to-face appointment, in our sample in 90% of cases, no face-to-face visit occurred in relation to the same type of specialist in the next week following the telemedicine consultation, leading us to conclude that the digital consultation successfully solved the patient request. Another limitation is the population bias, given that Sanitas policyholders are concentrated in the main cities of the country, with which the observed impact of digital health in CO₂ savings cannot be generalized to rural areas, where it would be higher due to the greater distances that users must travel to go to health centers, and where the effectiveness of telemedicine is even higher (11).

This study confirms that digital health, specifically digital consultation and the download of digital vs paper reports, reduces the environmental impact of healthcare by reducing the number of journeys for a face-to-face visit and the number of printed medical reports, contributing to both population and planet health. Further studies ought to include more information on other sustainable modes of transport and include air pollution in the cost-effectiveness analysis of face-to-face visits compared to telemedicine.

Nowhere are the effects of climate change manifesting more clearly than in human health. The modern healthcare sector contributes towards this serious phenomenon and, at the same time, it is being affected by it. Ameliorating the health care sector's environmental effects and reducing greenhouse-gas emissions could not only improve health for everyone, but also reduce costs of care (28).

The present study was thus conducted to identify one of the multiple ways in which the health sector can contribute to preventing climate change. The expansion of telemedicine programs ought to be considered an option as part of a global strategy to reduce the emission of atmospheric pollutants. As everything indicates that telemedicine is here to stay, digital consultation will be a key tool to solve, not only the health challenges of the future, but also environmental challenges.

Methods

This is a retrospective study analyzing the environmental impact of digital health activity of Sanitas insurance policyholders in Spain in 2020. Sanitas is a private Spanish healthcare company with around 2 million policyholders, and a hospital network with 29 healthcare facilities and teaching hospitals, with 3,136 doctors from 35 specialties available. Sanitas professionals have clinical protocols for the use of digital consultation by specialty and offer the health system 24 hours a day, 7 days a week.

Sanitas' policyholders have access to different digital health solutions through a mobile application and a web site; they are able to schedule a doctor's appointment, download their medical test results or reports as well as accessing the digital consultation platform. Video consultation is accessible using smart phones or computers, while tele consultation is feasible using any kind of phone.

To obtain the calculation of the net CO₂ emissions data avoided thanks to patient's a switch to digital processes, we worked with the Carbon Trust, a global climate change and sustainability consultancy. We reviewed the statistical data of the average distances travelled by Sanitas customers to get from their homes to a doctor's surgery and with this data they calculated the average distance covered nationally (approximately 13 Km for a round trip). The methodology included a review of the different modes of travel used by the population, according to Spain and UK's national statistics registers (29, 30). Different means of transport were analyzed (walking, cycling, bus, train, car) with the following considerations: In the large provinces (Madrid, Barcelona and Valencia) 50% of the clients would go by car; 21% by bus; 26% by train or metro and 3% by non-polluting method of transport (foot, bicycle). In the rest of the provinces, 80% would go by car; 9% by bus; 8.0% by train and 3% by non-polluting method of transport.

The Carbon Trust's methodology included in its equation the CO₂ emissions generated by using digital tools for video appointments (energy consumption of equipment and data transmission) or to download and save a digital medical report. The emissions related to videoconferencing were subtracted from the total avoided emissions in order to establish a "net" quota of avoided CO₂.

To calculate the emissions generated during a video consultation, the energy consumption of a videoconference was estimated to last an average 9.5 minutes and was calculated according to the energy intensity of the data centers, data transmission and the use of devices, in line with the reports of the International Energy Agenda. The emission factor of the Spanish electricity mix was used.

The savings derived from the use of paper were calculated based on 2 aspects: 1) Use of paper: emissions related to unused paper were calculated by multiplying the average weight of paper saved in each report by the production emission factor of paper. Emissions at the end of the useful life of the paper have also been taken into account, multiplying the Spanish statistics of paper and cardboard waste on recycling, landfills and incineration by the related emission factors and the weight of the paper. 2) Energy for printing: The energy saved, by avoiding the printing of paper in each consultation, was calculated by multiplying the average consumption of electricity to print an A4 page by the average number of sheets of medical reports. Emissions avoided by printing were obtained by multiplying the electricity emission factor by the energy saved by printing.

The net carbon savings for digital appointments and downloaded reports was calculated by summing the carbon savings deriving from the avoided patients' travel and documents printing and subtracting the videoconferencing and downloading emissions, as shown in figure 2. Performing a digital consultation reduced carbon emissions primarily (>99%) through reduced patients' travel. A small fraction (<1%) of carbon savings is also derived from the avoidance of using paper for printing the visit's results.

The result of the calculation described above gave an average of 3,057 Kgs of net CO₂ emissions avoided for every digital appointment and 1,5 Kgs avoided for every medical report downloaded instead of being physically collected in the clinic. After each video appointment patients can access information on the CO₂ they have avoided, if their video appointment has avoided their need to use a car to travel in for a face to face appointment. The message to users, in the personal area of digital platform, reads "If this visit has saved you a trip to the practice, you have avoided 3,1 Kgs in CO₂ emissions".

Microsoft Excel and Microsoft Power BI were used for data processing and quantitative analysis.

Declarations

Data availability

The datasets generated and/or analysed during the current study are not publicly available due to they include private data about the activity of the insurance company, but are available from the corresponding author on reasonable request.

There isn't any human participation or human data involved in the study.

Author Contributions

A.A.T and C.M.S. conceived and designed the study, and drafted, review and edited the manuscript. A.A.T, C.M.C. and C.M.S. collected data and made the analysis. A.J.F and J.F.T.M. provided critical review. All authors reviewed the manuscript. C.M.S.. had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Ethics declarations and Competing Interests statement

All authors declare no competing interests.

References

1. Morcillo ,C. & González, J.L. New digital healthcare technologies. *Med Clin Barc* **154**, 257-259 (2020). doi.org/10.1016/j.medcli.2019.07.004.

2. WHO guideline: recommendations on digital interventions for health system strengthening. Geneva: World Health Organization. Licence: CC BY-NC-SA 3.0 IGO (2019).
3. Mehrotra, A. & Ray, K. Rapidly Converting to “Virtual Practices”: Outpatient Care in the Era of Covid-19. *NEJM Catalyst*. April 1 (2020). DOI: 10.1056/CAT.20.0091.
4. Shah, R. & Schulman, K. Do Not Let a Good Crisis Go to Waste: Health Care’s Path Forward with virtual Care. *NEJM Catalyst*. March 30 (2021). DOI: 10.1056/CAT.20.0693.
5. Croymans, D. & Hurst, I. Telehealth: The Right Care, at the Right time, via the Right Medium. *NEJM Catalyst*. December 30 (2020). DOI 10.1056/CAT.20.0564.
6. Reed, M.E. et al. Real-Time Patient–Provider Video Telemedicine Integrated with Clinical Care. *N Engl J Med* **379**, 1478-1479 (2018). doi: 10.1056/NEJMc1805746.
7. Tuckson, R.V., Edmunds, M. & Hodgkins, M.L. Telehealth. *N Engl J Med* **377**, 1585-1592 (2017). DOI: 10.1056/NEJMSr1503323.
8. Zorron Cheng Tao Pu, L. et al. Video consultations during the coronavirus disease 2019 pandemic are associated with high satisfaction for both doctors and patients. *JGH Open* **5**, 542-548 (2021). doi: 10.1002/jgh3.12547.
9. Zhang, A.L. et al. Traffic-related air pollution, biomarkers of metabolic dysfunction, oxidative stress, and CC16 in children. *J Expo Sci Environ Epidemiol* (2021). <https://doi.org/10.1038/s41370-021-00378-6>.
10. IPCC: Summary for Policymakers. In: *Climate Change: Mitigation of Climate Change*. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA (2014).
11. Vidal-Alaball, J., Franch-Parella, J., Lopez, F., Garcia, F. & Mendioroz, J. Impact of a Telemedicine Program on the Reduction in the Emission of Atmospheric Pollutants and Journeys by Road. *Int. J. Environ. Res. Public Health* **16**, 4366 (2019). doi:10.3390/ijerph16224366.
12. Oliveira, T.C., Barlow, J., Gonçalves, L., & Bayer, S. Teleconsultations reduce greenhouse gas emissions. *J. Health Serv. Res. Policy* **18**, 209-214 (2013). doi: 10.1177/1355819613492717.
13. Sherman, J.D., MacNeill, A. & Thiel, C. Reducing Pollution from the Health Care Industry. *JAMA* **322**, 1043-1044 (2019). doi: 10.1001/jama.2019.10823.
14. Whetten, J., Montoya, J. & Yonas, H. ACCESS to Better Health and Clear Skies: Telemedicine and Greenhouse Gas Reduction. *Telemed. e-Health* **25**, 960-965 (2019). doi: 10.1089/tmj.2018.0172.
15. Paquette, S. & Lin, J.C. Outpatient telemedicine program in vascular surgery reduces patient travel time, cost, and environmental pollutant emissions. *Ann. Vasc. Surg* **59**, 167-172 (2019). doi:

10.1016/j.avsg.2019.01.021.

16. Stone, R.L. How an Ohio-based Physician Organization Overcame Internal Hurdles and Launched a Telehealth Service as Covid-19 Shutdowns Loomed, *NEJM Catalyst*. October 8 (2020). DOI: 10.1056/CAT.20.0515.

17. Bimal, R.S. & Schulman, K. Do Not Let a Good Crisis Go to Waste: Health Care's Path Forward with Virtual Care. *NEJM Catalyst*. March 30 (2021). DOI: 10.1056/CAT.20.0693.

18. Schettini, P. et al. Keeping care connected: e-Consultation program improves access to nephrology care. *J Telemed Telecare* **25**, 142-150 (2019). doi: 10.1177/1357633X17748350.

19. Flodgren, G., Rachas, A., Farmer, A.J., Inzitari, M. & Shepperd, S. Interactive telemedicine: effects on professional practice and health care outcomes. *Cochrane Database Syst Rev* **9**, CD002098 (2015). doi:10.1002/14651858.CD002098.pub2.

20. Su, D. et al. Does telemedicine improve treatment outcomes for diabetes? A meta-analysis of results from 55 randomized controlled trials. *Diabetes Res Clin Pract* **116**, 136-48 (2016). doi: 10.1016/j.diabres.2016.04.019.

21. Schwamm, L.E. et al On behalf of the American Heart Association Advocacy Coordinating Committee. Recommendations for the Implementation of Telehealth in Cardiovascular and Stroke Care: A Policy Statement From the American Heart Association. *Circulation* **135**, e24e44 (2017). doi.org/10.1161/CIR.0000000000000475.

22. Liu, Z et al. Near-real-time monitoring of global CO₂ emissions reveals the effects of the COVID-19 pandemic. *Nat Commun* **11**, 5172 (2020). <https://doi.org/10.1038/s41467-020-18922-7>

23. Informe Anual del Sistema Nacional de Salud. Ministerio de Sanidad. NIPO: 133-20-031-6 (2019). <https://cpage.mpr.gob.es/> (accessed on 1 Dec 2021).

24. Morcillo, C. & Aroca, A. Teleconsultation and videoconsultation forever? *Med Clin (Barc)* (2021). In press. <https://doi.org/10.1016/j.medcli.2021.09.008>

25. Ritchie, H. & Roser, M. "CO₂ and Greenhouse Gas Emissions". *Published online at OurWorldInData.org*. Retrieved from: '<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>' (2020) [Online Resource] (accessed on 1 Dec 2021).

26. Holmner, A., Ebi, K.L., Lazuardi, L. & Nilsson, M. Carbon footprint of telemedicine solutions—Unexplored opportunity for reducing carbon emissions in the health sector. *PLoS ONE* **9**, e105040 (2014). doi: 10.1371/journal.pone.0105040.

27. Pimpin, L. et al. Estimating the costs of air pollution to the National Health Service and social care: An assessment and forecast up to 2035. *PLoS Med* **15**, e1002602 (2018). <https://doi.org/>

28. Dzau, V.J., Levine, R., Barrett, G., & Witty, A. Decarbonizing the U.S. Health Sector – A Call to Action. *N Engl J Med* **385**, 2117-2119 (2021). doi: 10.1056/NEJMp2115675.

29. Reparto modal del transporte nacional de viajeros (2018). <https://observatoriotransporte.mitma.es> (accessed on 1 Dec 2021).

30. Average distance travelled for Personal Business by mode in England (2019). Table NTS0409b, National Travel Survey. <https://www.gov.uk/government/collections/national-travel-survey-statistics>. (accessed on 1 Dec 2021).

Figures

Figure 1
Number of appointments and CO₂ emissions avoided.

Evolution of the number of face-to-face and digital appointments made monthly during 2020. The yellow line shows the monthly CO₂ emissions avoided, result of multiplying the number of digital appointments by the average saving of 3,057 Kgs of CO₂ for every digital appointment.

Figure 2

Calculation of carbon savings of performing a visit online.

The net carbon savings of performing a visit online were calculated by summing the carbon savings deriving from the avoided patients' travel and documents printing and subtracting the videoconferencing emissions.