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RESEARCH ARTICLE

REDES DE DIAGNÓSTICOS DE ENFERMEDADES ASOCIADAS A LA COVID-19 DE 2020 A 2022 EN EL CENTRO DE MÉXICO

NETWORKS FOR DIAGNOSIS OF DISEASES ASSOCIATED WITH COVID-19 FROM 2020 TO 2022 IN CENTRAL MEXICO

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RESUMEN

Introducción: Los diagnósticos de las enfermedades asociadas a la COVID-19 cobran relevancia a la luz de su incidencia y prevalencia en el centro de México. Objetivo: El objetivo del presente trabajo fue comparar un modelo de red neuronal con los hallazgos reportados en la literatura. Metodología: Se realizó un trabajo documental, transversal, correlacional y retrospectivo con una muestra de 6500 casos seleccionados por entidad centralizada en México. Resultados: Los resultados demuestran la secuencia de aprendizaje que va de los diagnósticos hacia las

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entidades de aplicación lo cual revela una red colaborativa orientada por las tomografías. Discusión: Con relación al estado del arte donde prevalecen hallazgos centrados en las decisiones, estrategias colaborativas y gestoras de conocimiento, el presente trabajo sugiere incluir estas dimensiones a fin de poder anticipar las respuestas de las instituciones de salud pública en futuras contingencias sanitarias.

PALABRAS CLAVES: Análisis de Redes Neuronales, Aprendizaje Organizacional, COVID-19, Diagnósticos, Enfermedades.

SUMMARY

Introduction: Diagnoses of diseases associated with COVID-19 become relevant considering their incidence and prevalence in central Mexico. Objective: The objective of this work was to compare a neural network model with the findings reported in the literature. Methodology: A documentary, cross-sectional, correlational, and retrospective work was conducted with a sample of 6,500 cases selected by centralized entity in Mexico. Results: The results demonstrate the learning sequence that goes from diagnoses to application entities, which reveals a collaborative network guided by tomography. Discussion: In relation to the state of the art where findings focused on decisions, collaborative strategies and knowledge management prevail, this work suggests including these dimensions to anticipate the responses of public health institutions in future health contingencies.

KEYWORDS: Neural Network Analysis, Organizational Learning, COVID-19, Diagnoses, Diseases.

Introduction

Organizational theories help to understand and improve the diagnosis of diseases related to COVID-19 by analyzing how health systems adapt and respond to complex challenges. COVID-19 has tested health systems, revealing both strengths and weaknesses in their capacity to diagnose and treat secondary conditions (Argyris & Schön, 1978).

Hierarchical structures and well-defined processes enhance diagnostic efficiency (Senge, 1990). This is evident in the use of standardized

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protocols for laboratory testing. However, rigid adherence to these protocols can limit flexibility when confronting a constantly evolving virus. Therefore, diagnostic processes require adaptability to specific conditions such as viral variants and unequal access to resources.

Health systems that successfully adjusted their protocols according to the severity of local outbreaks exemplify the effective application of organizational theories. These adaptive systems demonstrate how learning organizations can evolve practices based on feedback and changing contexts, ultimately improving diagnostic accuracy and healthcare outcomes during the pandemic.

Health is a complex interconnected system; therefore, diagnoses must integrate biological, social, and economic factors (Garvin, 1993). Consider diagnostic programs integrated with community care, although it can be challenging to identify which subsystem fails in critical situations.

From Chaos Theory, diagnoses during the pandemic must be managed within an environment of uncertainty and unpredictable events (Nonaka, 1994). Agile responses to new variants indicate an entropic system adapting dynamically.

However, from the Humanistic Theory perspective, the well-being of medical personnel is key to accurate diagnoses (Fiol & Lyles, 1985). Psychological support programs for healthcare workers exemplify this subsystem, even though implementing humanistic measures can be difficult in emergency contexts.

From an institutional perspective, hospitals must legitimize reliable diagnostic practices before society (Meyer & Rowan, 1977). This is exemplified by diagnostic tests regulated by oversight bodies; however, such bureaucracy can delay the implementation of innovations (see Table 1).

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Table 1. Comparative organizational learning versus COVID-19 associated diseases.

Authors	Sample	Instruments	Interpretation of results	Organizational theories
Mintzberg (1979)	Case studies of companies	Qualitative analysis of organizational structures	Identifies key organizational configurations (simple, machine bureaucracy, professional, divisional, adhocratic).	Organizational design
Schein (1985)	Organizations from various sectors	Observation, interviews	Organizational culture directly impacts performance and organizational change.	Organizational culture
DiMaggio & Powell (1983)	Academic institutions and companies	Document analysis, interviews	Organizations tend to become homogeneous due to coercive, mimetic, and normative isomorphic processes.	Institutional theory
Freeman & Reed (1983)	Multinational companies	Surveys, interviews	The relationship with stakeholders is key to long-term sustainability and success.	Stakeholder theory

March & Simon (1958)	Workers in manufacturing industries	Questionnaires, observation	Decisions in organizations are influenced by bounded rationality and internal norms.	Organizational behavior theory
Lawrence & Lorsch (1967)	Chemical and food companies	Comparative studies	Organizational effectiveness depends on the ability to integrate differentiated parts according to their specific environment.	Contingency theory
Pfeffer & Salancik (1978)	Companies in competitive markets	Longitudinal studies	Dependence on external resources conditions strategic decisions and internal power.	Resource dependence theor
Nonaka & Takeuchi (1995)	Japanese technology companies	Interviews, document analysis	The creation of organizational knowledge is key for innovation and competitiveness.	Knowledge management
Barney (1991)	Companies from various sectors	Case analysis, theoretical models	Valuable, rare, inimitable, and organized resources generate sustainable	Resource-based view (RBV)

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	competitive advantages.

However, the learning networks for COVID-19-related disease care suggest structures that the literature has identified as neural sequences without considering sociodemographic factors. Therefore, the objective of the present work was to compare the structure reported in the literature with the structure observed in the present work.

Are there significant differences between the theoretical structure of the learning networks reported in the literature and the networks observed in the present work?

Given that lockdown and distancing policies will focus biosecurity on risk prevention, significant differences are expected between the structure reported in the literature and the cases reported in local healthcare institutions.

Method

Diseño. A cross-sectional, exploratory, correlational, and retrospective study was conducted with a sample of 6,000 COVID-19 cases reported in the local health system of Morelos, central Mexico, during the period from 2020 to 2022.

Instrument. The Questionnaire on Sociodemographic, Socioeconomic, and Socio educational Data of COVID-19-associated diseases was used (see Annex A). It includes: 1) Sociodemographic data, 2) Socio educational variables, 3) Socioeconomic aspects, 4) Health variables, 5) Additional information.

Procedure.

1. Definition of the objective by establishing the purpose of the analysis and identifying how organizations share knowledge related to COVID-19-associated diseases. Assessment of collaboration dynamics in the generation, distribution, and implementation of knowledge.

2. Identification of nodes and relationships by selecting key actors within the organizational network, such

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as: Health institutions (hospitals, laboratories, research centers), Governments and international organizations (WHO, PAHO, local governments), Educational organizations (universities, training centers), and Private companies (pharmaceuticals, technology developers). Definition of interactions between actors, such as: Exchange of scientific information, collaboration in research projects, implementation of joint health measures, training and education.

3. Data collection from information sources: Review of scientific databases (Scopus, Web of Science). Interviews with representatives of the identified nodes. Document analysis (protocols, reports, public policies). Registration of sociodemographic variables: size and location of the actors; socio educational variables: quantity and quality of training programs implemented; and socioeconomic variables: investment in learning and collaboration resources. Networks: frequency and type of interactions (virtual meetings, joint publications).

4. Network construction through graphical representation: Use of Social Network Analysis (SNA) tools such as UCINET, with nodes represented as actors and edges as the interactions between them. Identification of central nodes (with higher degrees of connection) and peripheral nodes (with lower participation).

5. Analysis of network metrics and evaluation of the overall level of connection among actors. Calculation of measures such as degree, closeness, and betweenness to determine key actors in the network. Identification of subgroups of actors working in specific areas such as vaccination, mental health, or risk communication. Analysis of the network's evolution during the 2020–2022 period to identify changes in collaboration.

6. Interpretation of results through the identification of organizational learning patterns (e.g., knowledge flow, communication barriers). Assessment of how these networks influence the management of COVID-19-associated diseases.

7. Presentation of results and graphical visualizations of the network. Statistical analysis of network metrics and specific recommendations for each group of actors.

Results

The centrality analysis suggests the establishment of a neural-like structure around which the nodes revolve around a hegemonic one (see Fig. 1). The results indicate the prevalence of linear tomography as the hegemonic test in the diagnosis of COVID-19-associated diseases.

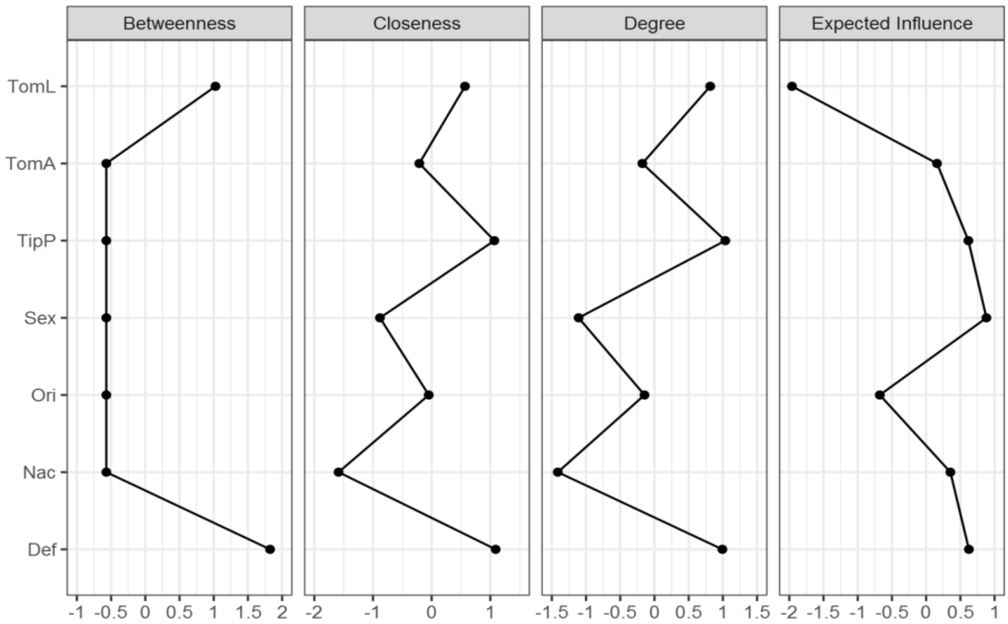

Fig. 1. Centrality of the tests associated with COVID-19.

The clustering analysis indicates the degree of configuration around which the other nodes revolve in relation to a hegemonic one (see Fig. 2). The findings demonstrate the prevalence of palliative treatment as the axis around which the other tests revolve.

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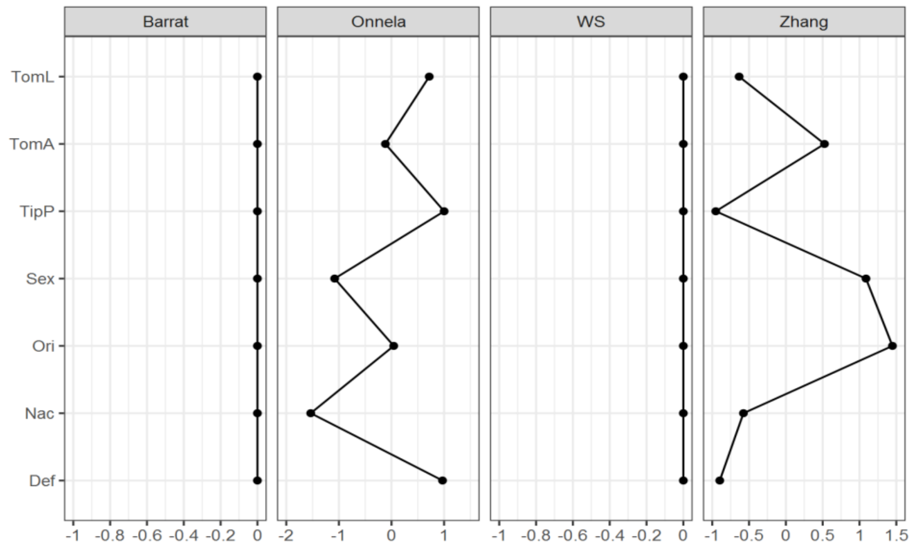

Fig. 2. Grouping of exams associated with COVID-19

The analysis of the network structure suggests the degree of learning and strategy based on the relationships between the first and last node in a left-to-right sequence (see Fig. 3). The results indicate that the learning sequence begins with sex and ends with the origin of the case..

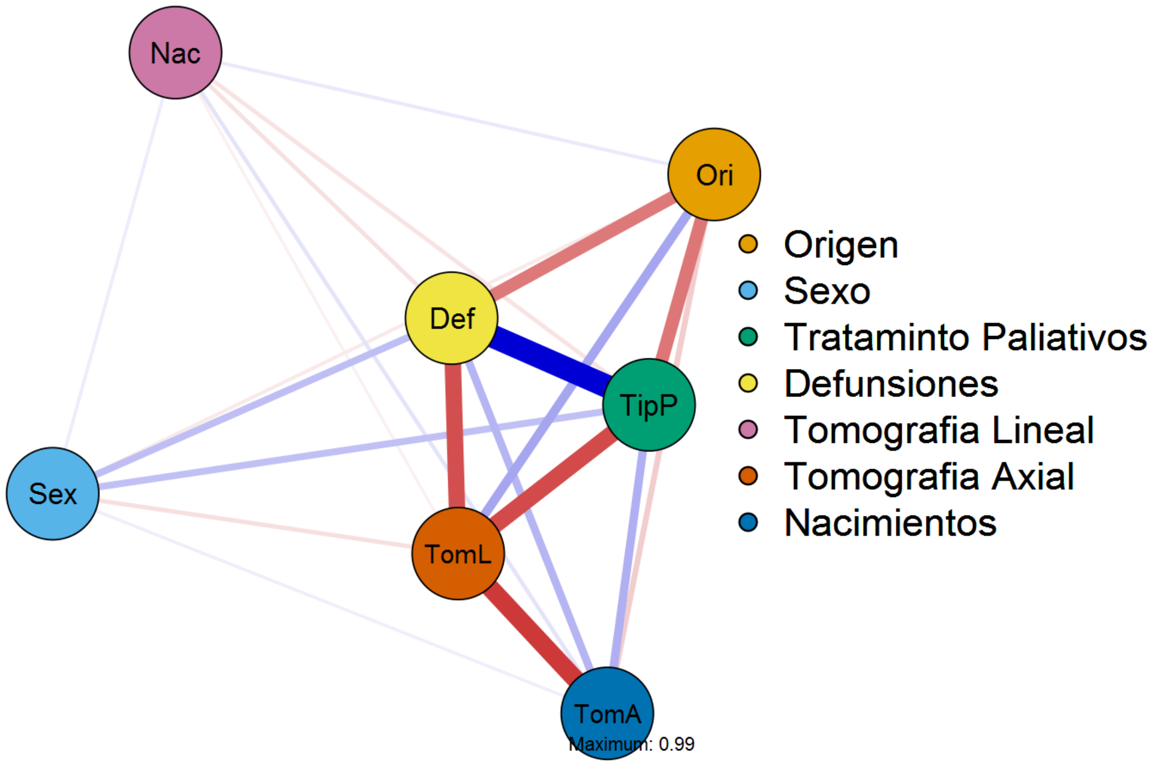

Fig. 3. Structuring of the examinations associated with COVID-19

The centrality, clustering, and structuring coefficients suggest the non-rejection of the hypothesis regarding the differences between the theoretical structure and the empirical observations of the present work.

Discussion

The contribution of the present work to the state of the art lies in the establishment of a neural network to explain the incidence and prevalence of COVID-19-associated diseases in central Mexico. The results highlight the centrality, clustering, and structuring of the neural network based on sex, Linear Tomography, Palliative Treatments, and place of origin.

The neural network presented can be interpreted through organizational theories by analyzing the interactions between the nodes (variables) and the strength of their connections (Easterby-Smith, Crossan & Nicolini, 2000). Each node represents an organizational or analytical variable, and the connections reflect relationships or interdependencies among them. The key elements are analyzed here in terms of organizational theories: Contingency theory suggests that organizational decisions and structures depend on the environment and the relationships between variables (Huber, 1991). In the network, the nodes Def (Deaths), TomA (Axial Tomography), and TipP (Palliative Treatments) show strong relationships (thicker lines). This indicates that the performance of these variables is highly influenced by their interdependence. The contingency here lies in how the environment (e.g., sex, births) affects the need for specific tomography tests or treatments.

From the perspective of Resource Dependence Theory, organizations rely on key resources, and these relationships are reflected in the network (Dodgson, 1993). Central nodes such as TipP and TomA appear to act as critical resources that depend on inputs like origin (Ori) and deaths (Def). The thickness of the connections may reflect the intensity of this dependence within the healthcare system.

Regarding Social Network Theory, the dynamics are based on the relationships between nodes (Cohen & Levinthal, 1990). In this case, Def and TipP appear to function as high-centrality nodes, acting as key mediators between other variables. This makes them influencers within the organizational network. Weaker connections, such as those of Nac (Births), suggest a lower influence on the main dynamics.

With respect to Institutional Theory, the observed patterns may represent structured practices within an institutional system (such as the healthcare system) (Barney, 1991). Nodes with greater centrality, such as TipP, may reflect standardized practices (e.g., palliative treatments) that legitimize the system in a changing environment.

From a Knowledge Management perspective, the interactions between nodes reflect flows of information (Freeman & Reed, 1983). In particular, the relationship between TomL (Linear Tomography), TipP, and TomA indicates a flow of medical knowledge and diagnostic decisions. This suggests that the network is configured to facilitate evidence-based clinical decision-making.

Relationship between critical variables

In the presented network, the nodes Def (Deaths), TipP (Palliative Treatments), and TomA (Axial Tomography) show strong connections, suggesting that these variables are closely related in terms of clinical decisions and health outcomes. According to studies such as Guan et al. (2020), COVID-19 mortality rates were significantly associated with clinical variables such as the initial severity of cases and access to specialized treatments, aligning with the strong connection observed between Def, TipP, and TomA. Research by Grasselli et al. (2020) has also highlighted that the use of advanced diagnostic tools, such as tomography, was critical in determining disease progression and planning treatments.

Importance of origin (Ori) and sex (Sex)

In the identified network, the node Ori (Origin) has important connections with variables such as Def, indicating possible inequalities related to place of origin. Likewise, Sex (Sex) is linked, although less intensely, with relevant nodes. Studies by Chowdhury et al. (2021) have emphasized that factors such as geographic origin and unequal access to healthcare services influenced mortality rates and treatment quality. The research by Richardson et al. (2020) also identified significant differences in mortality and morbidity rates according to sex, although these differences may vary depending on regional context and available resources.

Births and their tenuous connection

In the observed graph, Nac (Births) has weaker connections with the other variables, suggesting that its impact is marginal compared to critical variables such as Def (Deaths) or TipP (Palliative Treatments). The literature, such as the work of Kotlar et al. (2021), suggests that although births were not directly related to the progression of COVID-19, access to maternal and child health services was indirectly affected by the overload of healthcare systems.

This network analysis aligns with patterns reported in studies on health systems during the pandemic, highlighting the interdependence between clinical and sociodemographic factors. The findings could be used to prioritize resources and organizational strategies in future health emergencies. If you need detailed references or specific examples, I can provide them.

Conclusion

The objective of the present work within the state of the art lies in establishing an explanatory neural network of organizational learning focused on diagnostic tests for COVID-19-associated diseases during the period from 2020 to 2022. The results suggest the prevalence of nodes associated with decision-making and strategies linked to institutionalism and knowledge management. Accordingly, it is recommended to extend the analysis to include outcomes reported in the state of the art. In this regard, incorporating variables observed in other studies will allow anticipating the organizational performance of the healthcare system in the face of future pandemics.

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