

Profiling Cancer Patients in Telemedicine: A Case Study in Chilean Private Healthcare

Matías Cornejo¹^a, Esteban Chiu², Sebastián Valderrama^{3,5}^b,
Sebastián Mondaca^{4,5}^c and Eric Rojas^{6,7}^c

¹Center for Medical Informatics and Telemedicine, School of Medicine, Universidad de Chile, Santiago, Chile

²School of Dentistry, Pontificia Universidad Católica de Chile, Santiago, Chile

³Department of Internal Medicine, School of Medicine, Pontificia Universidad Católica de Chile, Santiago, Chile

⁴Department of Hematology and Oncology, School of Medicine, Pontificia Universidad Católica de Chile, Santiago, Chile

⁵Red de Salud UC CHRISTUS, Pontificia Universidad Católica de Chile and CHRISTUS Health, Santiago, Chile

⁶Institute for Biological and Medical Engineering, Pontificia Universidad Católica de Chile, Santiago, Chile

⁷Department of Clinical Laboratories, School of Medicine, Pontificia Universidad Católica de Chile, Santiago, Chile

Keywords: Telemedicine, Oncology, Cancer, Patient Characterization.

Abstract: Cancer is a devastating disease that affects patients and places a growing burden on healthcare systems globally. In recent years, cancer diagnoses have increased, exacerbating the challenges faced by both patients and healthcare providers. With the advancement of innovative technologies and rising demands for care, telemedicine has become a viable option for ensuring continued treatment, including for cancer patients. However, little is known about the characteristics and behaviors of these patients. This study aims to characterize cancer patients accessing telemedicine services at a private healthcare institution in Chile from 2020 to 2023, providing deeper insights into their profiles. Preliminary findings indicate a decline in adult patients and telemedicine appointments between 2020 and 2023. Similarly, pediatric patients experienced a decrease in telemedicine use from 2020 to 2022, followed by a slight increase in 2023. Understanding the profiles and behaviors of cancer patients utilizing telemedicine is crucial for improving their healthcare journeys. By analyzing their experiences, healthcare providers can enhance the allocation and management of resources, ensuring more effective and personalized care. This characterization also supports the development of strategies to optimize telemedicine services, improving outcomes for cancer patients in a rapidly evolving healthcare landscape.


1 INTRODUCTION


Cancer is a disease that impacts a large segment of the global population, with a total of 20 million new cases recorded in 2022. The number of new annual cases is expected to increase to 29.3 million by 2040 (Chilean National Cancer Institute, 2024). Consequently, investigations into cancer, the characterization of the disease and improvements in clinical processes involving patients represent a fundamental pillar of biomedical research.


Furthermore, telemedicine has recently gained considerable popularity in the treatment of a range of diseases and illnesses, hence its current widespread


use, and cancer pathologies are no exception to this growing trend (Shafer et al, 2023). Nevertheless, as this digital phenomenon expands, it is important to continuously improve research into and analysis of telemedicine among cancer patients in order to enhance understanding regarding the patient experience during the telemedicine care process. In this sense, the present paper aims to characterize cancer patients treated by telemedicine in order to improve knowledge relating to the context in which they operate.

This research forms part of the “Improving the patient journey in telemedicine using process mining” project. It introduces the preliminary results of the

^a <https://orcid.org/0009-0005-2905-1842>

^b <https://orcid.org/0000-0003-3913-6661>

^c <https://orcid.org/0000-0002-1130-0370>

^d <https://orcid.org/0000-0002-2570-1861>

characterization of the first cohort of patients that form the subject of the study.

The present paper is constructed as follows. Section 2 presents background in relation to the current state of cancer patients in Chile and the use of telemedicine generally. Section 3 describes the research objectives herein. Section 4 details the methodology used. Section 5 provides information about the study setting. Section 6 discusses the results. Finally, Section 7 outlines the conclusions and the future direction to be taken by this line of research.

2 BACKGROUND

2.1 Cancer in Chile

Cancer is a multifaceted disease that incorporates a large number of pathologies. The most prevalent forms of cancer are as follows: breast cancer, prostate cancer, lung and bronchial cancer, colorectal cancer, melanoma of skin, bladder cancer, kidney and renal pelvis cancer, non-Hodgkin's lymphoma, endometrial cancer, pancreatic cancer, leukemia, thyroid cancer and liver cancer (Moini et al., 2022).

In Chile, the cancer mortality rate increased by 109% between 1986 and 2016, positioning the disease as the first most common cause of death in the country since 2019 according to the Department of Health Information Statistics (Departamento de Estadísticas de Información de Salud [DEIS], Ministerio de Salud, 2022). This growth rate has sounded the alarm at the State level with regards to public health (Parra-Soto et al., 2020). Moreover, the challenge it represents is compounded by the estimate of the International Agency for Research on Cancer (IARC, 2018) which predicts that the number of annual deaths from cancer will rise to 55,698 nationwide by 2040, up from 33,625 in 2020 (an increase of 65,64%) (Navarro and Bralic, 2024) while new annual cases will reach 94,807 by the same year, an increase of 77.6% from the 2020 rate (Parra-Soto et al., 2020).

To this end, the characterization of cancer patients is essential in order to better understand their experience of the care provided by health services. A more detailed knowledge of patients and their behavior allows for an improved management of both human and economic resources, as well as those of the medical facilities in question (Hassan et al., 2022). The overall aim behind this line of research is not only to enhance implementation at the clinical level, but

also to improve national cancer-related programs more generally.

2.2 Telemedicine

Telemedicine refers to the use of information and communication technologies to provide healthcare in a remote, non-face-to-face manner. Such technologies are used to interchange all valid information to ensure the diagnosis, treatment and prevention of diseases in a more effective way and at a reduced cost (World Health Organization [WHO], 2019). Examples of certain types of telemedicine include telehealth appointments, telediagnosis and remote monitoring, among others.

Despite the multiple benefits of telemedicine, it continues to face challenges regarding how to strengthen its implementation (Mendoza-Alonso et al., 2021). Due to the increasing demand in this new healthcare modality among all types of patients following the COVID-19 pandemic (Zheng Wong et al., 2021), exploring opportunities to improve the way in which it provides efficient patient care has now become a necessity.

Similarly, the use of telemedicine among cancer patients still requires further research if practitioners wish to be able to fully optimize the care experience received by end users.

3 OBJECTIVES

The objective of the present study is threefold. First, to characterize a cohort of cancer patients who undertook telemedicine appointments in a specific study setting. Second, to use this characterization to enhance knowledge pertaining to patient behavior over time. Third, and during subsequent stages of the research, to ensure this characterization results in an improved understanding and a more detailed description of each patient journey taken in telemedicine.

4 METHODOLOGY

An exploratory analysis of the statistical database belonging to the Red de Salud UC CHRISTUS (UC CHRISTUS Healthcare Network) was undertaken. This database contains sociodemographic information on patients, in addition to data on medical specialties available for telemedicine care and patient financing. Patient data from 1 June 2020 to 1 June

2023 was used. The use of this data was approved by the Scientific Ethics Committee of Health Sciences of the Pontificia Universidad Católica de Chile.

First, the data was filtered according to the categories of telemedicine care related to cancer. Second, the characteristics that formed part of the analysis were determined, which include: sex, age, residence, health insurance type, number of patients and number of appointments for each of the categories related to oncology. Third, the aforementioned characteristics were assessed in more granular detail. Initially, a global count of the number of patients and appointments was conducted for both sexes. A similar analysis was subsequently performed over three separate 12-month periods to observe the variation in patient numbers over time. Statistical comparisons were then calculated to evaluate the proportion of users as a ratio of patients, in order to track changes between sexes, consecutive years and types of patients in the same year.

In this way, a more accurate insight into the type of cancer patient being treated via Red de Salud UC CHRISTUS through telemedicine was obtained. In turn, this approach will help to guide the next phases of the project in a more effective manner.

In conjunction with a group of clinical experts, the type of patient to be used was then determined in order to discover patient trajectories. For this, clinical and administrative criteria related to patient care flow were considered.

In subsequent stages of the research, a quality control of the extracted data will be performed in order to verify whether it meets all necessary criteria to build the event log, as outlined in van der Aalst (2016). Patient trajectories will then be modeled by means of process mining. Finally, patient trajectories will be compared with the expected care flow, in collaboration with clinical experts and based on clinical and administrative criteria.

5 STUDY SETTING

The study took place in Chile, where healthcare coverage is varied. Accordingly, 75% of Chileans are beneficiaries of FONASA (the public health fund), while 19% are enrolled in the ISAPRE (private insurance) scheme, and the remaining 6% belong to the State-funded Armed Forces social security system (a State agency). This reality generates significant asymmetries with regards to access to healthcare (Crespo, 2018).

In 2005, the Chilean State implemented the Sistema de Garantías Explícitas en Salud (Explicit Guarantees System in Health), known by its Spanish acronym as 'GES'. The GES system acts as a universal health plan and, as of 2024, provides explicit healthcare guarantees and coverage for 87 health problems which have been established by law. This includes 17 cancers.

GES allows users of the different healthcare systems guaranteed access to and financing of the diagnosis, treatment, follow-up and medicines for the illnesses and diseases included on the list. Additionally, it establishes prudent deadlines to enable the patient to cope with their disease while simultaneously ensuring that the system itself remains robust enough to meet the growing demand.

Cancer patients were chosen for this study because they generate a great impact for the healthcare system in different aspects: they imply a great effort for healthcare professionals and a considerable financial burden for patients and insurers. On the other hand, every year the number of patients increases and a 96.5% rise in mortality is predicted for the year 2045 (IARC, 2018).

In addition, this disease significantly affects patients in psychosocial and family aspects such as deterioration of mental health (Peters, et al., 2020), inability to perform daily activities such as work, etc.

For this reason, the study and the implementation of new care alternatives will allow improving the provided care, in the ways in which this disease is approached by health systems.

Also providing novel opportunities for a better adoption and reception of treatment by patients and their families.

6 RESULTS

6.1 Characterization

The institutional database of Red de Salud UC CHRISTUS was analyzed for patients receiving telemedicine appointments between 1 June 2020 and 1 June 2023. The database underwent a primary filtering for all categories of telemedicine care available in the system related to cancer-based pathologies, with six categories identified in total: Oncologic Surgery, Adult Oncology, Pediatric Oncology, Chemotherapy, Radiotherapy and Radiotherapy in Treatment. A total of 7,115 patients and 21,322 appointments were identified over the aforementioned period of study.

The data were then subjected to a secondary filtering with regards to the specialties of Adult Oncology and Pediatric Oncology, since it was determined that the patients of the remaining four specialties had already been accounted for in these two areas, since they constitute part of the regular clinical pathway for any such patient. As such, the total number of patients identified, and that constitute part of the present study, is 4,502 persons in conjunction with 17,209 appointments. Of these patients, 49.51% are women (n=2,229) and 32.9% are men (n=1,438). The remainder of the sample did not provide information on their sex.

In addition, data were analyzed in one-year periods in order to assess patient behavior during the pandemic. The periods for both adult and pediatric patients were defined as follows: from 1 June 2020 to 31 May 2021 (20-21); from 1 June 2021 to 31 May 2022 (21-22); and from 1 June 2022 to 1 June 2023 (22-23). Figure 1 shows the variation among adult patients and appointments over the three periods. The number of adult patients decreased by 6% between the 20-21 and 21-22 periods, and by 12.6% between the 21-22 and 22-23 periods. Total telemedicine appointments decreased by 18.9% and 20.9%, respectively, over the same periods.

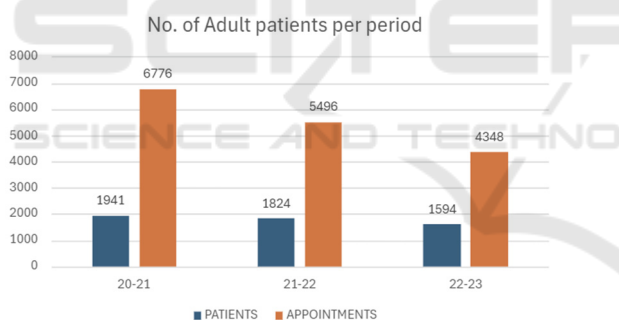


Figure 1: Number of adult patients and appointments for periods 20-21, 21-22, 22-23. A slight decrease in patients over time is observed; the decrease in appointments is more pronounced.

Similarly, the variation among pediatric patients and their appointments over the course of the three periods of study was analyzed. During the period 21-22, the number of patients decreased by 25.4% compared to the previous period, while appointments decreased by 23.8% over the same timeframe. However, for the 22-23 period, patients increased by 32% and appointments rose by 15% with respect to the previous period. The results are shown in Figure 2.

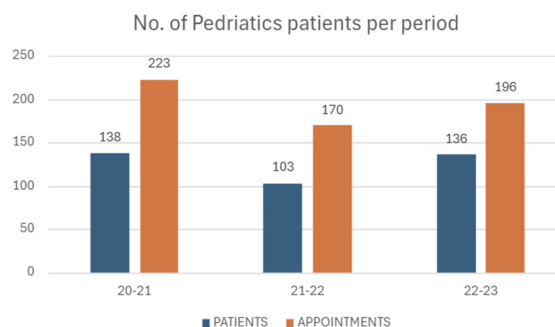


Figure 2: Number of pediatric patients and appointments for periods 20-21, 21-22, 22-23. A decrease in patients and appointments is observed between the first and second periods, but an increase in patients can be seen between the second and third periods.

6.2 Ratio of Appointments by User Type

In order to standardize the characterization used in the present study, a breakdown of the ratios of appointments according to the diverse types of patients was carried out to determine the use of the telemedicine service by user type.

First, Table 1 summarizes the ratios of appointments versus patients by sex for pediatric patients. It can be seen that during the periods 20-21 and 21-22, male patients experienced slightly more appointments than female patients with a delta of appointments of 0.04 and 0.03 respectively, i.e., showing a minimal difference. However, during the 22-23 period, female appointments became more prominent with a delta in their favor of 0.17, close to 6 times the previous delta. No ratio of pediatric patients divided by sex exceeds the ratio of total pediatric patients in the same time period. It should be noted that this is due to the fact that there are a number of patients for whom no information is available regarding their sex.

Second, and with respect to adult patients, higher deltas can be seen in the 20-21 and 21-22 periods with regards to pediatric patients. In this period, the pediatric trend is maintained in that the patients with the highest appointment rates are male, but the delta compared to female patients is 0.57 and 0.2, respectively, for these years. The trend is opposite to that observed among pediatric patients in 22-23, whereby male patients remain the users with the most appointments, with a delta rate of 0.33. In addition, it can be observed that the male rate exceeded the overall rate during the 20-21 period, with a difference of 0.3.

Finally, with regards to the overall tendencies between pediatric and adult patients, it can be seen that there is a constant trend related to a higher frequency of appointments among adult patients and a similar decrease over the time studied.

Table 1: Ratio of pediatric appointments versus pediatric appointments by sex.

| Period | Pediatric appointments | Pediatric appointments girls | Pediatric appointments boys |
|--------|------------------------|------------------------------|-----------------------------|
| 20-21 | 1.61 | 1.55 | 1.59 |
| 21-22 | 1.65 | 1.6 | 1.63 |
| 22-23 | 1.44 | 1.29 | 1.12 |

Table 2: Ratio of adults appointments versus adults appointments by sex.

| Period | Adult appointments | Adult appointments women | Adult appointments men |
|--------|--------------------|--------------------------|------------------------|
| 20-21 | 3.49 | 3.22 | 3.79 |
| 21-22 | 3.01 | 2.81 | 3.01 |
| 22-23 | 2.72 | 1.79 | 2.11 |

7 DISCUSSION

Analysis of Red de Salud UC CHRISTUS data shows a gradual decrease in the number of telemedicine patients and appointments between 2020 and 2023, particularly among the adult population. This decrease was more abrupt at different points in time, with a reduction of almost 20% observed during the last two periods. Such behavior may be related to several factors, such as the reduced availability of patients seeking telemedicine appointments, whether due to the additional time required to undertake in-office work compared to remote work, the preference for face-to-face appointments, or a reduction in the demand for care due to health-related conditions caused during pandemic confinement (Straßburger et al., 2023). Indeed, mobility restrictions during the strictest phases of the pandemic no doubt influenced the increased accessibility and willingness of patients to use telemedicine in the first place, especially in the case of adults.

On the other hand, the trend observed among the pediatric population shows a different pattern, with a noticeable decrease in telemedicine appointments in the period 21-22, followed by a significant increase in

the number of patients and appointments in 22-23. This increase, of 32% in patients and 15% in appointments, may reflect a change in parental attitudes towards telemedicine, given the advantages it affords in terms of them being able to coordinate medical appointments in line with their work obligations and according to the schooling requirements of their children (Troncoso, 2022). It is also possible that pediatricians, who were faced with a greater demand due to the increased rate of post-pandemic illnesses, such as the common cold in schools, chose to pursue telemedicine more frequently in order to optimize their care of immunosuppressed patients.

In terms of distribution by patient sex, it should be noted that in the case of children the appointments were predominantly for boys during the first two periods, with only a small difference compared to girls. However, in the 22-23 period, girls began to receive more appointments than boys, with a difference of 0.17 in their favor, a figure that is significantly greater than the differences observed in the previous periods. This change was unique among the six distinct comparisons undertaken on the basis of patient sex.

In the case of adults, behavior by sex displayed more pronounced differences. Over the first two periods, men outnumbered women in the overall number of appointments made, sometimes significantly, such as during the period 20-21. However, this trend leveled out during the last period (22-23), whereby men still maintained a higher appointment rate, albeit in a lower ratio than during the previous periods. This may indicate a more equitable adaptation of both sexes to the evolving modalities of telemedicine care.

One of the main challenges for telemedicine in the context of cancer patients is the inherent limitation of remote clinical evaluation. Despite its benefits, such as accessibility and convenience, telemedicine cannot completely replicate physical examination, which is so relevant in assessing the evolution of most cancer patients under treatment. Cancer specialists rely heavily on physical examinations, including palpation of tumors, observation of changes in the general condition of patients, and assessments of treatment adverse events that cannot be easily diagnosed via virtual channels. However, telemedicine can be a very pragmatic alternative in asymptomatic patients who are doing regular follow up with laboratory tests and imaging.

Another key challenge is the digital divide, which particularly affects cancer patients in rural or low-income areas. The adoption of telemedicine requires

access to appropriate technology, such as electronic devices, stable internet connectivity and the digital skills required to manage telemedicine platforms (Ganiele et al., 2024). In many cases, older patients, who make up a sizable proportion of all cancer patients, may be unfamiliar with the technological tools needed for virtual appointments or they might lack access to suitable devices. This technological inequality can lead to the exclusion of certain vulnerable populations, therefore increasing disparity in health care.

8 CONCLUSIONS

Analysis of the data shows that, despite the decrease in the number of patients and appointments during the early part of the pandemic, telemedicine has consolidated itself as a viable alternative form of care for cancer patients. The changes observed in the use of this modality of care by patients, particularly among the pediatric population, suggest that patients and their families have successfully overcome initial related obstacles. Consequently, this could render telemedicine a sustainable model in the long term. These evolving trajectories are an essential part of understanding whether telemedicine is capable of providing care equivalent to the traditional, face-to-face format, both in terms of clinical quality and administrative efficiency.

Tracking these patterns through process mining will allow researchers to build models that integrate both virtual and face-to-face appointments, which have the potential to improve care processes and clinical decision-making. However, challenges associated with telemedicine, such as limitations relating to the physical examination of patients, as well as technological barriers, raise important considerations when analyzing cancer patient trajectories. If healthcare is considered a process with a defined and clear structure, it is possible to study the patient trajectory as a process model (Rojas E., 2016).

In subsequent stages of the research presented herein, the authors propose studying the trajectory of telemedicine patients in greater detail to better understand the entirety of the healthcare process as a whole. To this end, care data from these patients will be requested in order to build their trajectories using different data science and process modeling techniques.

ACKNOWLEDGEMENTS

We thank the Red de Salud UC CHRISTUS for their valuable collaboration in providing the necessary data for this research. We extend our appreciation to the Universidad de Chile for the academic support provided through the participation of a master's student in this project. Finally, we express our gratitude to Agencia Nacional de Investigación y Desarrollo ANID for the financial support granted through the Fondo Nacional de Desarrollo Científico y Tecnológico (FONDECYT) project N°11230708, entitled "Improving the Patient Journey in Telemedicine using Process Mining", under the framework of which this study was developed.

REFERENCES

- Instituto Nacional del Cancer. (2024). Estadísticas del cáncer. 5.
- Shaffer, K. M., Turner, K. L., Siwik, C., Gonzalez, B. D., Upasani, R., Glazer, J. V., Ferguson, R. J., Joshua, C., & Low, C. A. (2023). Digital health and telehealth in cancer care: a scoping review of reviews. *The Lancet. Digital health*, 5(5), e316–e327. [https://doi.org/10.1016/S2589-7500\(23\)00049-3](https://doi.org/10.1016/S2589-7500(23)00049-3)
- Moini, J., Avgeropoulos, N. G., & Badolato, C. (2022). *Global epidemiology of cancer: Diagnosis and treatment*. John Wiley & Sons.
- Ministerio de Salud, Departamento Agencia Nacional de Cáncer, Subsecretaría de Salud Pública, Subsecretaría de Redes Asistenciales, División de Prevención y Control de Enfermedades, División de Políticas Públicas Saludables, División de Planificación Sanitaria, División de Atención Primaria, División de Gestión de la Red Asistencial, División de Gestión y Desarrollo de las Personas, & División de Inversiones. (2022). *Plan Nacional del Cáncer 2022-2027*. In www.minsal.cl/wp-content/uploads/2024/03/Plan-Nacional-de-Cancer-2022-2027.pdf. Departamento Agencia Nacional de Cáncer. Retrieved November 17, 2024, from <https://www.minsal.cl/wp-content/uploads/2024/03/Plan-Nacional-de-Cancer-2022-2027.pdf>
- Parra-Soto, S., Petermann-Rocha, F., Martínez-Sanguinetti, M. A., Leiva-Ordeñez, A. M., Troncoso-Pantoja, C., Ulloa, N., Diaz-Martínez, X., & Celis-Morales, C. (2020). Cáncer en Chile y en el mundo: Una mirada actual y su futuro escenario epidemiológico. *Revista médica de Chile*, 148(10), 1489-1495. <https://doi.org/10.4067/S0034-98872020001001489>
- International Agency for Research on Cancer. *Cancer Tomorrow*. 2018. From <https://gco.iarc.fr/tomorrow/en>.
- Navarro, E. & Bralic, T. (2024). Sobrevivencia de cáncer en Chile 1998-2020: aproximación general y por

- diagnósticos específicos. In *VII Congreso Chileno de Salud Pública, IX Congreso Chileno de Epidemiología*. Medwave. doi.org/10.5867/medwave.2024.S1.SP104
- Hassan, A. M., Chu, C. K., Liu, J., Angove, R., Rocque, G., Gallagher, K. D., Momoh, A. O., Caston, N. E., Williams, C. P., Wheeler, S., Butler, C. E., & Offodile, A. C. (2022). Determinants of telemedicine adoption among financially distressed patients with cancer during the COVID-19 pandemic: insights from a nationwide study. *Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer*, 30(9), 7665–7678. https://doi.org/10.1007/s00520-022-07204-1
- Crespo, C. F. (2018). Chile: Nuevos desafíos sanitarios e institucionales en un país en transición. *Revista Panamericana de Salud Pública*, 42. https://doi.org/10.26633/RPSP.2018.137
- Ministerio de Salud. Listado Específico de Prestaciones AUGE. From https://auge.minsal.cl/problemasdesalud/lep
- Peters, L., Brederbecke, J., Franzke, A., De Zwaan, M., & Zimmermann, T. (2020). Psychological distress in a sample of inpatients with Mixed Cancer—A Cross-Sectional Study of Routine Clinical Data. *Frontiers in Psychology*, 11. https://doi.org/10.3389/fpsyg.2020.591771
- World Health Organization. (2019). *Recommendations on Digital Interventions for Health System Strengthening* 1st edition. WHO.
- Mendoza-Alonzo, P., Mendoza-Alonzo, J. (2021). Telemedicine: expected challenges in Chile based on the experience in the United States during the pandemic. *Revista Médica de Chile*, 149(8).
- Mark Yu Zheng Wong, Dinesh Visva Gunasekeran, Simon Nusinovici, Charumathi Sabanayagam, Khung Keong Yeo, Ching-Yu Cheng, and Yih-Chung Tham. (2021). Telehealth demand trends during the covid19 pandemic in the top 50 most affected countries: Infodemiological evaluation. *Journal of Medical Internet Research Public Health and Surveillance*, 7(2):e24445, 2021
- Rojas, E., Munoz-Gama, J., Sepulveda, M., Capurro, D. (2016). Process mining in healthcare: A literature review. *Journal of Biomedical Informatics* 61.224–236.
- Straßburger, C., Hieber, D., Karthan, M., Jüster, M., & Schobel, J. (2023). Return to work after Post-COVID: describing affected employees' perceptions of personal resources, organizational offerings and care pathways. *Frontiers in public health*, 11, 1282507. https://doi.org/10.3389/fpubh.2023.1282507
- Troncoso Araya, Jose Luis. (2022). Back to normal? psychological analysis of the return to classes in post-pandemic COVID-19. *Cuadernos de neuropsicología*, 16(1), 94-99. https://dx.doi.org/10.7714/cnps/16.1.206
- Ganiele, M. D. L. N., Weisbrot, M. A., Sian, A. M., Carosella Reboledo, J. M., Weisbrot, M. V., & Grande Ratti, M. F. (2024). Alcances y limitaciones de la teleconsulta en pandemia de covid-19: Relatos de profesionales de la salud del primer nivel de atención de la Ciudad Autónoma de Buenos Aires. *Salud Colectiva*, 20, e4579. https://doi.org/10.18294/sc.2024.4579.