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Savings for patients in relation to an outpatient Telemedicine program in a hospital in southwestern Colombia.

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Abstract:

Background: Telemedicine, a method of healthcare service delivery bridging geographic distances between patients and providers, has gained prominence. This modality is particularly advantageous for outpatient consultations, addressing inherent barriers of travel time and cost.

Objective: We aim to describe economical outcomes towards the implementation of a multidisciplinary telemedicine service in a high-complexity Hospital in Latin America, from the perspective of patients.

Design: A cross-sectional study was conducted, analyzing the institutional data obtained over a period of 9 months, between April 2020 and December 2020.

Setting: A high-complexity hospital located in Cali, Colombia.

Participants: Individuals who received care via telemedicine. The population was categorized into three groups based on their place of residence: Cali, Valle del Cauca, and the entire country of Colombia.

Outcome measures: Travel distance, time, fuel and public round-trip cost savings, and potential loss of productivity were estimated from the patient's perspective.

Results: A total of 62,258 teleconsultations were analyzed. Telemedicine led to a total distance savings of 4,514,903 kilometers, and 132,886 hours. The estimated cost savings were $250,840 USD for private transportation and $400,788 USD for public transportation. Patients in the Colombia group experienced an estimated average time savings of 21.23 hours, translating to an average fuel savings of $54.90 USD or an average savings of $57.70 USD in public transportation costs. Areas with exclusive air access achieved a mean cost savings of $133.71 USD per teleconsultation.

Conclusion: Telemedicine emerges as a powerful tool for achieving substantial travel savings for patients, especially in regions confronting geographical and socioeconomic obstacles. These findings underscore the potential of telemedicine to bridge healthcare accessibility gaps in low-

and middle-income countries, calling for further investment and expansion of telemedicine services in such areas.

Key Words: Health economics, Telemedicine, Latin America.

Strengths and limitations of this study

- Our study was based on institutional administrative data and carried out retrospectively. This study solely focused on transportation savings and did not consider other potential costs, such as waiting time in the waiting room, food, lodging expenses, among others.
- Clinical outcomes were not included in our analysis. Nevertheless, the substantial sample size of this study and the inclusion of heterogenous areas provide both internal and external validation, allowing for the extrapolation of our results.
- Our study offers valuable insights into travel savings from the Colombian perspective; and contributes to filling the knowledge gap on this topic in Low- and Middle-Income countries.

Introduction:

In the last decade, there have been significant technological advances in healthcare. Telemedicine is a modality of healthcare services delivery, where patients and providers are separated by distance. Telehealth uses information and communication technology for the exchange of information, related to the diagnosis and treatment of diseases and injuries, and to strengthen research and continuing education of health professionals (1). This care model can be especially helpful for outpatient consultations, where barriers related to travel time and cost are constantly inherent for patients (2,3).

Positive results regarding patient satisfaction and outcomes of telemedicine care have been reported in the literature (4). This tool has reduced costs in the health system of several countries (5,6). From the patient's perspective, despite its inherent limitations, telemedicine has been well-received and has generated excellent patient satisfaction (6,7). Telemedicine led savings for

patients and their companions, mainly those related to care, including travel time, distance, and costs (8–10). However, most of the studies about patient savings related to telemedicine use had been conducted in high-income countries, providing information on the teleconsultation offered for a single state, locality, or city.

The development and enhancement of telemedicine in Colombia has been under discussion since 2010. However, it wasn't until 2020, during the COVID-19 pandemic's public health emergency, that the government began to actively promote its utilization; this was driven by the enforcement of mandatory lockdown measures and the imperative to ensure continuous medical care. In this circumstance, the Fundación Valle del Lili (FVL), a highly complex Colombian university hospital, quickly introduced a telemedicine service. Implementing this service encountered significant challenges, the availability of resources and the cultural resistance exhibited by patients toward this modality of attention (11). Our aim was to estimate the hypotetical transportation-related savings in time, distance, and costs assumed for the patient due to outpatient care by the FVL telemedicine program during April to December 2020.

Methods:

Design and population:

A retrospective study focused on the time and transportation cost savings experienced by the patients as a result of telemedicine interventions. Our study included patient who resided in Colombia and received outpatient teleconsultation through the FVL Telemedicine program between April and December 2020. We excluded patients residing in countries other than Colombia, as well as those lacking residence information or address details. The study population was categorized based on their place of residence into the following three groups:

- Cali: People who live in the city of Cali, Valle del Cauca.
- Valle del Cauca: people who live in other cities in Valle del Cauca, different to Cali.
- Colombia: people who live in other departments, different to Valle del Cauca.

A sample size calculation was performed for the population of Cali, which consisted of 814 individuals selected through simple random sampling. This resulted in a total of 1,708 teleconsultations in the selected sample, representing 3.9% of the 44,182 teleconsultations conducted in this group. As a result, calculations for the total savings in this group were carried out by multiplying the value obtained in the sample by 25.87.

Factor de expansion.

Overview of the Fundación Valle del Lili Telemedicine Program:

FVL is a private, non-profit, high-complexity hospital located in Santiago de Cali. Serving as a referral center in the southwest region of Colombia, the institution provides across various health specialties to around 12,700 patients annually. FVL has a telemedicine service, which was promoted and strengthened in March 2020 to ensure the continuity of ambulatory health services, in view of the declaration of health emergency by COVID-19 by the Ministry of Health, throughout the Colombian territory.

FVL's telemedicine service facilitates outpatient care across 64 medical specialties, employing an interactive modality that establishes remote communication between patients and healthcare professionals through real-time video calls, facilitated by the Microsoft Teams platform. The care information was recorded in the SAP electronic medical record system. Upon the conclusion of the teleconsultation, a Portable Document File (PDF) containing the medical record, orders, and prescriptions was sent directly to the patient's designated email address.

Outcome measures:

The following outcome measures were taken into consideration:

a) Travel distance savings: The distance in kilometer of round-trip that the patient would have traveled for an in-person consultation at the FVL.

b) Travel time savings: The time in hours of round-trip that the patient would have wasted for an in-person consultation at the FVL; it represents the patient work time loss due to the travel for an in-person consultation.

c) Travel cost savings: The expenses related to round-trip that the patient would have spent for an in-person consultation at the FVL. For all cases, two modes of transportation were considered: 1) private transportation, for which round-trip fuel expenses were calculated for; and 2) public transportation, for which taxi costs (Cali group) or intermunicipal bus costs (Valle del Cauca and Colombia groups) were calculated based on 2020 fare rates.

d) Potential loss of productivity: It pertains to the value of work time that the patient would have lost due to the round-trip travel required if they had made the consultation in-person.

Distance and time calculation: Measurements of car transportation were performed using Google Maps, taking the main FVL center as the destination and the patient's place of residence as the origin. The patient's home address was defined by the address (for Cali residents) or the registered municipality of residence in the electronic medical record system. The car transport option and the quickest route were selected. The estimated distance and travel time were doubled to encompass the round-trip travel to and from the FVL.

Fuel cost calculation: We took has a reference the cost per gallon of fuel reported by the Ministry of Mines and Energy for the year 2020 that was $8,268 COP ($2,24 USD); and an average consumption of 40 km traveled per gallon.

$$Fuel\ \text{cost saved} = \frac{\text{Round trip distance (km)}}{40\ (\text{km})} * \$\ 8{,}268$$

Calculation of public transportation cost savings: To calculate the cost public transportation for the population living in Cali, we considered the cab fare reported by the Cali Municipal Hall for the year 2020, which was $84 COP for each 80 meters traveled. For residents in other areas of

Valle del Cauca and Colombia, we searched on the virtual platforms of the country's public transportation terminals to determine the fare cost of inter-municipal bus travel from the different localities to the city of Cali.

It should be highlighted that for the municipalities where river transportation is necessary, the travel cost and time required for each municipality were consulted, in addition to the cost and time of land transportation. For the municipalities that do not have land access, estimates were made of the airfare costs, these were excluded in the calculations of distance and time savings.

Calculation of the potential loss of productivity: In Colombia the legal minimum wage in force for the year 2020 was $877,803 COP ($235,90 USD), the workday corresponds to 48 hours per week, which is adjusted to 8 hours per day. The value of 1 hour worked was $ 3,657 COP ($0,98 USD). With the above, the value that the patient would have lost due to lost work time secondary to the round-trip to attend an in-person consultation was calculated.

$$\text{Work cost of time saved} = \text{Round trip time (hour)} * \$\ 3{,}657\ \text{COP}$$

All costs were calculated in Colombian Pesos and subsequently converted to US Dollars according to the average market exchange rate (TRM, by its Spanish acronym) for the year 2020, which was $3,721 COP (12).

Ethics Approval

This study was conducted according to the Declaration of Helsinki guidelines; and was classified as a risk-free study according to resolution No. 008430 of 1993, article 11, numeral A of the Ministry of Health and Social Protection of Colombia. The institutional ethics committee reviewed and approved the protocol (Protocol No. 1742; IRB/EC No. 090 – 2021, Act No. 06 - 2021). This study did not require intervention or intentional modification of the biological, physiological, psychological, or social variables of the participants. Therefore, no informed consent was necessary.

Results

A total of 296,170 outpatient care con consultations were made from April to December 2020. Among these, 152 consultations were excluded due to patients residing outside of Colombia. Consequently, 296,018 consultations were included, out of which 62,258 (21.03%) were conducted via telemedicine, involving to 27,948 individuals **(Table 1)**. The median age of the population was 41 years (IQR 21-61), the majority were female (62.95%), and the median of teleconsultations per person were 1 (IQR 1-2) **(Table 2)**. Telemedicine services were primarily provided by Psychiatry (8891, 14.28%), Endocrinology (6088, 9.78%), and Psychology (4603, 7.39%).

Table 1. Number of outpatient care provided per moth according to modality of care, between April and December 2020.

Month	Telemedicine consultations	In-person consultations
April	4181	8920
May	7378	13674
June	7770	20576
July	9427	25897
August	8117	24679
September	7707	33305
October	6521	36153
November	5609	36094
December	5548	34462
Total	62258	233760

Table 2. Sociodemographic characteristics of the patients attended via telemedicine, between April and December 2020.

Variable	No. of patients, n (%)
Age, median (IQR)	41 (21 - 61)
Sex	
Female	17594 (62.95)
Male	10354 (37.05)
Number of teleconsultations per patient, median (IQR)	1 (1 – 2)
1 – 5	26246 (93.91)
6 – 10	1078 (3.86)
11 – 20	455 (1.63)
> 20	169 (0.60)

Total travel savings in terms of distance amounted to 4,514,903 kilometers, and in terms of time, it reached 132,886 hours. The estimated travel cost savings were $381,451 USD for private transportation (combining fuel cost savings and potential productivity gains) and $531,399 USD for public transportation (cost of public transportation saved and potential productivity gains). The largest savings were in the rest of Colombia group, which are those people living in departments of Colombia other than Valle del Cauca. Table 3 shows the total and average savings per teleconsultation for each group. Furthermore, it was estimated that individuals residing in areas where access can only be achieved by air, a savings of $134 USD (SD 131.17) per teleconsultation (Table 3).

Table 3. Distance, time, fuel, and public transportation savings observed by telemedicine consultation, between April and December 20202.

Variable	Total n=62,258	Cali n=44,182	Valle del Cauca n=12,707	Rest of Colombia n=5,369
Number of patients attended by telemedicine	27,948	19,630	5,703	2,605
Round-trip distance saved (km)				
Total	4,514,903	644,758	1,295,538	2,574,607
Mean (SD)	72.55 (190)	14.60 (9.44)	101.95 (82.88)	481.15 (454.02)
Median (IQR)	20.80(8.6 -33.4)	11.60 (6 - 23.6)	76.40 (30.40 - 149)	328 (258 - 750)
Round-trip time saved (hours)				
Total	132,886	43,461	34,127	55,298
Mean (SD)	1.80 (7.02)	0.98 (0.35)	2.69 (1.43)	10.33 (22.11)
Median (IQR)	0.93 (0.43 – 1.27)	0.90 (0.67 - 1.27)	2.40 (1.33 - 3.17)	6.73 (5.63 - 17.0)
Potential loss of productivity (USD)				
Total	130,611	42,711	33,545	54,355
Mean (SD)	2.10 (6.90)	0.97 (0.34)	2.64 (1.41)	10.16 (21.73)
Median (IQR)	1.25 (0.75 – 1.57)	0.88 (0.66 - 1.25)	2.4 (1.3 - 3.1)	6.62 (5.54 - 16.71)
Total fuel cost saved (USD)				
Total	250,840	35,855	71967	143,018
Mean (SD)	4.03 (10.55)	0.81 (0.52)	5.66 (4.60)	26.73 (25.22)
Median (IQR)	1.16 (0.48 - 1.86)	0.64 (0.33 - 1.31)	4.24 (1.69 - 8.28)	18.22 (14,33 - 41.66)
Total cost of public transportation saved* (USD)				
Total	400,788	182,098	68,373	150,317
Mean (SD)	6.44 (10.94)	4.12 (2.66)	5.38 (5.09)	28.09 (27.49)

Median (IQR)	3.27 (2.15 – 7.28)	3.27 (1.69 - 6.66)	2.69 (2.15 - 7.79)	16.12 (15.05 - 40.31)
Saved transportation costs for municipalities with exclusively air income (USD) *				
Total	NA	NA	NA	2,273
Mean (SD)	NA	NA	NA	133.71 (59.75)
Median (IQR)	NA	NA	NA	97.82 (97.82 - 182.75)

* Refers to teleconsultations from people living in areas with no land access: Guapi (Cauca), Timbiquí (Cauca), Leticia (Amazonas), San Andres (San Andres y Providencia).

NA: Not apply.

The mean number of teleconsultations per patient was 2.10 (SD2.54) in Cali, 2.23 (SD 3.14) in Valle del Cauca, and 2.05 (SD 2.28) for the Colombia group. The estimated mean cost savings for private transportation round-trip per patient was $3.73 USD in Cali, $18.5 USD in Valle del Cauca, and $75.77 USD in Colombia; and mean cost savings for public transportation expenses per patient was $10.68 USD in Cali, $17.87 USD in Valle del Cauca, and $78.57 USD in Colombia. In addition, the transportation cost savings for individuals residing in areas with exclusive air access amounted to $252.56 USD, with a standard deviation of $144.60. **(Table 4).**

Table 4. Distance, time, fuel, and public transportation per patient (all visits), between April and December 2020.

Variable	**Cali** N=19,630 n= 814	**Valle del Cauca** N=5,703	**Colombia** N=2,615

Teleconsultations per patient, mean (SD)	2.10 (2.54)	2.23 (3.14)	2.05 (2.28)
Distance saved per patient (km), mean (SD)	30.64 (52.80)	227.17 (398.38)	988.33 (1556.41)
Time saved per patients (hours), mean (SD)	2.06 (2.90)	5.98 (9.26)	21.23 (51.47)
Potential loss of productivity (USD), mean (SD)	2.03 (2.86)	5.88 (9.10)	20.87 (50.59)
Fuel cost saved per patient (USD), mean (SD)	1.70 (2.93)	12.62 (22.13)	54.90 (86.46)
Cost of public transportation saved* (USD), mean (SD)	8.65 (14.90)	11.99 (23.86)	57.70 (92.49)
Saved transportation costs for municipalities with exclusively air income (USD)*, mean (SD)	NA	NA	252.56 (144.60)

* Refers to teleconsultations from people living in areas with no land access: Guapi (Cauca), Timbiquí (Cauca), Leticia (Amazonas), San Andres (San Andres y Providencia).

NA: Not apply.

Discussion:

The present study estimated travel savings in time, distance, and out-of-pocket expenses resulting from outpatient telemedicine care, evidencing a benefit of the use of telemedicine in its teleconsultation modality for patients in a middle-income country (MIC). In April 2020, Fundación Valle del Lili, as a leading institution and reference center aligned with a social agenda towards achieving the Sustainable Development Goals (SDG), implemented an emergent telemedicine service to address the health needs of patients during the pandemic.

Over an eight-month period, 62,258 teleconsultations were conducted for 27,948 patients residing in Colombia. The population was divided into three categories based on their residence: Cali, Valle del Cauca, and the rest of Colombia. The last group had the greatest savings per patient, with an average distance saved of 481.15 km per teleconsultation; 10.33 hours per teleconsultation, which corresponds to an average saving of 26.73 USD in fuel or 28.09 USD in public transportation. Taking into consideration the aforementioned data and an average of 2.05 teleconsultations per patient, the average savings per person were as follows: 988.33 km in distance, 21.23 hours in time, $20.87 in Potential loss of productivity, $54.90 in private transportation, and $57.70 in public transportation.

In LMIC, the population at the base of the socioeconomic pyramid bears a disproportionately high of disease, often facing limited access to health services due to lower purchasing power and residence in underserved areas. In such contexts, there is an urgent need to identify innovative short-, medium-, and long-term to achieve effective universal health coverage, giving special strength to programs that allow access in the most remote and vulnerable areas (13,14). Telehealth systems strengthening has the potential to improve health and socioeconomic status of different population groups. Extending healthcare services to these remote areas through telemedicine helps bridge this gap and facilitates substantial reductions in both time and distance (15–18). In Colombia, 7.2% of the population lives in rural areas (19), with significant challenges and obstacles when accessing healthcare services, particularly specialized medical care (14).

In 2020, as the COVID-19 pandemic spread worldwide, world poverty increased, and poverty induced by COVID-19 (20). Colombia was significantly affected by this issue, with a noticeable deterioration in its economic growth indicators. In 2020, the pandemic led to a 6.8% decline in Colombia's economy (Gross Domestic Product (GDP)), contributing to an increase in the national

unemployment rate by at least 8 percentage points, resulting in an average rate of 15.9, a 5.4 percentage points rise from the previous year (21,22). Furthermore, the proportion of informal employment increased from 45% to 49% (23). Thus, savings achieved by the program were very timely in the midst of the worst economic year in Colombian history. The introduction of telemedicine led to average Potential loss of productivity savings of $2.03 and $5.88 USD per patient for the population of Cali and Valle del Cauca, equivalent to 26% and 75% of a full day's salary, respectively. For the population of Colombia, $20.87 USD was saved per patient, representing 9% of the minimum monthly salary.

Transportation cost is a determining factor in access to health care, especially for those living in rural areas not having a tertiary or complex center nearby that can provide services by medical specialties (24). However, the need for more training in the use of technologies and the difficulties in acquiring technology that allows remote connection limits the implementation of telemedicine in these areas (6,25). In our study, the telemedicine program succeeded in extending its reach to remote locations facing geographical challenges. These areas are accessible solely by air or sea. Examples include municipalities such as Guapi, Timbiquí, Leticia, and San Andres island. Enhancing telecommunication networks in these regions could yield substantial savings in time, distance, and travel expenses for their residents (26). For people living in those municipalities savings in transportation costs estimated per patient exceeded the 2020 monthly minimum wage. Significant savings related to transportation and fuel expenses have been reported. These costs vary widely; studies have reported savings ranging from $4.66 to $150 per teleconsultation (4,27). Other studies have reported saved costs that encompass fuel expenses, insurance, and maintenance, resulting in higher per-person savings. Few studies have addressed costs related to public transportation; given the importance of public transportation in Colombia, especially between and within cities, this variable was key for a more realistic measurement (28). When comparing the average public transportation expenses saved for the Cali, Valle del Cauca, and

rest of Colombia locations to the legal monthly minimum salary in Colombia for year 2020, it represents 3.67%, 5.08%, and 24.19%, respectively for the average patient.

Future implications

The results encourage developing public policies and strengthening strategies incorporating digital health and telemedicine in Latin America's countries. Our experience shows results aimed at reducing indirect patient costs related to providing health services and facilitating care by multiple specialties through teleconsultation.

Conclusion:

Telemedicine brings to patients a significant travel savings, both in terms of time, distance, cost and potential loss of productivity; particularly in regions facing geographical and socioeconomic challenges. These findings emphasize the potential of telemedicine to bridge healthcare accessibility gaps in middle-income countries and the need to further develop and expand telemedicine services in such areas.

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Conflicts of Interest

The authors report there are no competing interests to declare.

Data availability statement

The data that support the findings of this study are available from the corresponding author [MFE], upon reasonable request.

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Author contributions

SIP and MFE designed and supervised the study; JJT and JA contributed to data collection; SIP, JJT, EEP and LLP contributed data analysis; SIP, MFE, EEP, LLP and JA contributed to literature review; EEP, LLP, JA, SIP and MFE contributed to drafted the manuscript. All authors read drafts of the manuscript and approved the final version

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STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-7*
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-7
		(*b*) Describe any methods used to examine subgroups and interactions	4-7
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	4-5
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-12
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-12
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-12

		(*b*) Report category boundaries when continuous variables were categorized	8-12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Impact of a teaching hospital based multidisciplinary telemedicine program in Southwestern Colombia: A cross sectional resource analysis.

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Abstract:

Background: Telemedicine, a method of healthcare service delivery bridging geographic distances between patients and providers, has gained prominence. This modality is particularly advantageous for outpatient consultations, addressing inherent barriers of travel time and cost.

Objective: We aim to describe economical outcomes towards the implementation of a multidisciplinary telemedicine service in a high-complexity Hospital in Latin America, from the perspective of patients.

Design: A cross-sectional study was conducted, analyzing the institutional data obtained over a period of 9 months, between April 2020 and December 2020.

Setting: A high-complexity teaching hospital located in Cali, Colombia.

Participants: Individuals who received care via telemedicine. The population was categorized into three groups based on their place of residence: Cali, Valle del Cauca excluding Cali, and Outside of Valle del Cauca.

Outcome measures: Travel distance, time, fuel and public round-trip cost savings, and potential loss of productivity were estimated from the patient's perspective.

Results: A total of 62 258 teleconsultations were analyzed. Telemedicine led to a total distance savings of 4 514 903 kilometers, and 132 886 hours. The estimated cost savings were $680 849 USD for private transportation and $1 087 849 USD for public transportation. Patients in the Outside of Valle del Cauca group experienced an estimated average time savings of 21.2 hours, translating to an average fuel savings of $149.0 USD or an average savings of $156.6 USD in public transportation costs. Areas with exclusive air access achieved a mean cost savings of $362.9 USD per teleconsultation.

Conclusion: Telemedicine emerges as a powerful tool for achieving substantial travel savings for patients, especially in regions confronting geographical and socioeconomic obstacles. These findings underscore the potential of telemedicine to bridge healthcare accessibility gaps in low- and middle-income countries, calling for further investment and expansion of telemedicine services in such areas.

Key Words: Health economics, Telemedicine, Latin America.

Strengths and limitations

- A strength of this study is that it originates from a database rich in georeferenced information for each patient.
- Another strength is the use of actual costs of public and intermunicipal transportation for each individual in the dataset.
- A limitation of the study is that it did not take into account individual preferences for public or private transportation.
- Another limitation is that productivity loss estimation did not take into account the employment status of participants.
- Last, the measured calculations are indirect as there is no validated instrument to measure individuals' expenditure costs.

Introduction:

In the last decade, there have been significant technological advances in healthcare. Telemedicine is a modality of healthcare services delivery, where patients and providers are separated by distance. Telehealth uses information and communication technology for the exchange of information, related to the diagnosis and treatment of diseases and injuries, and to strengthen research and continuing education of health professionals (1). This care model can be especially helpful for outpatient consultations, where barriers related to travel time and cost are constantly inherent for patients (2,3).

Positive results regarding patient satisfaction and outcomes of telemedicine care have been reported in the literature (4). This tool has reduced costs in the health system of several countries (5,6). From the patient's perspective, despite its inherent limitations, telemedicine has been well-received and has generated excellent patient satisfaction (6,7). Telemedicine led savings for

patients and their companions, mainly those related to care, including travel time, distance, and costs (8–10). However, most of the studies about patient savings related to telemedicine use had been conducted in high-income countries, providing information on the teleconsultation offered for a single state, locality, or city.

The development and enhancement of telemedicine in Colombia has been under discussion since 2010. However, it wasn't until 2020, during the COVID-19 pandemic's public health emergency, that the government began to actively promote its utilization; this was driven by the enforcement of mandatory lockdown measures and the imperative to ensure continuous medical care. In this circumstance, Fundación Valle del Lili (FVL), a highly complex Colombian teaching hospital, quickly introduced a telemedicine service. Implementing this service encountered significant challenges, the availability of resources and the cultural resistance exhibited by patients toward this modality of attention (11). Our aim was to estimate the hypothetical transportation-related savings in time, distance, and costs assumed for the patients due to outpatient care by the FVL telemedicine program during April to December 2020.

Methods:

Design and population:

A retrospective study focused on the time and transportation cost savings experienced by the patients as a result of telemedicine interventions. Our study included patient who resided in Colombia and received outpatient teleconsultation through the FVL Telemedicine program between April and December 2020. We excluded patients residing in countries other than Colombia, as well as those lacking residence information or address details. The study population was categorized based on their place of residence into the following three groups (Figure 1):

- Cali: People who live in the city of Cali, Valle del Cauca.
- Valle del Cauca excluding Cali: people who live in other cities in Valle del Cauca, different to Cali.

- Outside of Valle del Cauca: people who live in other departments, different to Valle del Cauca.

The sample size of patients for the city of Cali was determined based on the formula for estimating the mean of a population with a specified margin of error of 0.5 km, a standard deviation of 7 km, and Z=1.96 for a 95% confidence interval. Rounding up to the nearest whole number to ensure an integer sample size, the calculated sample size was 753. This calculation did not correct for the finite population correction factor as the population size was large relative to the sample size (N=19 630). However, to ensure adequate statistical power the sample size was increased by 8% to 814 participants. This resulted in a total of 1 708 teleconsultations in the selected sample, indicating that a single individual may have undergone multiple consultations and follow-up appointments throughout the study period. These consultations represented 3.9% of the 44,182 teleconsultations conducted in this group. As a result, calculations for the total savings in this group were later extrapolated by multiplying the value obtained in the sample by 25.87.

Green shaded area refers to the region of Valle del Cauca. Red point indicates Fundación Valle del Lili (FVL). Green points represent areas of teleconsultation in Cali, Valle del Cauca excluding Cali, and areas outside of Valle del Cauca

Figure 1. Study area map with locations of patient residences.

Overview of Fundación Valle del Lili Telemedicine Program:

In Colombia, hospitals are categorized into four levels based on their degree of specialization, subject to evaluation and approval by the national government. Level I hospitals primarily have low-complexity technology and provide care by general practitioners, offering outpatient consultations, hospitalization, emergency services, and essential diagnostic and treatment support. Level II hospitals expand their services to include gynecology and obstetrics, surgery, internal medicine, and pediatrics, incorporating technology of moderate complexity. Level III hospitals feature subspecialized personnel, adult and neonatal intensive care units, and advanced technology. At the highest level of care, Level IV hospitals cater to patients in critical condition, offering highly complex subspecialties and the potential for organ transplantation (12).

Moreover, it is noteworthy that the 3 largest cities in Colombia, Bogotá, Medellín , and Cali, concentrate the majority of Level III and IV hospitals in the country, providing comprehensive medical services to the surrounding population. Additionally, Colombia boasts only 16 government-accredited teaching hospitals, representing hubs of specialist concentration. Access to specialist care in Colombia's healthcare system requires authorization from the patient's healthcare plan, as patients cannot freely choose their own specialist. The patient healthcare plan assigns the care location based on contractual agreements, with telemedicine services typically included within the health plan. Conversely, smaller cities and towns may house Level 1 and 2 hospitals, offering care of basic to moderate complexity (12).

Fundación Valle del Lili (FVL) is a private, non-profit, high-complexity hospital located in Santiago de Cali, serving as a referral center in the southwest region of Colombia. In 2019 the institution provided 511,124 outpatient visits, 75,890 ER visits and 26,878 inpatient stays. FVL's telemedicine service, promoted and strengthened in March 2020 in response to the declaration of a health emergency by COVID-19 by the Ministry of Health, ensures the continuity of ambulatory health services throughout the Colombian territory. This initiative aims to address accessibility

challenges, particularly in rural regions, by extending high-level medical services to remote areas. Through a robust referral and counter-referral mechanism, eligible patients requiring outpatient or home-based management can access specialized consultations, facilitating consultation scheduling and ensuring necessary care irrespective of geographic location.

FVL's telemedicine service facilitates outpatient care across 64 medical specialties, employing an interactive modality that establishes remote communication between patients and healthcare professionals through real-time video calls. FVL's telemedicine service is meticulously organized to ensure seamless access to outpatient care for patients. The process begins with appointment scheduling via telephone, available from Monday to Friday between 7 a.m. and 5 p.m., and on Saturdays from 8 a.m. to 1 p.m. Patients are carefully guided through administrative procedures, supplemented by instructional emails detailing telemedicine processes. Appointment confirmations are diligently conducted 24 hours in advance by verifying the submission of requisite documents to the designated email address. Teleconsultations and real-time video calls are facilitated through the Microsoft Teams platform. Patient data is recorded in the Enterprise Resource Planning systems of the hospital (SAP-IS-H Software), which host the electronic medical record. Following the consultation, a PDF containing consultation details, medical directives, and prescriptions is dispatched to the patient's email address. Patients who have difficulty due to low technology literacy or cognitive issues are assisted by the appointment agent during the booking process. Additionally, the receptionist provides support during the teleconsultation setup, including guidance on using the application for initiating the call.

Outcome measures:

The following outcome measures were taken into consideration:

a) Travel distance savings: The distance in kilometer of round-trip that the patient would have traveled for an in-person consultation at the FVL.

b) Travel time savings: The time in hours of round-trip that the patient would have wasted for an in-person consultation at the FVL; it represents the patient work time loss due to the travel for an in-person consultation.

c) Travel cost savings: The expenses related to round-trip that the patient would have spent for an in-person consultation at the FVL. For all cases, two modes of transportation were considered: 1) private transportation, for which round-trip fuel expenses were calculated for; and 2) public transportation, for which taxi costs (Cali group) or intermunicipal bus costs (Valle del Cauca and Colombia groups) were calculated based on 2020 fare rates.

d) Potential loss of productivity: It pertains to the value of work time that the patient would have lost due to the round-trip travel required for in-person consultations. This particularly affects the adult population aged between 21 and 61 years. Additionally, the retirement age in Colombia for women is 57 years and for men is 62 years. Within the scope of the study, this constitutes a limitation as it was not measured.

Distance and time calculation: Measurements of car transportation were performed using Google Maps, taking the main FVL center as the destination and the patient's place of residence as the origin. The patient's home address was defined by the address (for Cali residents) or the registered municipality of residence in the electronic medical record system. The car transport option and the quickest route were selected. The estimated distance and travel time were doubled to encompass the round-trip travel to and from the FVL.

Fuel cost calculation: We took as a reference the cost per gallon of fuel reported by the Ministry of Mines and Energy for the year 2020 that was $8 268 COP ($2.24 USD); and an average consumption of 40 km traveled per gallon.

$$Fuel\ \text{cost saved} = \frac{\text{Round trip distance (km)}}{40\ \text{(km)}} * \$\ 8\ 268$$

Calculation of public transportation cost savings: To calculate the cost public transportation for the population living in Cali, we considered the cab fare reported by the Cali Municipal Hall for the year 2020, which was $84 COP for each 80 meters traveled. For residents in other areas of Valle del Cauca and Colombia, we searched on the virtual platforms of the country's public transportation terminals to determine the fare cost of inter-municipal bus travel from the different localities to the city of Cali.

It should be highlighted that for the municipalities where river transportation is necessary, the travel cost and time required for each municipality were consulted, in addition to the cost and time of land transportation. For the municipalities that do not have land access, estimates were made of the airfare costs, these were excluded in the calculations of distance and time savings.

Calculation of the potential loss of productivity: In Colombia the legal minimum wage in force for the year 2020 was $877 803 COP ($640.31 USD), the workday corresponds to 48 hours per week, which is adjusted to 8 hours per day. The value of 1 hour worked was $3 657 COP ($2.67 USD). With the above, the value that the patient would have lost due to lost work time secondary to the round-trip to attend an in-person consultation was calculated.

$$\text{Work cost of time saved} = \text{Round trip time (hour)} * \$\ 3\ 657\ \text{COP}$$

All costs were calculated with the Purchasing Power Parity Exchange rate of 1 370.9 COP per USD as per CCEMG–EPPI Centre Cost Converter' (v.1.7 last update: January 2024) (https://eppi.ioe.ac.uk/costconversion/) designed to facilitate international comparison of costs. (13).

Ethics Approval

This study was conducted according to the Declaration of Helsinki guidelines; and was classified as a risk-free study according to resolution No. 008430 of 1993, article 11, numeral A of the Ministry of Health and Social Protection of Colombia. The institutional ethics committee reviewed and approved the protocol (Protocol No. 1742; IRB/EC No. 090 – 2021, Act No. 06 - 2021). This

study did not require intervention or intentional modification of the biological, physiological, psychological, or social variables of the participants. Therefore, no informed consent was necessary.

Patient and Public Involvement

None

Results

A total of 296 170 outpatient care consultations were made from April to December 2020. Among these, 152 consultations were excluded due to patients residing outside of Colombia. Consequently, 296 018 consultations were included, out of which 62 258 (21.03%) were conducted via telemedicine, involving to 27 948 individuals **(Supplementary Table 1)**. The median age of the population was 41 years (IQR 21-61), the majority were female (62.95%), and the median of teleconsultations per person were 1 (IQR 1-2) **(Table 1)**. Further details regarding the distribution of the number of teleconsultations per patient can be observed in **(Figure 2)**. Telemedicine services were primarily provided by Psychiatry (8 891, 14.28%), Endocrinology (6 088, 9.78%), and Psychology (4 603, 7.39%).

Table 1. Sociodemographic characteristics of the patients attended via telemedicine, between April and December 2020.

Variable	Total	Cali	Valle del Cauca excluding Cali	Outside of Valle del Cauca
Age, median (IQR)	41 (21 - 61)	41 (22 - 61)	42 (19 - 61)	41 (17 - 60.5)
Sex				
Female	17 594 (62.95)	12 462 (63.48)	3 573 (62.65)	1 552 (59.58)
Male	10 354 (37.05)	7 168 (36.52)	2 130 (37.35)	1 053 (40.42)
Number of teleconsultations per patient				

1 - 2	22 136 (79.23)	15 574 (79.34)	4 499 (78.89)	2 063 (79.19)
3 - 5	4 100 (14.68)	2 817 (14.35)	870 (15.26)	413 (15.85)
6 - 10	1 078 (3.86)	783 (3.99)	198 (3.47)	97 (3.72)
>10	624 (2,23)	456 (2.32)	136 (2.38)	32 (1.23)

Figure 2. Distribution of the frequency of teleconsultations per person.

Total travel savings in terms of distance amounted to 4 514 903 kilometers, and in terms of time, it reached 132 886 hours. The estimated travel cost savings were $1 035 363 USD for private transportation (combining fuel cost savings and potential productivity gains) and $ 1 442 363 USD for public transportation (cost of public transportation saved and potential productivity gains). The largest savings were in the rest of Colombia group, which are those people living in departments of Colombia other than Valle del Cauca. Table 2 shows the total and average savings per teleconsultation for each group. Furthermore, it was estimated that individuals residing in areas where access can only be achieved by air, a savings of $134 USD (SD 131.17) per teleconsultation.

Table 2. Distance, time, fuel, and public transportation savings observed by telemedicine consultation, between April and December 20202.

Variable	**Total** n=62,258	**Cali** n=44,182	**Valle del Cauca excluding Cali** n=12,707	**Outside of Valle del Cauca** n=5,369

Number of patients attended by telemedicine	27,948	19,630	5,703	2,615
Round-trip distance saved (km)				
Total	4,514,903	644,758	1,295,538	2,574,607
Mean (SD)	72.55 (190)	14.60 (9.44)	101.95 (82.88)	481.15 (454.02)
Median (IQR)	20.80(8.6 -33.4)	11.60 (6 - 23.6)	76.40 (30.40 - 149)	328 (258 - 750)
Round-trip time saved (hours)				
Total	132,886	43,461	34,127	55,298
Mean (SD)	1.80 (7.02)	0.98 (0.35)	2.69 (1.43)	10.33 (22.11)
Median (IQR)	0.93 (0.43 – 1.27)	0.90 (0.67 - 1.27)	2.40 (1.33 - 3.17)	6.73 (5.63 - 17.0)
Potential loss of productivity (USD)				
Total	354,514	115,963	91,049	147,533
Mean (SD)	5.70 (18.73)	2.62 (0.92)	7.17 (3.82)	27.6 (59.0)
Median (IQR)	3.39 (2.04 - 4.26)	2.40 (1.78 - 3.38)	6.40 (3.56 - 8.45)	18.0 (15.0 - 45.4)
Total fuel cost saved (USD)				
Total	680,849	97,294	195,337	388,191
Mean (SD)	10.94 (28.64)	2.20 (1.42)	15.37 (12.50)	72.5 (68.5)
Median (IQR)	3.15 (1.30 - 5.05)	1.75 (0.90 - 3.56)	11.52 (4.58 - 22.47)	49.5 (38.9 – 113.1)
Total cost of public transportation saved* (USD)				
Total	1,087,849	494,237	185,582	408,002
Mean (SD)	17.48 (29.69)	11.19 (7.23)	14.60 (13.81)	76.2 (74.6)
Median (IQR)	8.88 (5.84 - 19.76)	8.88 (4.60 - 18.08)	7.29 (5.84 - 21.25))	43,8 (40,8 – 109,4)
Saved transportation costs for municipalities with exclusively air income (USD) *				

Total	NA	NA	NA	6,170
Mean (SD)	NA	NA	NA	362.92 (356.05)
Median (IQR)	NA	NA	NA	265.51 (265.51 - 496.03)

* Refers to teleconsultations from people living in areas with no land access: Guapi (Cauca), Timbiquí (Cauca), Leticia (Amazonas), San Andres (San Andres y Providencia).

NA: Not apply.

The mean number of teleconsultations per patient was 2.10 (SD2.54) in Cali, 2.23 (SD 3.14) in Valle del Cauca excluding Cali, and 2.05 (SD 2.28) for the Outside of Valle del Cauca group. The estimated mean cost savings for private transportation round-trip per patient was $10.13 USD in Cali, $66.79 USD in Valle del Cauca excluding Cali, and $205.65 USD in outside of Valle del Cauca; and mean cost savings for public transportation expenses per patient was $28.98 USD in Cali, $50.22 USD in Valle del Cauca excluding Cali, and $213.25USD in outside of Valle del Cauca . In addition, the transportation cost savings for individuals residing in areas with exclusive air access amounted to $658.52 USD, with a standard deviation of $392.49. **(Table 3).**

Table 3. Distance, time, fuel, and public transportation per patient (all visits), between April and December 2020.

Variable	**Cali** N=19,630 n= 814	**Valle del Cauca excluding Cali** N=5,703	**Outside of Valle del Cauca** N=2,615
Teleconsultations per patient, mean (SD)	2.10 (2.54)	2.23 (3.14)	2.05 (2.28)

Distance saved per patient (km), mean (SD)	30.64 (52.80)	227.17 (398.38)	988.33 (1556.41)
Time saved per patients (hours), mean (SD)	2.06 (2.90)	5.98 (9.26)	21.23 (51.47)
Potential loss of productivity (USD), mean (SD)	5.51 (7.75)	34.25 (60.7	56.63 (137.33)
Fuel cost saved per patient (USD), mean (SD)	4.62 /7.96)	32.54 (65.51)	149.02 (234.67)
Cost of public transportation saved* (USD), mean (SD)	23.47 (40.44)	15.97 (24.70)	156.62 (251.04)
Saved transportation costs for municipalities with exclusively air income (USD)*, mean (SD)	NA	NA	658.52 (392.49)

* Refers to teleconsultations from people living in areas with no land access: Guapi (Cauca), Timbiquí (Cauca), Leticia (Amazonas), San Andres (San Andres y Providencia).

NA: Not apply.

Discussion:

In LMIC, the population at the base of the socioeconomic pyramid bears a disproportionately high burden of disease, often facing limited access to health services due to lower purchasing power and residence in underserved areas. In such contexts, there is an urgent need to identify innovative short-, medium-, and long-term to achieve effective universal health coverage, giving special strength to programs that allow access in the most remote and vulnerable areas (14,15). Strengthening telehealth systems has the potential to improve health and socioeconomic status of different population groups. Extending healthcare services to these remote areas through

telemedicine helps bridge this gap and facilitates substantial reductions in both time and distance (16–19). In Colombia, 7.2% of the population lives in rural areas (20), with significant challenges and obstacles when accessing healthcare services, particularly specialized medical care (15).

In 2020, as the COVID-19 pandemic spread worldwide, world poverty increased, and poverty induced by COVID-19 (21). Colombia was significantly affected by this issue, with a noticeable deterioration in its economic growth indicators. In 2020, the pandemic led to a 6.8% decline in Colombia's economy (Gross Domestic Product (GDP)), contributing to an increase in the national unemployment rate by at least 8 percentage points, resulting in an average rate of 15.9, a 5.4 percentage points rise from the previous year (22,23). Furthermore, the proportion of informal employment increased from 45% to 49% (24). Thus, savings achieved by the program were very timely in the midst of the worst economic year in Colombian history. The introduction of telemedicine led to average Potential loss of productivity savings of $5.51 and $34.25 USD per patient for the population of Cali and Valle del Cauca, equivalent to 26% and 75% of a full day's salary, respectively. For the population of Colombia, $56.63 USD was saved per patient, representing 9% of the minimum monthly salary.

Transportation cost is a determining factor in access to health care, especially for those living in rural areas not having a tertiary or complex center nearby that can provide services by medical specialties (25). However, the need for more training in the use of technologies and the difficulties in acquiring technology that allows remote connection limits the implementation of telemedicine in these areas (6,26). In our study, the telemedicine program succeeded in extending its reach to remote locations facing geographical challenges. These areas are accessible solely by air or sea. Examples include municipalities such as Guapi, Timbiquí, Leticia, and San Andres Island. Enhancing telecommunication networks in these regions could yield substantial savings in time,

distance, and travel expenses for their residents (27). For people living in those municipalities savings in transportation costs estimated per patient exceeded the 2020 monthly minimum wage.

Significant savings related to transportation and fuel expenses have been reported. These costs vary widely; studies have reported savings ranging from $4.66 to $150 per teleconsultation (4,28). Other studies have reported saved costs that encompass fuel expenses, insurance, and maintenance, resulting in higher per-person savings. Few studies have addressed costs related to public transportation; given the importance of public transportation in Colombia, especially between and within cities, this variable was key for a more realistic measurement (29). When comparing the average public transportation expenses saved for the Cali, Valle del Cauca, and rest of Colombia locations to the legal monthly minimum salary in Colombia for year 2020, it represents 3.67%, 5.08%, and 24.19%, respectively for the average patient.

Limitations of the current study include the retrospective approach to data collection, which limited the depth of analysis possible. Prospective data collection would have allowed for a more comprehensive examination, including factors such as work absenteeism, wait times, appointment duration, and associated costs. In addition, the absence of provider expenditures in the cost-effectiveness assessment of telemedicine represents a significant gap. On the other hand, the Colombian healthcare system fully covers diagnostic and treatment services, which may mitigate the cost impact on patients or hospitals. However, the study did not measure these consequences and costs, which is a limitation.

The study also overlooked critical factors like internet usage and telecommunications connectivity, impacting the assessment of cost savings achieved through telemedicine adoption. Failure to consider participants' transportation mode and employment status hindered insights into socioeconomic dynamics influencing telemedicine utilization. Methodologically, the indirect

calculation of expenditures introduced ambiguity, compounded by the absence of a validated instrument for precise measurement. Our objective in this paper was measuring savings using TM in comparison to a regular visit by the patient to our location, we did not seek a full economic evaluation which will include a cost-effectiveness (CE) study. The CE literature has shown that from a health systems perspective telemedicine programs remain cost-effective, but from a societal perspective there is a gap, and we leave a full economic evaluation for further research.

Future implications

The results encourage developing public policies and strengthening strategies incorporating digital health and telemedicine in Latin America's countries. Our experience shows results aimed at reducing indirect patient costs related to providing health services and facilitating care by multiple specialties through teleconsultation.

Conclusion:

Telemedicine brings to patients a significant travel savings, both in terms of time, distance, cost and potential loss of productivity; particularly in regions facing geographical and socioeconomic challenges. These findings emphasize the potential of telemedicine to bridge healthcare accessibility gaps in middle-income countries and the need to further develop and expand telemedicine services in such areas.

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Conflicts of Interest

The authors report there are no competing interests to declare.

Data availability statement

The data that support the findings of this study are available from the corresponding author [MFE], upon reasonable request.

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Author contributions

SIP and MFE designed and supervised the study; JJT and JA contributed to data collection; SIP, JJT, EEP and LLP contributed data analysis; SIP, MFE, EEP, LLP and JA contributed to literature review; EEP, LLP, JA, SIP and MFE contributed to drafted the manuscript. All authors read drafts of the manuscript and approved the final version

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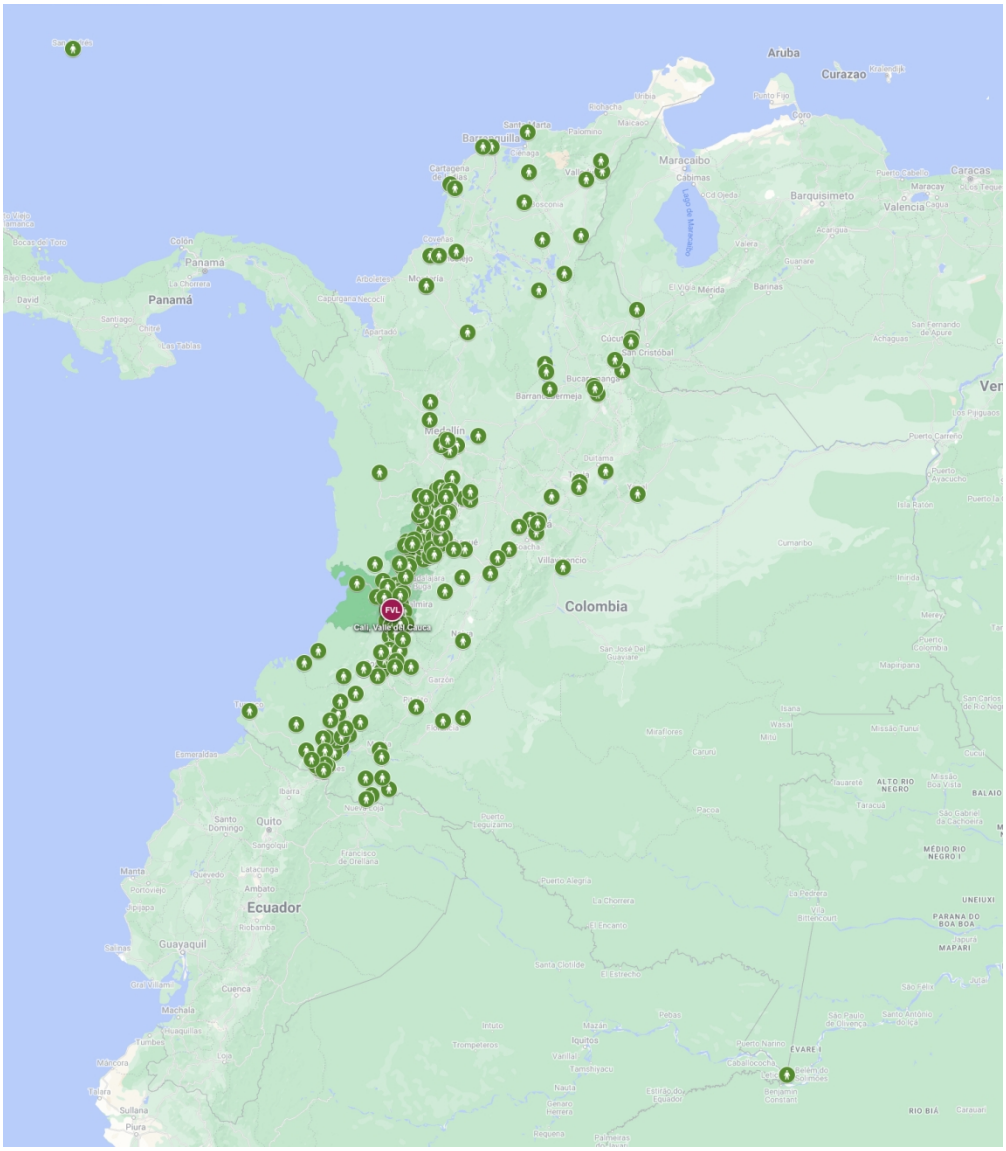

Green shaded area refers to the region of Valle del Cauca. Red point indicates Fundación Valle del Lili (FVL). Green points represent areas of teleconsultation in Cali, Valle del Cauca excluding Cali, and areas outside of Valle del Cauca

Figure 1. Study area map with locations of patient residences.

127x144mm (300 x 300 DPI)

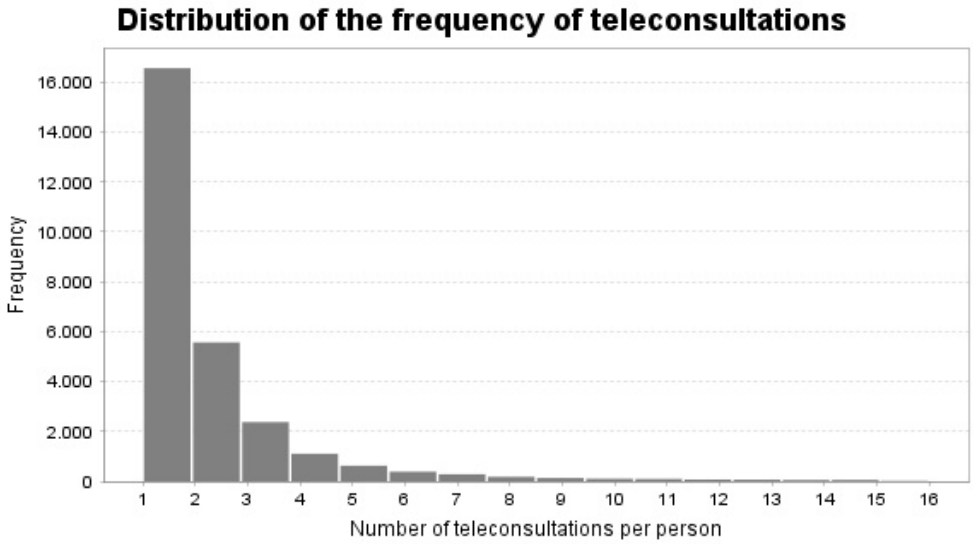

Figure 2. Distribution of the frequency of teleconsultations per person.

206x114mm (72 x 72 DPI)

Supplementary Table 1. Number of outpatient care provided per month according to modality of care, between April and December 2020.

Month	Telemedicine consultations	In-person consultations
April	4 181	8 920
May	7 378	13 674
June	7 770	20 576
July	9 427	25 897
August	8 117	24 679
September	7 707	33 305
October	6 521	36 153
November	5 609	36 094
December	5 548	34 462
Total	62 258	233 760

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-7*
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-7
		(*b*) Describe any methods used to examine subgroups and interactions	4-7
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	4-5
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-12
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-12
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-12

		(*b*) Report category boundaries when continuous variables were categorized	8-12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Impact of a teaching hospital based multidisciplinary telemedicine program in Southwestern Colombia: A cross sectional resource analysis.

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Abstract:

Background: Telemedicine, a method of healthcare service delivery bridging geographic distances between patients and providers, has gained prominence. This modality is particularly advantageous for outpatient consultations, addressing inherent barriers of travel time and cost.

Objective: We aim to describe economical outcomes towards the implementation of a multidisciplinary telemedicine service in a high-complexity Hospital in Latin America, from the perspective of patients.

Design: A cross-sectional study was conducted, analyzing the institutional data obtained over a period of 9 months, between April 2020 and December 2020.

Setting: A high-complexity teaching hospital located in Cali, Colombia.

Participants: Individuals who received care via telemedicine. The population was categorized into three groups based on their place of residence: Cali, Valle del Cauca excluding Cali, and Outside of Valle del Cauca.

Outcome measures: Travel distance, time, fuel and public round-trip cost savings, and potential loss of productivity were estimated from the patient's perspective.

Results: A total of 62 258 teleconsultations were analyzed. Telemedicine led to a total distance savings of 4 514 903 kilometers, and 132 886 hours. The estimated cost savings were $680 849 USD for private transportation and $1 087 849 USD for public transportation. Patients in the Outside of Valle del Cauca group experienced an estimated average time savings of 21.2 hours, translating to an average fuel savings of $149.0 USD or an average savings of $156.6 USD in public transportation costs. Areas with exclusive air access achieved a mean cost savings of $362.9 USD per teleconsultation, specifically related to transportation costs.

Conclusion: Telemedicine emerges as a powerful tool for achieving substantial travel savings for patients, especially in regions confronting geographical and socioeconomic obstacles. These findings underscore the potential of telemedicine to bridge healthcare accessibility gaps in low-

and middle-income countries, calling for further investment and expansion of telemedicine services in such areas.

Key Words: Health economics, Telemedicine, Latin America.

Strengths and limitations

- This study originates from a database rich in georeferenced information for each patient.
- The study utilizes actual costs of public and intermunicipal transportation for each individual in the dataset.
- Individual preferences for public or private transportation were not accounted for in this study.
- Productivity loss estimation did not consider the employment status of participants.
- The measured calculations are indirect since there is no validated instrument available to measure individuals' expenditure costs.

Introduction:

In the last decade, there have been significant technological advances in healthcare. Telemedicine is a modality of healthcare services delivery, where patients and providers are separated by distance. Telehealth uses information and communication technology for the exchange of information, related to the diagnosis and treatment of diseases and injuries, and to strengthen research and continuing education of health professionals (1). This care model can be especially helpful for outpatient consultations, where barriers related to travel time and cost are constantly inherent for patients (2,3).

Positive results regarding patient satisfaction and outcomes of telemedicine care have been reported in the literature (4). This tool has reduced costs in the health system of several countries (5,6). From the patient's perspective, despite its inherent limitations, telemedicine has been well-received and has generated excellent patient satisfaction (6,7). Telemedicine led savings for

patients and their companions, mainly those related to care, including travel time, distance, and costs (8–10). However, most of the studies about patient savings related to telemedicine use had been conducted in high-income countries, providing information on the teleconsultation offered for a single state, locality, or city.

The development and enhancement of telemedicine in Colombia has been under discussion since 2010. However, it wasn't until 2020, during the COVID-19 pandemic's public health emergency, that the government began to actively promote its utilization; this was driven by the enforcement of mandatory lockdown measures and the imperative to ensure continuous medical care. In this circumstance, Fundación Valle del Lili (FVL), a highly complex Colombian teaching hospital, quickly introduced a telemedicine service. Implementing this service encountered significant challenges, the availability of resources and the cultural resistance exhibited by patients toward this modality of attention (11). Our aim was to estimate the hypothetical transportation-related savings in time, distance, and costs assumed for the patients due to outpatient care by the FVL telemedicine program during April to December 2020.

Methods:

Design and population:

A retrospective study focused on the time and transportation cost savings experienced by the patients as a result of telemedicine interventions. Our study included patient who resided in Colombia and received outpatient teleconsultation through the FVL Telemedicine program between April and December 2020. We excluded patients residing in countries other than Colombia, as well as those lacking residence information or address details. The study population was categorized based on their place of residence into the following three groups (Figure 1):

- Cali: People who live in the city of Cali, Valle del Cauca.
- Valle del Cauca excluding Cali: people who live in other cities in Valle del Cauca, different to Cali.

- Outside of Valle del Cauca: people who live in other departments, different to Valle del Cauca.

Grey shaded area refers to the region of Valle del Cauca. Black point indicates Fundación Valle del Lili (FVL). Grey points represent areas of teleconsultation in Cali, Valle del Cauca excluding Cali, and areas outside of Valle del Cauca

Figure 1. Study area map with locations of patient residences.

Overview of Fundación Valle del Lili Telemedicine Program:

In Colombia, hospitals are categorized into four levels based on their degree of specialization, subject to evaluation and approval by the national government. Level I hospitals primarily have low-complexity technology and provide care by general practitioners, offering outpatient consultations, hospitalization, emergency services, and essential diagnostic and treatment support. Level II hospitals expand their services to include gynecology and obstetrics, surgery, internal medicine, and pediatrics, incorporating technology of moderate complexity. Level III hospitals feature subspecialized personnel, adult and neonatal intensive care units, and advanced technology. At the highest level of care, Level IV hospitals cater to patients in critical condition, offering highly complex subspecialties and the potential for organ transplantation (12).

Moreover, it is noteworthy that the 3 largest cities in Colombia, Bogotá, Medellín , and Cali, concentrate the majority of Level III and IV hospitals in the country, providing comprehensive medical services to the surrounding population. Additionally, Colombia boasts only 16 government-accredited teaching hospitals, representing hubs of specialist concentration. Access to specialist care in Colombia's healthcare system requires authorization from the patient's healthcare plan, as patients cannot freely choose their own specialist. The patient healthcare plan assigns the care location based on contractual agreements, with telemedicine services typically

included within the health plan. Conversely, smaller cities and towns may house Level 1 and 2 hospitals, offering care of basic to moderate complexity (12).

Fundación Valle del Lili (FVL) is a private, non-profit, high-complexity hospital located in Santiago de Cali, serving as a referral center in the southwest region of Colombia. In 2019 the institution provided 511,124 outpatient visits, 75,890 ER visits and 26,878 inpatient stays. FVL's telemedicine service, promoted and strengthened in March 2020 in response to the declaration of a health emergency by COVID-19 by the Ministry of Health, ensures the continuity of ambulatory health services throughout the Colombian territory. This initiative aims to address accessibility challenges, particularly in rural regions, by extending high-level medical services to remote areas. Through a robust referral and counter-referral mechanism, eligible patients requiring outpatient or home-based management can access specialized consultations, facilitating consultation scheduling and ensuring necessary care irrespective of geographic location.

FVL's telemedicine service facilitates outpatient care across 64 medical specialties, employing an interactive modality that establishes remote communication between patients and healthcare professionals through real-time video calls. FVL's telemedicine service is meticulously organized to ensure seamless access to outpatient care for patients. The process begins with appointment scheduling via telephone, available from Monday to Friday between 7 a.m. and 5 p.m., and on Saturdays from 8 a.m. to 1 p.m. Patients are carefully guided through administrative procedures, supplemented by instructional emails detailing telemedicine processes. Appointment confirmations are diligently conducted 24 hours in advance by verifying the submission of requisite documents to the designated email address. Teleconsultations and real-time video calls are facilitated through the Microsoft Teams platform. Patient data is recorded in the Enterprise Resource Planning systems of the hospital (SAP-IS-H Software), which host the electronic medical record. Following the consultation, a PDF containing consultation details, medical

directives, and prescriptions is dispatched to the patient's email address. Patients who have difficulty due to low technology literacy or cognitive issues are assisted by the appointment agent during the booking process. Additionally, the receptionist provides support during the teleconsultation setup, including guidance on using the application for initiating the call.

Outcome measures:

The following outcome measures were taken into consideration:

a) Travel distance savings: The distance in kilometer of round-trip that the patient would have traveled for an in-person consultation at the FVL.

b) Travel time savings: The time in hours of round-trip that the patient would have wasted for an in-person consultation at the FVL; it represents the patient work time loss due to the travel for an in-person consultation.

   Measurements of car transportation were performed using Google Maps, taking the main FVL center as the destination and the patient's place of residence as the origin. The patient's home address was defined by the address (for Cali residents) or the registered municipality of residence in the electronic medical record system. The car transport option and the quickest route were selected. The estimated distance and travel time were doubled to encompass the round-trip travel to and from the FVL.

c) Travel cost savings: The expenses related to round-trip that the patient would have spent for an in-person consultation at the FVL. For all cases, two modes of transportation were considered: 1) private transportation, for which round-trip fuel expenses were calculated for; and 2) public transportation, for which taxi costs (Cali group) or intermunicipal bus costs (Valle del Cauca and Colombia groups) were calculated based on 2020 fare rates.

Fuel cost calculation: We took as a reference the cost per gallon of fuel reported by the Ministry of Mines and Energy for the year 2020 that was $8 268 COP ($2.24 USD); and an average consumption of 40 km traveled per gallon.

$$Fuel\ \text{cost saved} = \frac{\text{Round trip distance (km)}}{40\ (\text{km})} * \$\ 8\ 268$$

Calculation of public transportation cost savings: To calculate the cost public transportation for the population living in Cali, we considered the cab fare reported by the Cali Municipal Hall for the year 2020, which was $84 COP for each 80 meters traveled. For residents in other areas of Valle del Cauca and Colombia, we searched on the virtual platforms of the country's public transportation terminals to determine the fare cost of inter-municipal bus travel from the different localities to the city of Cali.

It should be highlighted that for the municipalities where river transportation is necessary, the travel cost and time required for each municipality were consulted, in addition to the cost and time of land transportation. For the municipalities that do not have land access, estimates were made of the airfare costs, these were excluded in the calculations of distance and time savings.

d) Potential loss of productivity: It pertains to the value of work time that the patient would have lost due to the round-trip travel required for in-person consultations.

Calculation of the potential loss of productivity: In Colombia the legal minimum wage in force for the year 2020 was $877 803 COP ($640.31 USD), the workday corresponds to 48 hours per week, which is adjusted to 8 hours per day. The value of 1 hour worked was $3 657 COP ($2.67 USD). With the above, the value that the patient would have lost due to lost work time secondary to the round-trip to attend an in-person consultation was calculated.

$$\text{Work cost of time saved} = \text{Round trip time (hour)} * \$\ 3\ 657\ \text{COP}$$

All costs were calculated with the Purchasing Power Parity Exchange rate of 1 370.9 COP per USD as per CCEMG–EPPI Centre Cost Converter' (v.1.7 last update: January 2024) (https://eppi.ioe.ac.uk/costconversion/) designed to facilitate international comparison of costs. (13).

To estimate distance per-patient-per-trip for patients outside the city of Cali but with land access to the city we used the distance between the center of the town and the exact address at Fundación Valle del Lili using available free software. For patients without land access distance was not computed. For patients in the city of Cali, an exact street address to street address estimation was done with the help of specialized software that takes into account traffic and real routes. This however was costly to do for the 19630 patients, so we estimated a sample of 753 using the formula for a minimum sample size for estimating a population mean with 95% level of confidence (parameter = 1.96), a standard deviation of 7 km and a marging of error (E) of 0.5 km. This calculation did not correct for the finite population correction factor as the population size was large relative to the sample size An extra 8% of patients were added to complete a sample of 814, allowed by the budget allocated to this task, increasing precision and accuracy. This resulted in a total of 1 708 teleconsultations in the selected sample, indicating that a single individual may have undergone multiple consultations and follow-up appointments throughout the study period. These consultations represented 3.9% of the 44,182 teleconsultations conducted in this group. As a result, calculations for the total savings in this group were later extrapolated by multiplying the value obtained in the sample by 25.87.

Ethics Approval

This study was conducted according to the Declaration of Helsinki guidelines; and was classified as a risk-free study according to resolution No. 008430 of 1993, article 11, numeral A of the Ministry of Health and Social Protection of Colombia. The institutional ethics committee reviewed

and approved the protocol (Protocol No. 1742; IRB/EC No. 090 – 2021, Act No. 06 - 2021). This study did not require intervention or intentional modification of the biological, physiological, psychological, or social variables of the participants. Therefore, no informed consent was necessary.

Patient and Public Involvement

None

Results

A total of 296 170 outpatient care consultations were made from April to December 2020. Among these, 152 consultations were excluded due to patients residing outside of Colombia. Consequently, 296 018 consultations were included, out of which 62 258 (21.03%) were conducted via telemedicine, involving to 27 948 individuals **(Supplementary Table 1)**. The median age of the population was 41 years (IQR 21-61), the majority were female (62.95%), and the median of teleconsultations per person were 1 (IQR 1-2) **(Table 1)**. Further details regarding the distribution of the number of teleconsultations per patient can be observed in **(Figure 2)**. Telemedicine services were primarily provided by Psychiatry (8 891, 14.28%), Endocrinology (6 088, 9.78%), and Psychology (4 603, 7.39%).

Table 1. Sociodemographic characteristics of the patients attended via telemedicine, between April and December 2020.

Variable	Total	Cali	Valle del Cauca excluding Cali	Outside of Valle del Cauca
Age, median (IQR)	41 (21 - 61)	41 (22 - 61)	42 (19 - 61)	41 (17 - 60.5)
Sex				
Female	17 594 (62.95)	12 462 (63.48)	3 573 (62.65)	1 552 (59.58)
Male	10 354 (37.05)	7 168 (36.52)	2 130 (37.35)	1 053 (40.42)

Number of teleconsultations per patient				
1 - 2	22 136 (79.23)	15 574 (79.34)	4 499 (78.89)	2 063 (79.19)
3 - 5	4 100 (14.68)	2 817 (14.35)	870 (15.26)	413 (15.85)
6 - 10	1 078 (3.86)	783 (3.99)	198 (3.47)	97 (3.72)
>10	624 (2,23)	456 (2.32)	136 (2.38)	32 (1.23)

Figure 2. Distribution of the frequency of teleconsultations per person.

Total travel savings in terms of distance amounted to 4 514 903 kilometers, and in terms of time, it reached 132 886 hours. The estimated travel cost savings were $1 035 363 USD for private transportation (combining fuel cost savings and potential productivity gains) and $ 1 442 363 USD for public transportation (cost of public transportation saved and potential productivity gains). The largest savings were in the rest of Colombia group, which are those people living in departments of Colombia other than Valle del Cauca. Table 2 shows the total and average savings per teleconsultation for each group. Furthermore, it was estimated that individuals residing in areas where access can only be achieved by air, a savings of $134 USD (SD 131.17) per teleconsultation.

Table 2. Distance, time, fuel, and public transportation savings observed by telemedicine consultation, between April and December 20202.

Variable	**Total** n=62,258	**Cali** n=44,182	**Valle del Cauca excluding Cali** n=12,707	**Outside of Valle del Cauca** n=5,369

Number of patients attended by telemedicine	27,948	19,630	5,703	2,615
Round-trip distance saved (km)				
Total	4,514,903	644,758	1,295,538	2,574,607
Mean (SD)	72.55 (190)	14.60 (9.44)	101.95 (82.88)	481.15 (454.02)
Median (IQR)	20.80(8.6 -33.4)	11.60 (6 - 23.6)	76.40 (30.40 - 149)	328 (258 - 750)
Round-trip time saved (hours)				
Total	132,886	43,461	34,127	55,298
Mean (SD)	1.80 (7.02)	0.98 (0.35)	2.69 (1.43)	10.33 (22.11)
Median (IQR)	0.93 (0.43 – 1.27)	0.90 (0.67 - 1.27)	2.40 (1.33 - 3.17)	6.73 (5.63 - 17.0)
Potential loss of productivity (USD)				
Total	354,514	115,963	91,049	147,533
Mean (SD)	5.70 (18.73)	2.62 (0.92)	7.17 (3.82)	27.6 (59.0)
Median (IQR)	3.39 (2.04 - 4.26)	2.40 (1.78 - 3.38)	6.40 (3.56 - 8.45)	18.0 (15.0 - 45.4)
Total fuel cost saved (USD)				
Total	680,849	97,294	195,337	388,191
Mean (SD)	10.94 (28.64)	2.20 (1.42)	15.37 (12.50)	72.5 (68.5)
Median (IQR)	3.15 (1.30 - 5.05)	1.75 (0.90 - 3.56)	11.52 (4.58 - 22.47)	49.5 (38.9 – 113.1)
Total cost of public transportation saved* (USD)				
Total	1,087,849	494,237	185,582	408,002
Mean (SD)	17.48 (29.69)	11.19 (7.23)	14.60 (13.81)	76.2 (74.6)
Median (IQR)	8.88 (5.84 - 19.76)	8.88 (4.60 - 18.08)	7.29 (5.84 - 21.25))	43,8 (40,8 – 109,4)
Saved transportation costs for municipalities with exclusively air income (USD) *				

Total	NA	NA	NA	6,170
Mean (SD)	NA	NA	NA	362.92 (356.05)
Median (IQR)	NA	NA	NA	265.51 (265.51 - 496.03)

* Refers to teleconsultations from people living in areas with no land access: Guapi (Cauca), Timbiquí (Cauca), Leticia (Amazonas), San Andres (San Andres y Providencia).

NA: Not apply.

The mean number of teleconsultations per patient was 2.10 (SD2.54) in Cali, 2.23 (SD 3.14) in Valle del Cauca excluding Cali, and 2.05 (SD 2.28) for the Outside of Valle del Cauca group. The estimated mean cost savings for private transportation round-trip per patient was $10.13 USD in Cali, $66.79 USD in Valle del Cauca excluding Cali, and $205.65 USD in outside of Valle del Cauca; and mean cost savings for public transportation expenses per patient was $28.98 USD in Cali, $50.22 USD in Valle del Cauca excluding Cali, and $213.25USD in outside of Valle del Cauca . In addition, the transportation cost savings for individuals residing in areas with exclusive air access amounted to $658.52 USD, with a standard deviation of $392.49. **(Table 3).**

Table 3. Distance, time, fuel, and public transportation per patient (all visits), between April and December 2020.

Variable	**Cali** N=19,630 n= 814	**Valle del Cauca excluding Cali** N=5,703	**Outside of Valle del Cauca** N=2,615
Teleconsultations per patient, mean (SD)	2.10 (2.54)	2.23 (3.14)	2.05 (2.28)

Distance saved per patient (km), mean (SD)	30.64 (52.80)	227.17 (398.38)	988.33 (1556.41)
Time saved per patients (hours), mean (SD)	2.06 (2.90)	5.98 (9.26)	21.23 (51.47)
Potential loss of productivity (USD), mean (SD)	5.51 (7.75)	34.25 (60.7	56.63 (137.33)
Fuel cost saved per patient (USD), mean (SD)	4.62 /7.96)	32.54 (65.51)	149.02 (234.67)
Cost of public transportation saved* (USD), mean (SD)	23.47 (40.44)	15.97 (24.70)	156.62 (251.04)
Saved transportation costs for municipalities with exclusively air income (USD)*, mean (SD)	NA	NA	658.52 (392.49)

* Refers to teleconsultations from people living in areas with no land access: Guapi (Cauca), Timbiquí (Cauca), Leticia (Amazonas), San Andres (San Andres y Providencia).

NA: Not apply.

Discussion:

In LMIC, the population at the base of the socioeconomic pyramid bears a disproportionately high burden of disease, often facing limited access to health services due to lower purchasing power and residence in underserved areas. In such contexts, there is an urgent need to identify innovative short-, medium-, and long-term to achieve effective universal health coverage, giving special strength to programs that allow access in the most remote and vulnerable areas (14,15). Strengthening telehealth systems has the potential to improve health and socioeconomic status of different population groups. Extending healthcare services to these remote areas through

telemedicine helps bridge this gap and facilitates substantial reductions in both time and distance (16–19). In Colombia, 7.2% of the population lives in rural areas (20), with significant challenges and obstacles when accessing healthcare services, particularly specialized medical care (15).

In 2020, as the COVID-19 pandemic spread worldwide, world poverty increased, and poverty induced by COVID-19 (21). Colombia was significantly affected by this issue, with a noticeable deterioration in its economic growth indicators. In 2020, the pandemic led to a 6.8% decline in Colombia's economy (Gross Domestic Product (GDP)), contributing to an increase in the national unemployment rate by at least 8 percentage points, resulting in an average rate of 15.9, a 5.4 percentage points rise from the previous year (22,23). Furthermore, the proportion of informal employment increased from 45% to 49% (24). Thus, savings achieved by the program were very timely in the midst of the worst economic year in Colombian history. The introduction of telemedicine led to average Potential loss of productivity savings of $5.51 and $34.25 USD per patient for the population of Cali and Valle del Cauca, equivalent to 26% and 75% of a full day's salary, respectively. For the population of Colombia, $56.63 USD was saved per patient, representing 9% of the minimum monthly salary.

Transportation cost is a determining factor in access to health care, especially for those living in rural areas not having a tertiary or complex center nearby that can provide services by medical specialties (25). However, the need for more training in the use of technologies and the difficulties in acquiring technology that allows remote connection limits the implementation of telemedicine in these areas (6,26). In our study, the telemedicine program succeeded in extending its reach to remote locations facing geographical challenges. These areas are accessible solely by air or sea. Examples include municipalities such as Guapi, Timbiquí, Leticia, and San Andres Island. Enhancing telecommunication networks in these regions could yield substantial savings in time,

distance, and travel expenses for their residents (27). For people living in those municipalities savings in transportation costs estimated per patient exceeded the 2020 monthly minimum wage.

Significant savings related to transportation and fuel expenses have been reported. These costs vary widely; studies have reported savings ranging from $4.66 to $150 per teleconsultation (4,28). Other studies have reported saved costs that encompass fuel expenses, insurance, and maintenance, resulting in higher per-person savings. Few studies have addressed costs related to public transportation; given the importance of public transportation in Colombia, especially between and within cities, this variable was key for a more realistic measurement (29). When comparing the average public transportation expenses saved for the Cali, Valle del Cauca, and rest of Colombia locations to the legal monthly minimum salary in Colombia for year 2020, it represents 3.67%, 5.08%, and 24.19%, respectively for the average patient.

Limitations of the current study include the retrospective approach to data collection, which limited the depth of analysis possible. Prospective data collection would have allowed for a more comprehensive examination, including factors such as work absenteeism, wait times, appointment duration, and associated costs. In addition, the absence of provider expenditures in the cost-effectiveness assessment of telemedicine represents a significant gap. On the other hand, the Colombian healthcare system fully covers diagnostic and treatment services, which may mitigate the cost impact on patients or hospitals. However, the study did not measure these consequences and costs, which is a limitation. Additionally, the potential loss of productivity particularly affects the adult population aged between 21 and 61 years. The retirement age in Colombia for women is 57 years and for men is 62 years. Within the scope of the study, this constitutes a limitation as it was not measured.

The study also overlooked critical factors like internet usage and telecommunications connectivity, impacting the assessment of cost savings achieved through telemedicine adoption. Failure to

consider participants' transportation mode and employment status hindered insights into socioeconomic dynamics influencing telemedicine utilization. Methodologically, the indirect calculation of expenditures introduced ambiguity, compounded by the absence of a validated instrument for precise measurement. Our objective in this paper was measuring savings using TM in comparison to a regular visit by the patient to our location, we did not seek a full economic evaluation which will include a cost-effectiveness (CE) study. The CE literature has shown that from a health systems perspective telemedicine programs remain cost-effective, but from a societal perspective there is a gap, and we leave a full economic evaluation for further research.

Future implications

The results encourage developing public policies and strengthening strategies incorporating digital health and telemedicine in Latin America's countries. Our experience shows results aimed at reducing indirect patient costs related to providing health services and facilitating care by multiple specialties through teleconsultation.

Conclusion:

Telemedicine brings to patients a significant travel savings, both in terms of time, distance, cost and potential loss of productivity; particularly in regions facing geographical and socioeconomic challenges. These findings emphasize the potential of telemedicine to bridge healthcare accessibility gaps in middle-income countries and the need to further develop and expand telemedicine services in such areas.

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Conflicts of Interest

The authors report there are no competing interests to declare.

Data availability statement

The data that support the findings of this study are available from the corresponding author [MFE], upon reasonable request.

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Author contributions

SIP and MFE designed and supervised the study; JJT and JA contributed to data collection; SIP, JJT, EEP and LLP contributed data analysis; SIP, MFE, EEP, LLP and JA contributed to literature review; EEP, LLP, JA, SIP and MFE contributed to drafted the manuscript. All authors read drafts of the manuscript and approved the final version

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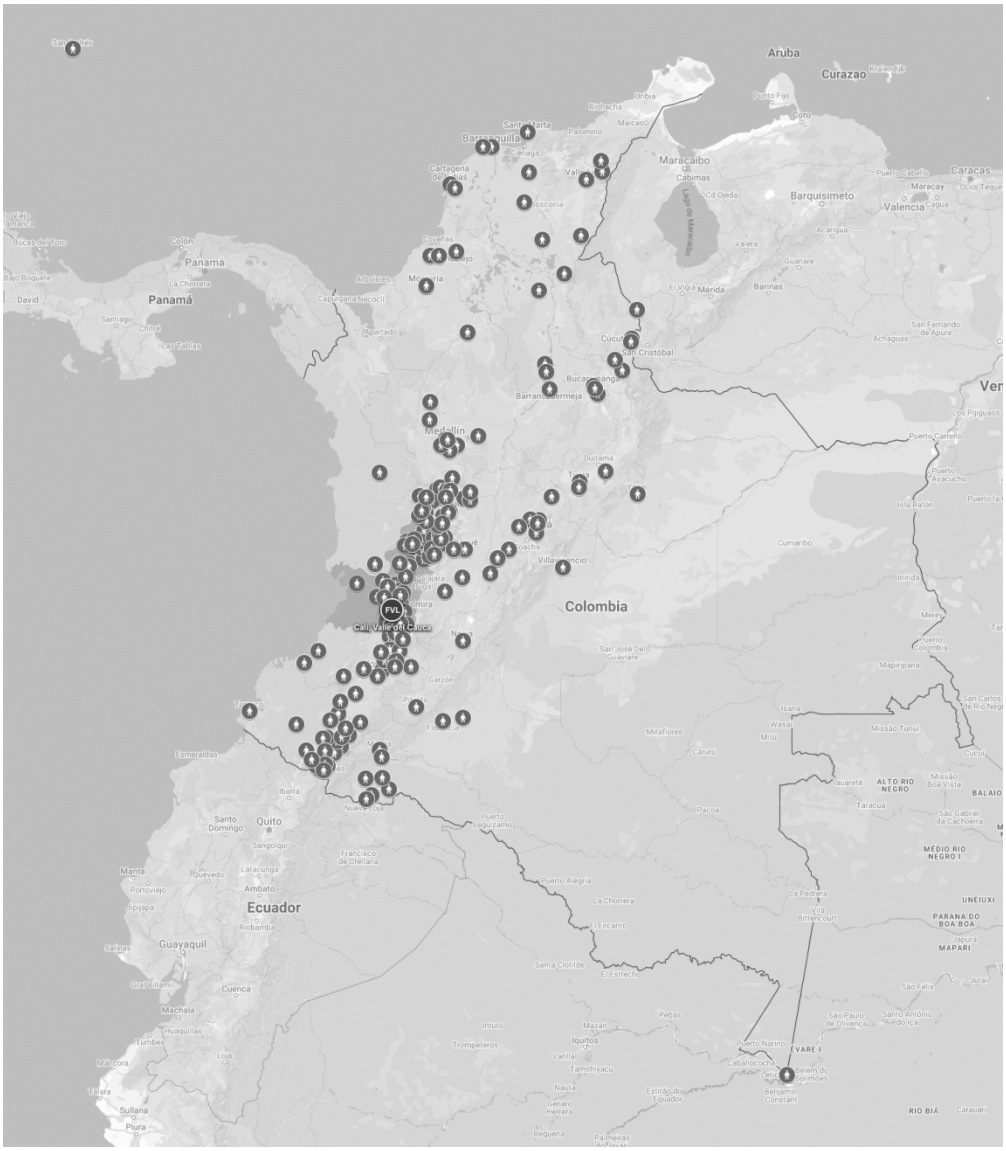

Grey shaded area refers to the region of Valle del Cauca. Black point indicates Fundación Valle del Lili (FVL). Grey points represent areas of teleconsultation in Cali, Valle del Cauca excluding Cali, and areas outside of Valle del Cauca

Figure 1. Study area map with locations of patient residences.

127x144mm (300 x 300 DPI)

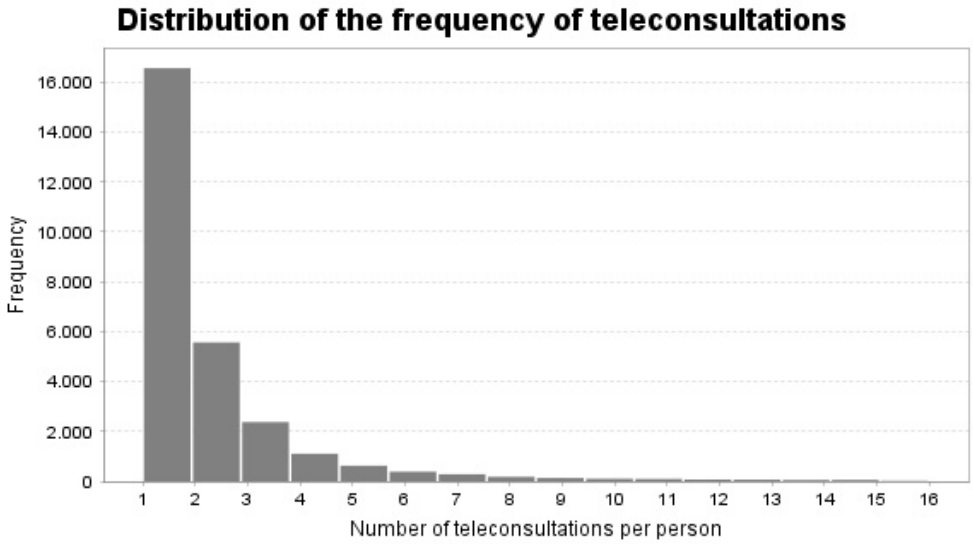

Figure 2. Distribution of the frequency of teleconsultations per person.

206x114mm (72 x 72 DPI)

Supplementary Table 1. Number of outpatient care provided per month according to modality of care, between April and December 2020.

Month	Telemedicine consultations	In-person consultations
April	4 181	8 920
May	7 378	13 674
June	7 770	20 576
July	9 427	25 897
August	8 117	24 679
September	7 707	33 305
October	6 521	36 153
November	5 609	36 094
December	5 548	34 462
Total	62 258	233 760

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4-5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4-5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-7*
Bias	9	Describe any efforts to address potential sources of bias	6-7
Study size	10	Explain how the study size was arrived at	4-5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5-7
		(*b*) Describe any methods used to examine subgroups and interactions	4-7
		(*c*) Explain how missing data were addressed	NA
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	4-5
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-12
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-12
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	8-12
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-12

		(*b*) Report category boundaries when continuous variables were categorized	8-12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.