

RESEARCH ARTICLE (ORIGINAL)

Use of Technologies in Primary Health Care During the COVID-19 Pandemic: A Cross-Sectional Study

Uso de Tecnologias nos Cuidados de Saúde Primários Durante a Pandemia de COVID-19: Estudo Transversal

Uso de Tecnologías en la Atención Primaria de Salud Durante la Pandemia de COVID-19: Estudio Transversal

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Abstract

Background: During the COVID-19 pandemic, the use of technology in Primary Health Care intensified as a coping strategy.

Objective: To analyze the use of municipal health data and information in combating COVID-19 in Primary Health Care in Minas Gerais, Brazil.

Methodology: Observational, cross-sectional study, with data collected through a structured online questionnaire. A total of 278 professionals participated, of whom 53.4% were municipal health secretaries and 40.6% were Primary Health Care coordinators.

Results: The Municipal Health Department used health data and information to plan actions related to COVID-19, management, and other health conditions. However, barriers persisted, including difficulties among teams in handling health data and limited technological resources.

Conclusion: The COVID-19 pandemic boosted the use of technology, health data, and information, strengthening planning and decision-making. Nevertheless, infrastructure limitations and access difficulties remain, compromising the effectiveness of interventions.

Keywords: COVID-19; primary health care; health information systems; health management

Resumo

Enquadramento: Durante a pandemia de COVID-19, intensificou-se o uso de tecnologia nos Cuidados de Saúde Primários como estratégia de *coping*.

Objetivo: Analisar a utilização de dados e informação municipais no combate à COVID-19 nos Cuidados de Saúde Primários em Minas Gerais, Brasil.

Metodologia: Estudo observacional, transversal, com recolha de dados por questionário *online* estruturado. Participaram 278 profissionais, sendo 53,4% secretários municipais de saúde e 40,6% coordenadores dos Cuidados de Saúde Primários.

Resultados: Verificou-se o uso de dados e informação em saúde pelo Departamento Municipal de Saúde para planejar ações relacionadas com a COVID-19, gestão e outros agravos. Persistem, contudo, barreiras como a dificuldade das equipas em trabalhar com dados e a escassez de recursos tecnológicos.

Conclusão: A pandemia de COVID-19 impulsionou a utilização de tecnologias, dados e informação em saúde, fortalecendo o planeamento e a tomada de decisão. No entanto, persistem limitações de infraestrutura e dificuldades de acesso, que compromete a eficácia das ações.

Palavras-chave: COVID-19; cuidados de saúde primários; sistema de informação em saúde; gestão em saúde

Resumen

Marco contextual: Durante la pandemia de COVID-19, se intensificó el uso de la tecnología en la atención primaria de salud como estrategia de afrontamiento.

Objetivo: Analizar el uso de datos e información municipales en la lucha contra la COVID-19 en la atención primaria de salud en Minas Gerais, Brasil.

Metodología: Estudio observacional, transversal, con recopilación de datos mediante un cuestionario *online* estructurado. Participaron 278 profesionales, de los cuales el 53,4 % eran secretarios municipales de salud y el 40,6 % coordinadores de atención primaria.

Resultados: Se ha comprobado el uso de datos e información sanitaria por parte del Departamento Municipal de Salud para planificar acciones relacionadas con la COVID-19, la gestión y otras enfermedades. Sin embargo, persisten obstáculos como la dificultad de los equipos para trabajar con datos y la escasez de recursos tecnológicos.

Conclusión: La pandemia de COVID-19 ha impulsado el uso de tecnologías, datos e información en materia de salud, lo que ha reforzado la planificación y la toma de decisiones. Sin embargo, persisten las limitaciones de infraestructura y las dificultades de acceso, lo que compromete la eficacia de las acciones.

Palabras clave: COVID-19; atención primaria de salud; sistema de información sanitaria; gestión sanitaria

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Introduction

The COVID-19 pandemic posed a significant challenge to both society and science, requiring rapid and diversified responses from health systems, which had to reorganize to combat it (Cabral et al., 2020; Cerqueira-Silva et al., 2023; Ribeiro et al., 2020).

Initially, the increasing number of COVID-19 cases served as a key indicator for guiding non-pharmacological interventions aimed at reducing SARS-CoV-2 transmission. Subsequently, morbidity indicators contributed to decision-making processes and informed the definition of priority groups at the onset of the vaccination campaign (Vilela et al., 2021).

Primary Health Care (PHC) formed the foundation of high-performance health systems and played a critical role in planning and responding to pandemics and other health emergencies (Martins et al., 2025). Through PHC systems, it was possible to identify fluctuations in case numbers, analyze potential trends, and detect new patterns of disease presentation. These actions were only feasible due to the availability of high-quality data and timely information. Interventions proposed in response to the pandemic, particularly in light of case dynamics and periods of high lethality, were made possible, in part, by the rapid detection of cases, which may have prevented an even greater number of deaths and severe cases (Vilela & Gomes, 2022).

In this context, PHC teams played a key role in containing the spread of COVID-19 and preventing the worsening of affected individuals' conditions by anticipating potential public health impacts. PHC addressed problems arising from prolonged social isolation and the deterioration of economic and social conditions during this period (Teixeira et al., 2020).

This study aims to analyze municipal health data and information used in the fight against COVID-19 in PHC settings in Minas Gerais, Brazil.

Background

Technological tools have played an important role in controlling the COVID-19 pandemic (Fernandes et al., 2022; Lukas et al., 2020; Ribeiro et al., 2020). These tools represent an alternative means of communication that ensures the continuity of care and monitoring of suspected or confirmed COVID-19 cases, both during the pandemic and in the current context (Silva et al., 2022). The use of health data and information in PHC is recognized as an established management practice at the municipal level. Managers produce, analyze, and use data from health information systems to inform decision-making within the municipal care process (Quites et al., 2022). Information and communication technologies (ICTs) associated with PHC interventions benefit professionals, users, and communities by promoting health care delivery and expanding access to services during and after the pandemic (Harzheim et al., 2022).

Studies on the use of municipal data and information in

combating the COVID-19 pandemic in PHC contribute to a better understanding of this context and support the development of strategies to improve the effectiveness of the health system and facilitate decision-making by PHC managers and professionals (Ranzi et al., 2021). This evidence supports the development of this study.

Research question

In municipalities with an appropriate structure for the use of municipal health data and information and the use of e-SUS (Brazil's electronic health information system for PHC) resources, health education initiatives and diagnostic activities were developed for the population during the pandemic by trained professionals.

Methodology

This observational, cross-sectional study was conducted with a sample of municipal health secretaries and PHC coordinators in the Brazilian state of Minas Gerais. With a population of approximately 21 million inhabitants, this state has the largest number of municipalities in Brazil, accounting for about 10% of the national population (Instituto Brasileiro de Geografia e Estatística & Coordenação de População e Indicadores Sociais, 2019).

All municipal health secretaries and health sector advisors/coordinators in Minas Gerais were considered eligible for this study. Sample selection was performed using simple random sampling, considering population distribution and a 5% significance level, resulting in a calculated sample size of 455 municipalities. All mesoregions of the state were included in the sampling calculation.

Data were collected between January and September 2021. Managers received a link to the data collection instrument via email from the Municipal Health Department. Contact with participants and monitoring of responses were conducted by the Council of Municipal Health Departments of Minas Gerais (COSEMS/MG) via email. The expected response rate was 60% (Guimarães et al., 2011). Responses were obtained from 278 municipalities, corresponding to a response rate of 61.0%. Some municipalities ($n = 11$) that were not randomly selected received the link from collaborators and responded to the instrument.

The data collection instrument was pilot-tested in selected municipalities chosen by convenience, which were not included in the final sample. The questionnaire was developed based on an analysis of scientific publications retrieved from the Latin American and Caribbean Center on Health Sciences Information (BIREME) and the Medical Literature Analysis and Retrieval System Online (MEDLINE), focusing on the topics of Pandemic, Health Management, Family Health Strategy, and Primary Health Care published between 2015 and 2020.

The questionnaire comprised 53 questions addressing sociodemographic characteristics; professional background

and administrative experience of managers; number of PHC professionals; use of management tools in PHC; strategies and resources adopted by the municipality and health professionals to control infection and organize services; use of Emergency Plan; Biosafety; performance of diagnostic tests; establishment of partnerships and participation in infection control programs; health education actions; and main difficulties encountered. Most responses were rated using a five-point Likert-type scale reflecting frequency and satisfaction.

Data collection was carried out electronically (web-based survey) using Google Forms, and data were analyzed using IBM SPSS Statistics and R software version 3.0.2 (R Core Team, 2021). Categorical variables were described using absolute and relative frequency distributions, while numerical variables were described using measures of central tendency and dispersion (median, mean, and standard deviation).

Two structural equation models were developed: one to analyze associations among variables related to structure, use of e-SUS, diagnostic activities, alternative pandemic response actions, educational activities, and hindering factors affecting the implementation of COVID-19 response strategies in the municipality; and another to assess associations between municipal population size and the variables included in the model. Structural equation modeling (SEM) comprises a set of techniques and procedures that extend traditional multivariate methods by allowing the simultaneous evaluation of relationships between dependent and independent variables (Hair et al., 2005). Moreover, it can represent variables that cannot be measured directly through groups of observed variables, known as latent constructs.

This study complied with all ethical procedures established in Resolution 466/2012 of the National Health Council and was approved by the Human Research Ethics Committee of the Federal University of Minas Gerais (CAAE: 31764620.0.0000.5545). All participants signed an informed consent form at the beginning of the study. A limitation of this study is the potential for selection bias, as a small portion of the sample was obtained through convenience sampling rather than random sampling. This may have influenced the representativeness of the results. Although selection bias may limit the generalizability of the findings, it does not compromise the internal validity

of the analyses, which reliably reflect the context under study.

Results

Sample characterization

Of the 278 participants, 53.4% held the position of municipal health secretary and 40.6% were PHC coordinators. Just over one-third of the participants (31.1%) had previously held a health management position.

Use of Health Information Systems in combating COVID-19

The use of health data and information by the Municipal Health Department to plan actions with PHC teams and support decision-making was reported by 94.2% of respondents. This use was considered important for combating COVID-19 and management practices (78.1%) as well as for addressing other health problems in PHC (94.2%). Health Information Systems (HIS) available in PHC were identified as the main source of information (87.9%). The production of health data and information related to COVID-19 was rated as extremely satisfactory or very satisfactory in 72.7% of the municipalities.

Strategies to combat COVID-19 and the use of e-SUS

Municipal meetings to discuss PHC work processes related to the fight against COVID-19, supported by health data and information, were held very frequently (33.1%), frequently (30.6%), or regularly (31.7%).

Participants also reported the development of indicators (74.1%) and the use of management tools for data analysis (38.8%).

Most participants (59.4%) reported having the necessary structure and equipment to very frequently carry out data- and information-based management activities within the Municipal Health Department and Health Centers (59.7%).

Staff training and capacity-building activities aimed at developing skills related to infection prevention and control were conducted effectively in 58.6% of the municipalities and partially in 29.1%.

Table 1 describes the use of e-SUS resources in combating COVID-19.

Table 1

Distribution of Variables Related to the Use of e-SUS and its Contribution to Combating COVID-19 in Primary Health Care (N = 278)

Variables		<i>n</i>	%
Use of e-SUS resources in the municipality	Yes	262	94.2
	No	2	0.7
	Partly	14	5.0
Contribution of e-SUS in combating COVID-19	Yes	188	67.6
	No	9	3.2
	Partly	79	28.4
	Don't know	2	0.8
Contribution of the EHR in combating COVID-19	Yes	138	49.6
	No	21	7.6
	Partly	78	28.1
	Only used in PHC	29	10.4
	None of the above	12	4.3
Use of proprietary software similar to e-SUS in the municipality	Yes	98	35.3
	No	170	61.2
	Partly	10	3.6

Note. n = Sample; % = Percentage; EHR Electronic Health Record = PHC = Primary Health Care

It was observed that e-SUS resources were used by more than half of the responding municipalities, while approximately one-third still relied on other software with similar features.

Factors perceived by participants as hindering the fight against COVID-19 in PHC, particularly regarding the use of health data and information, included difficulties among PHC teams in handling health data and information, reported by 8 municipalities (2.8%); the large number of reports generated (18.5%); lack of computers and technological resources (3.9%); the large number of HIS databases (19.9%); and delays

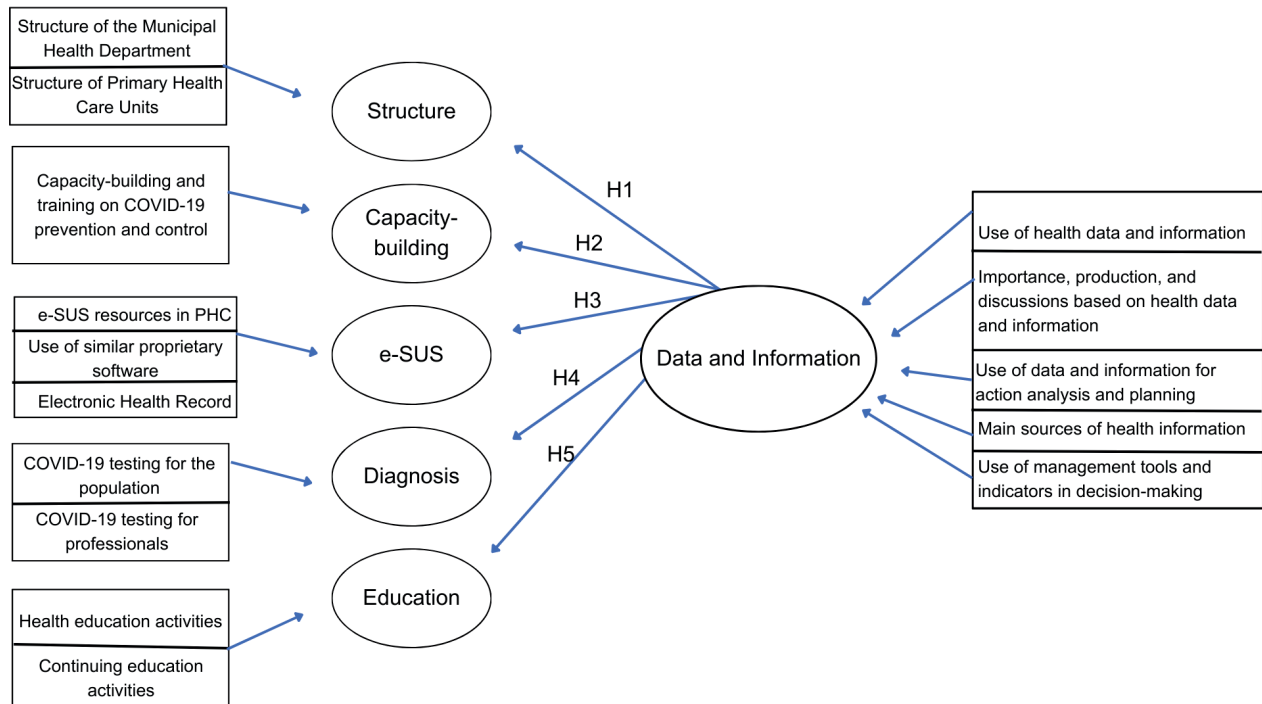
by the Ministry of Health in disseminating health information (12.8%).

Structural equation model

To better understand the relationships involving the use of health data and information during the pandemic, a model based on SEM was developed. The hypotheses and contextual variables are presented in Figure 1. The model yielded a χ^2 value of 781.276 with a *p*-value < 0.001, indicating good validation of the proposed model. Regarding model fit, very good quality was observed, with a Root Mean Square Error of Approximation (RMSEA) value of 0.072.

Figure 1

Model Tested to Evaluate Associations among Structure, Capacity-building, e-SUS Use, Diagnostic Activities, and Educational Actions Using Health Data and Information



Note. R^2 Data and Information = 0.430; R^2 Structure = 0.301; R^2 Capacity-building = 0.193; R^2 e-SUS = 0.203; R^2 Diagnosis = 0.651; R^2 Education = 0.016.

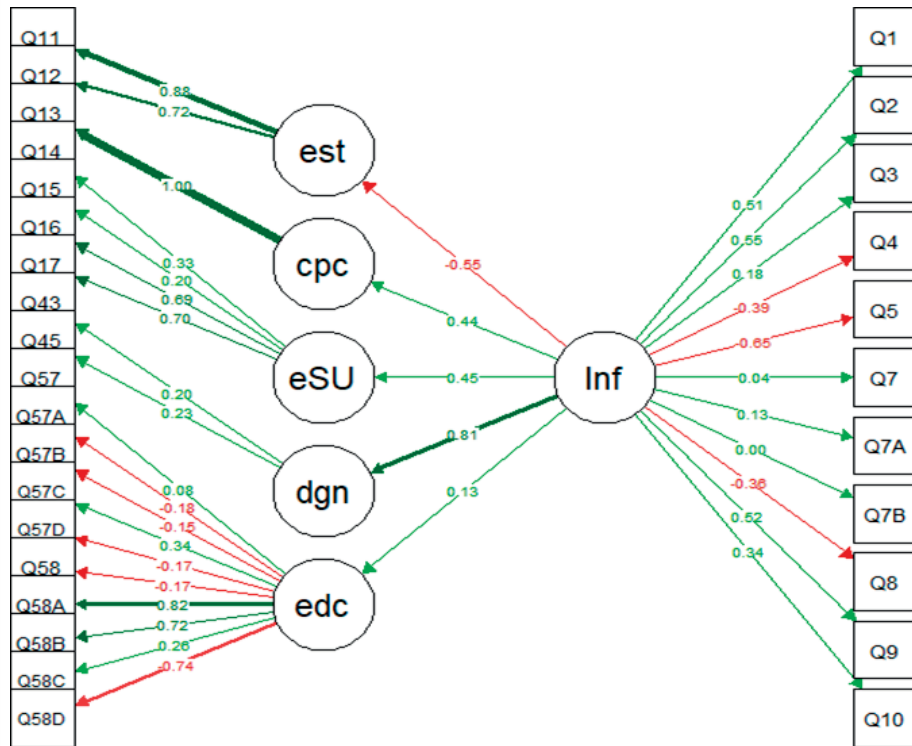
The model analysis identified associations for hypotheses H1, H2, and H3. Health structure (H1) showed a negative association with participants' reports on the use of health data and information in combating COVID-19 ($\beta = -0.656$; $p < 0.0001$). In the proposed model, greater availability of structure and equipment

in the Municipal Health Department and Health Centers was associated with lower reported use of health data and information for planning actions to combat COVID-19.

Figure 2 illustrates the relationships among the evaluated constructs.

Figure 2

Path Diagram between Structure, Capacity-building, Use of e-SUS, Diagnostic Activities, and Educational Actions Using Health Data and Information



Note. Q1–Q10 = questionnaire items addressing data use, the importance of discussions and data production, analysis and planning, main sources, and the use of management tools; Q11–Q12 = items related to the structure of the health centers and the Municipal Health Department; Q13–Q14 = items on training and capacity building; Q15–Q17 = items on e-SUS and the Electronic Health Record; Q43 and Q45 = items on population and professional diagnosis; Q57–Q58 = items on continuing education and health education. Category abbreviations: est = structure; cpc = capacity-building; eSU = e-SUS; dgn = diagnosis; edc = education.

2 presents questions Q4, Q5, and Q8, which supported this negative association and are described below.

Table 2

Distribution of Variables Related to the Importance of Health Data and Information, Their Production, and the Holding of Meetings on Combating COVID-19 in Primary Health Care (N = 281)

Variables		<i>n</i>	%	<i>Cumulative %</i>
(Q4) Importance of data and information for management practices in combating COVID-19	Extremely important	217	78.1	78.1
	Very important	51	18.3	96.4
	Important	10	3.6	100.0
(Q5) Production of data and information related to COVID-19 cases in PHC	Extremely satisfactory	93	33.5	33.5
	Very satisfactory	109	39.2	72.7
	Satisfactory	71	25.5	98.2
	Unsatisfactory	5	1.8	100.0
(Q8) Meetings held exclusively to discuss the work process at CSP in combating COVID-19	Very frequently	92	33.1	33.1
	Frequently	85	30.6	63.7
	Regularly	88	31.7	95.3
	Rarely	13	4.7	100.0

Note. *n* = Sample; % = Percentage; PHC = Primary Health Care

The next hypothesis, H2 ($\beta = -0.489$; $p < 0.001$), showed a positive effect, suggesting that greater investment in training and capacity-building activities related to infection prevention and control was associated with increased use of health data and information during the pandemic.

A similar association was observed between the use of health data and information for planning purposes and the use of e-SUS resources, similar municipal software, and the Electronic Health Record (EHR), considering their contribution to combating COVID-19 (H3; $\beta = 0.505$; $p < 0.001$). According to participants' reports, greater use and production of health data and information, development of indicators, and use of management tools to combat COVID-19 were associated with increased use of e-SUS resources and its components.

No association was found between the use of health data and information and the variables related to COVID-19 diagnostic activities in the municipality ($\beta = 1.3655$; $p = 0.584$) or educational actions ($\beta = 0.128$; $p = 0.944$). Diagnostic testing for COVID-19 was reported in 82.8% of municipalities, as well as health education actions (76.9%) and continuing education activities related to infection control measures (20.3%).

A potential association between municipal population size and the hypotheses tested in the previous model was also examined. This model yielded a χ^2 value of 363.428 with a p -value < 0.001 , indicating very good model fit, with an RMSEA value of 0.068.

No association was found between population size and variables related to structure ($\beta = 0.276$; $p = 0.848$), capacity-building ($\beta = 0.160$; $p = 0.486$), use of e-SUS ($\beta = 0.666$; $p = 0.755$), COVID-19 diagnostic activities ($\beta = -0.150$; $p = 0.886$), or implementation of educational activities ($\beta = -0.369$; $p = 0.650$).

Discussion

This study highlighted the use of health data and information by PHC teams in the Municipal Health Department to support strategy planning and decision-making related to combating COVID-19 and other health problems. Health management clearly requires alignment between decision-making processes and administrative competencies. The use of HIS is essential in this process, as these tools support knowledge management and sharing (Antunes et al., 2021).

The results of this study indicate that HIS constitute the main source of health information. This finding is consistent with a study conducted in the Czech Republic, which identified the need for system integration and strategic use of HIS to support decision-making and optimize interoperability (Komenda et al., 2025).

In this study, the use of health data and information for planning purposes and the use of e-SUS tools, similar software, and the EHR contributed to efforts to combat COVID-19. The implementation of the National Health Record has the potential to reduce bureaucratic processes related to health information recording (Ferreira et al., 2025; Massuda et al., 2021; Ribeiro et al., 2020). Moreover,

e-SUS represents an important tool for health management in PHC (Celuppi et al., 2024), corroborating the findings of the present study.

During the pandemic, the implementation of technologies in health services contributed to improved care delivery and support for users and families (Cabral et al., 2020). However, EHRs are not routinely shared across services to improve quality, research, or health system planning (Martins et al., 2025). To address this issue, information systems and database integration must be developed to ensure accessible and transparent information, with a particular focus on combating misinformation (Massuda et al., 2021).

During the pandemic, health professionals participated in meetings, training sessions, and workshops on strategies to combat COVID-19 (Pereira et al., 2021). Notably, distance education resources delivered via Moodle were used (Ribeiro et al., 2020), and management meetings were adapted to online formats during this period (Silva et al., 2022).

In this study, the Municipal Health Department and the Health Centers provided the physical infrastructure, materials, and equipment necessary to carry out management practices supported by health data and information. However, challenges encountered in combating COVID-19 in PHC included difficulties in handling data, excessive reporting, lack of resources, insufficient infrastructure, and multiple information databases, consistent with findings from other studies (Altobelli, 2024; Cabral et al., 2020; Fava & Lapão, 2024; Lana et al., 2020; Martins et al., 2025; Nedel, 2020). In addition, resistance from PHC managers and professionals (Ranzi et al., 2021), heterogeneous infrastructure, use of paper forms, and lack of data validation during online data entry may have posed obstacles to pandemic response efforts (Lana et al., 2020).

The quality of decision-making depends on the availability of technological infrastructure and on professionals' capacity to analyze and evaluate information generated by HIS. Therefore, training human resources in the implementation and analysis of public policies is essential for the management of the Unified Health System (SUS) (Antunes et al., 2021).

Strengthening the SUS must be based on policies that ensure appropriate training and (re)allocation of the health workforce. It is essential to establish a plan for the temporary hiring of professionals during pandemics and to ensure that training and continuing education programs include content related to public health practice, with an emphasis on the proper use of personal protective equipment (Massuda et al., 2021).

This study contributes to scientific knowledge by examining how the use of health data and information by PHC teams within the Municipal Health Department can inform decision-making related to COVID-19 and other health conditions. Despite limitations related to the specific sample, the results indicate that COVID-19 diagnostic testing and health education programs should be prioritized, as they contribute to reducing the spread of COVID-19. In summary, early diagnosis and detection

are essential (Lukas et al., 2020; Ribeiro et al., 2020), as is population adherence to and compliance with COVID-19 containment and treatment measures (Lima et al., 2020).

Conclusion

The pandemic required municipal managers to monitor suspected and confirmed COVID-19 cases, highlighting the importance of using technologies and health data and information in response actions due to the dynamic nature of the context. This study demonstrates that, although these tools contributed to planning and decision-making related to disease control and prevention, several barriers needed to be overcome in PHC during and after the pandemic. These barriers included lack of infrastructure, equipment, and computers; difficulties in accessing and using technologies and the internet; delays or incorrect completion of online forms; and lack of integration among information systems.

This study suggests that the pandemic required rapid adaptation and adoption of technologies to ensure continuity of health care delivery. From a practice perspective, the findings underscore the need to invest in resources and infrastructure, as well as in ongoing training for professionals and teams, which may enhance more effective PHC responses in similar future contexts. From a research perspective, the results point to opportunities for further analysis of the effects of online tools in the health sector.

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