Magna Scientia UCEVA

Volumen 4 - Nº 2 - 2024 http://revistas.uceva.edu.co/index.php/magnascientia/issue/archive e-ISSN:2805-6701 ISSN:2805-6884

Institución de Educación Superior
UCEVA®
Unidad Central del Valle del Cauca

Magna Scientia UCEVA

http://revistas.uceva.edu.co/index.php/magnascientia

COMITÉ EDITORIAL

COMITÉ CIENTÍFICO

Gestor Editorial:
Hermes Emilio Martínez Barrios

E-mail:
revistasuceva@uceva.edu.co
hermesmartinez@unicesar.edu.co

Página Web:
http://revistas.uceva.edu.co/index.php/magnascientia

Editorial:
Unidad Central del Valle del Cauca-UCEVA

Sometimiento de Manuscritos:
http://revistas.uceva.edu.co/index.php/MagnaScientiaU/about/submissions

Declaración de periodicidad

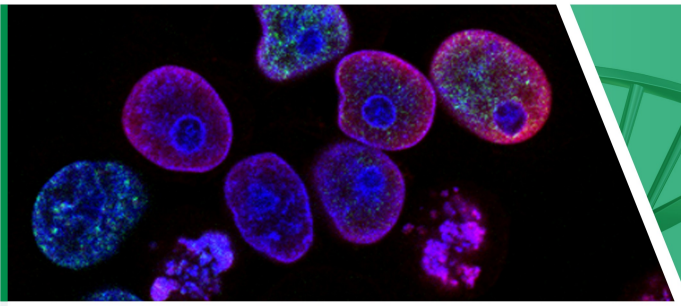
Magna Scientia UCEVA [ISSN 2805-6701 (en línea) 2805- 6884 (impreso)] es publicada semestralmente en acceso abierto y gratuito. Entidad editora: Unidad Central del Valle del Cauca. Carrera 27 A No. 48 -144 Kilómetro 1 Salida Sur. Tuluá, Valle del Cauca-Colombia, Suramérica. Código Postal: 763022.

Institución de Educación Superior UCEVA Unidad Central del Valle del Cauca

Enfoque y Alcance

Magna Scientia UCEVA es una publicación científica que propende por el acceso libre, gratuito e inmediato a todos sus contenidos, con circulación internacional, financiada y editada por la Unidad Central del Valle del Cauca. Su misión es difundir conocimiento científico de alta calidad sobre las ciencias de la vida y la salud, de acuerdo con el foco temático definido en la Misión de Sabios de MinCiencias. Publica artículos originales e inéditos con enfoque disciplinar y multidisciplinar en diversos aspectos relacionados con las ciencias de la vida y la salud en el mundo.

Magna Scientia UCEVA



Magna Scientia UCEVA
http://revistas.uceva.edu.co/index.php/magnascientia

GUÍA ABREVIADA PARA AUTORES

Tipos de artículos y estructuras

1. Tipos de artículos

1.1. Artículo de investigación científica (original e inédito)

Es un documento que presenta, de manera detallada, los resultados originales de proyectos terminados de investigación. La estructura generalmente utilizada contiene los siguientes apartados: introducción; materiales y métodos; resultados; discusión y conclusiones. Se invita a la comunidad de autores a que presenten la sección de "Resultados" y "Discusión" por separado, que no las presenten unidas, esto con el fin de facilitar el proceso de revisión editorial. Está compuesto por 3.500-5.000 palabras y máximo 30 referencias bibliográficas.

1.2. Artículo de reflexión

Es un documento que presenta resultados de investigación desde una perspectiva analítica, interpretativa o crítica del autor, sobre un tema específico, recurriendo a fuentes originales. Está compuesto por 3.000-5.000 palabras y máximo 30 referencias bibliográficas.

1.3. Artículo de revisión (invitación directa del Comité Editorial)

Es un documento resultado de una búsqueda de información donde se analizan, sistematizan e integran los resultados de investigaciones publicadas o no publicadas, sobre un campo en ciencia o tecnología, con el fin de dar cuenta de los avances y las tendencias de desarrollo. Consta de un rango de 8.000-12.000 palabras y de 60-80 referencias bibliográficas.

1.4. Reporte de caso

Documento que presenta los resultados de un estudio sobre una situación particular con el fin de dar a conocer las experiencias técnicas y metodológicas consideradas en un caso específico. Consta de mínimo 2.000 palabras y mínimo 20 referencias bibliográficas.

Los trabajos deben ser inéditos y sometidos exclusivamente a consideración de Magna Scientia UCEVA; se exceptúa la reproducción, con permiso del autor o editor, de artículos de especial interés en repositorios pre-print oficiales.

2. Estructura para todos los artículos

Título: en español-inglés (entre 10 y 20 palabras).

Resumen: en español-inglés (entre 150 y 250 palabras). Es una forma de divulgar el contenido del artículo de forma precisa y sintetizar el objetivo principal, metodologías, hallazgos, resultados y conclusiones relevantes de la investigación.

Palabras claves: en español-inglés (entre 3 y 5 palabras); cada palabra debe estar separada por un (;) en orden alfabético. Ejemplo: didáctica; evaluación; habilidad docente; metodología docente; profesores universitarios.

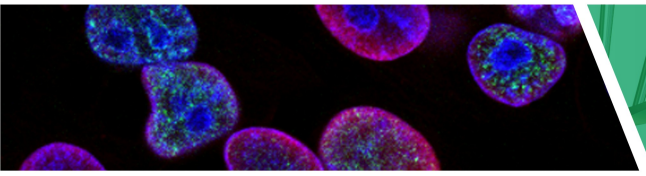
Introducción: en esta sección, se debe describir el problema planteado de investigación, su relevancia e impacto, los objetivos principales de la investigación, algunos referentes teóricos e indicadores de la problemática, la metodología elegida y los resultados principales. La introducción debe proporcionar un contexto claro y conciso, destacando la importancia del estudio y su contribución al campo de conocimiento.

Metodología-materiales y métodos: es fundamental describir la estructura lógica del proceso de investigación enmarcado en los objetivos planteados. Se debe revisar la metodología de investigación aplicada, detallando ampliamente si se trata de un método nuevo. Si se han utilizado varios métodos, es necesario integrar las referencias pertinentes y proporcionar una breve explicación de cada uno.

La descripción de la metodología debe integrar de forma secuencial los objetivos de la investigación, las variables de análisis definidas y, si aplica al estudio, el diseño experimental. Esta descripción debe ser ordenada y seguir una secuencia cronológica, detallando cómo se organizaron y analizaron los datos del estudio. Además, se debe incluir la sistematización de la información, los métodos estadísticos aplicados y el software utilizado.

Resultados: en este aparte, se debe describir la organización de los datos representativos, como el uso de gráficos de gran impacto comunicativo, autoexplicativo, figuras, tablas, mapas, cuadros... Análisis de la información con técnicas cuantitativas o cualitativas, utilizando las medidas que se adapten de acuerdo al estudio realizado. Datos/hallazgos representativos de acuerdo al problema de investigación formulado.

No dejar tablas o gráficas sin una correcta explicación del contenido de cada una. La redacción debe ser concisa, breve y con secuencia lógica que demuestre el impacto



del estudio, a qué se llegó, qué significa y el cumplimiento de los objetivos. Se deben describir de manera amplia y general los experimentos, pruebas, experiencias, intervenciones, indagaciones, sin repetir los detalles de la metodología. Los resultados deben redactarse en pasado.

Discusión: en esta sección, se deben interpretar los resultados y contextualizar los objetivos principales en relación con el conocimiento científico global y las conclusiones derivadas. Los datos, la información y los nuevos aportes generados en los resultados deben ser analizados, comparados e interpretados, haciendo énfasis en los hallazgos novedosos del estudio.

Se deben explicar y contextualizar los resultados para lograr una mejor comprensión del estudio y para dar a conocer el conocimiento nuevo y útil obtenido. Es importante organizar y resaltar los resultados principales que generan conclusiones relevantes según el análisis realizado. En la discusión, los resultados se exponen sin recapitular cifras y textos ya presentados en la sección de resultados.

Conclusiones: las conclusiones deben responder al problema planteado y a la pregunta de investigación, derivándose de la interpretación y análisis de los resultados en función de los objetivos formulados en el estudio. Estas deben ir más allá de los resultados, analizando e interpretando los datos hallados y avanzando en el conocimiento del problema. No se deben repetir los datos de los resultados ni los analizados en la discusión. Es fundamental ser conciso y riguroso en las deducciones y en los nuevos aportes.

Referencias bibliográficas: todos los textos citados en el manuscrito. Máximo 30 referencias bibliográficas. Usar normas Vancouver.

Recibido: revisado: aceptación.

3. Presentación

Normas Vancouver.
Tipo de letra: Arial 11
Interlineado: 1,5
Texto: justificado
Sin sangría en el cuerpo del texto
Con sangría francesa en las referencias

4. Cómo citar

Las citas deben hacerse bajo las normas Vancouver.

4.1. Cita directa corta: este tipo de citas se escriben textualmente y su extensión es menor a 40 palabras. La cita debe incorporarse al texto y escribirse entre comillas dobles.

Ejemplo: Sin embargo, los pacientes con dolor e historia de trastorno por uso de sustancias, "lo más frecuente es que se encuentren subdosificados"[1], más que el uso inadecuado de dichas sustancias.

4.2. Cita directa larga: citas textuales que superan en extensión las 40 palabras. Deben ir en un párrafo aparte, sin comillas y con sangría aplicada a todo el párrafo, con su respectivo superíndice.

4.3. Cita indirecta o parafraseo: este tipo de citas no son textuales, pues reescriben el texto para explicarlo o interpretarlo con otras palabras, o bien, para realizar un resumen de estas. Estas citas se incorporan al texto, sin comillas. El superíndice de referencia se incluye después del apellido del autor y antes de la cita. Si no se menciona al autor, va al final de la paráfrasis. Ejemplos:

Cuando se menciona al autor:

Certeau[2], en su texto La invención de lo cotidiano, reflexiona sobre la ciudad argumentando que es un lugar de transformaciones y de apropiaciones, objeto de intervenciones, pero sujeto sin cesar enriquecido con nuevos atributos: es al mismo tiempo la maquinaria y el héroe de la Modernidad.

Sin mencionar al autor:

Valledupar se conoce como capital del Departamento del Cesar, situada en la margen occidental del río Guatapuri, al pie de las últimas estribaciones de la Sierra Nevada de Santa Marta. El casco urbano tiene una longitud norte-sur de 8,3 km y este-oeste de 6,2 km. La ciudad se ha desarrollado desde sus inicios hacia el occidente, el norte y el sur; hacia el oriente ha crecido muy poco, por la limitante de ser una ciudad ribereña limitada y bañada por el río. Este territorio cuenta con una densidad poblacional moderada derivada de una mancha urbana relativamente grande; su casco urbano fue diseñado y construido en forma concéntrica, es decir, su punto de partida fue su centro (centros de negocio y comercio), y creció hacia las periferias[3].

4.4. Cita de varios autores

Cita con dos autores:

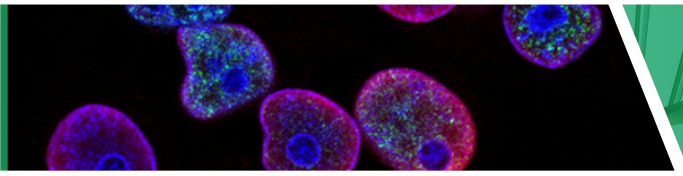
En estas citas se menciona el apellido de ambos autores.

Ejemplo:

Este problema intrínseco se acentúa si algunos grupos de habitantes llegan a compartir versiones divergentes del universo simbólico. Berger y Luckmann[2], por otra parte, también aseguran…

Cita con más de dos autores:

Cuando un libro o artículo tiene más de dos autores, se cita al primero de ellos seguido de la abreviatura "et al.", en letra cursiva.



5. Referencias

En Vancouver solo se incluyen las referencias que han sido citadas en el cuerpo del texto, es decir, no se tienen en cuenta las fuentes consultadas, solo las citadas.

Tampoco se referencian las comunicaciones personales, tales como entrevistas, correos, cartas, clases magistrales y demás.

5.1. Numeración consecutiva de las referencias

El estilo Vancouver establece que las referencias, que se incluyen al final del documento, deben numerarse según el orden consecutivo en el cual se mencionan por primera vez en el texto, y para ello se deben tener en cuenta los superíndices de las citas.

Por ejemplo:

> Un aspecto que no puede faltar a la hora de construir saberes, es la motivación, donde puede ser intrínseca, que es propia del individuo; es la capacidad que tiene de controlarse y auto reforzarse, se asume que cuando se disfruta de una tarea, las emociones activan los procesos cognitivos; por ejemplo, la satisfacción de realizar un cuidado y tomar decisiones donde todo es movido por el efecto motivacional de las emociones y la extrínseca es propia y realizada por el docente [5], de esta forma las actuaciones de los docentes deben de estar inmersas en los procesos curriculares de los planes de estudio y así demostrar que el estudiante represente el rol de activo en su aprendizaje [6,7].

En la superficie en el cuerpo del documento

[5] García Bacete F, Doménech Betoret F. Motivación, aprendizaje y rendimiento escolar. Reflexiones pedagógicas. *Motivación y Emoción* 2002;1:24–36. https://www3.uji.es/~betoret/Instruccion/Aprendizaje%20y%20DPersonalidad/Lecturas/Articulo%20Motivacion%20Aprendizaje%20y%20Rto%20Escolar.pdf

[6] Gargallo López B, Suárez Rodríguez J, Garfella Esteban P, Fernández March A. El cuestionario CEMEDEPU. Un instrumento para la evaluación de la metodología docente y evaluativa de los profesores universitarios. *Estudios Sobre Educación* 2011;21:9–40 https://revistas.unav.edu/index.php/estudios-sobre-educacion/article/view/4397/3783

[7] Marín Méndez D. Psicología del aprendizaje universitario. La formación en competencias. Juan Ignacio Pozo y M. del Puy Pérez Echeverría (coordinadores) Madrid, Ediciones Morata, 2009. *Perfiles Educativos* 2011;33:201–6. http://www.scielo.org.mx/pdf/peredu/v33n131/v33n131a13.pdf

Orden numérico en las referencias

5.2. Estructura de las referencias

En general, las referencias están constituidas por seis datos obligatorios:

- Número de la referencia
- Autor(es)
- Título
- Editor, compilador, traductor (cuando aplique)
- Lugar, editorial y fecha de publicación
- Y en el caso de los artículos de revista o libros digitales, la URL o el DOI también es información de obligatoria inserción

Ejemplos:

[1]. Day, R. Cómo escribir y publicar trabajos científicos. Washington: Organización Panamericana de la Salud; 1996.

[2]. Malacara, D. Óptica básica [Internet]. México: Fondo de Cultura Económica; 2015. Disponible en: https://bit.ly/2XiQDPo

Nota: si la referencia posee más de seis autores, se mencionan los primeros seis seguido de la expresión “et al.”.

Nota: en caso de que el autor sea corporativo o institucional, se escribe el nombre completo, no las siglas.

5.3. Citación de libros

5.3.1. Libros con autor o autores

Número de la referencia. Autor(es). Título. Edición. Lugar de publicación: Editorial; Año de publicación.

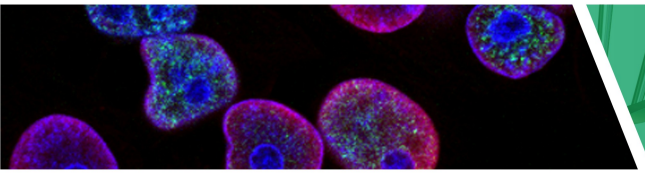
> [1]. Martínez, M., Briones, R., Cortés, J. Metodología de la investigación para el área de la salud. 2.ª ed. México: McGraw-Hill; 2020.

5.3.2. Libros con autor corporativo

Número de la referencia. Autor corporativo. Título. Edición. Lugar de publicación: Editorial; Año de publicación.

> [1]. Ministerio de Salud y Protección Social. Atención de Colombia a la pandemia de la COVID-19. Bogotá: MinSalud; 2020.

5.3.3. Capítulo de un libro (cuando el autor del



capítulo es el autor del libro)

Número de la referencia. Autor(es). Título del libro. Edición. Lugar de publicación: Editorial; Fecha. Número del capítulo, título del capítulo; páginas.

[1]. Hamill, E. Tanatología y bioética. México: Corinter; 2009. Capítulo 16, "Nuevas área de trabajo de tanatología y bioética"; 245-258.

5.3.4. Capítulo de un libro (cuando el autor del capítulo no es el autor del libro)

Número de la referencia. Autor(es) de la contribución. Título de la contribución. En: Autor(es) de la obra. Título de la obra. Edición. Lugar de publicación: Editorial; Año de publicación. Páginas.

[1]. Ciacedo, J., Vélez, J. "Sepsis en el embarazo y el puerperio". En: Hurtado, L. Salud integral de la mujer. Medellín: Editorial Universidad Pontificia Bolivariana; 2021. 127-144.

5.3.5. Libro en línea

Número de la referencia. Autor(es). Título. [Internet]. Volumen. Edición. Lugar de publicación: Editorial; Año de publicación. [Fecha de actualización; Fecha de consulta]. Disponible en: URL o DOI.

[1]. López Pi, Velarde M. Generalidades de psicología y salud. [Internet]. Medellín: Editorial Universidad Pontificia Bolivariana; 2021. [Citado el 25 de abril de 2023]. Disponible en: http://hdl.handle.net/20.500.11912/8225

5.4. Citación de artículo de revista

Número de la referencia. Autor(es). Título del artículo. Título de la revista. Año; Volumen(Número): páginas.

Martínez, H. E., Manjarrez, L. P. "Metodología de investigación en la salud". Anales de Pediatría. 2018; 78(1): 11-18.

5.4.1. Artículo en línea

Número de la referencia. Autor(es). Título del artículo. Título de la revista. [Internet]. Año [Fecha de consulta]; Volumen(Número): Páginas. Disponible en: URL o DOI.

[1]. Lara, D., Machuca, L., Duque, M., Daza, L., Torrez, L., Remolina, D. "El acetaminofén". Medicina UPB. [Internet]. 2023 [Consultado el 18 de mayo de 2024]; 42(1): 30-36. https://revistas.upb.edu.co/index.php/medicina/article/view/1345

5.4. Tesis

Número de la referencia. Autor. Título de la tesis. [Tesis de (indicar grado y área)]. Lugar de publicación: Universidad; Año.

[1] Ropero, V., Carolina, M. El papel del enfermero. [Trabajo de grado en enfermería]. Valledupar: Universidad Popular del Cesar; 2018.

5.5. Documento legal

Número de la referencia. Título de la ley, decreto o reglamento. Número de ley, decreto o reglamento. Nombre del boletín oficial, número del boletín (fecha publicación). Disponible en: URL.

[1]. Ley de Igualdad de oportunidades para las personas con discapacidad. Ley 7600. Diario Oficial La Gaceta, 102 (29 de mayo de 1996). Disponible en: https://www.tse.go.cr/pdf/normativa/leyigualdaddeoportunidades.pdf

Nota: cada autor debe enviar un resumen de su hoja de vida con los siguientes datos:

- Nombre completo
- Correo electrónico
- Afiliación
- Títulos académicos
- ORCID
- Una fotografía tipo documento con alta definición

Magna Scientia UCEVA
Volumen 3 Número 1,2023
http://revistas.uceva.edu.co/index.php/magnascientia

Contenido

Editorial

Medicina

Ciencias ambientales

Temas generales

Institución de Educación Superior UCEVA Unidad Central del Valle del Cauca

Magna Scientia UCEVA
Vol. 4, N°2 (2024) - P.P. 9-11
ISSN:2805-6884 e-ISSN:2805-6701
DOI:10.54502/msuceva.v4n2a1

Editorial

Integrating Knowledge for a Sustainable Future

Integrando saberes para un futuro sostenible

Juan Carlos Urriago Fontal, PhD.

Unidad Central del Valle del Cauca

The ***Magna Sciencia UCEVA*** Journal, published by the Central Unit of Valle del Cauca, is pleased to present its Volume 4, Number 2 for the year 2024. This edition is a clear manifestation of our firm commitment to open access and the dissemination of high-quality scientific research in the field of Life and Health Sciences. In a world where scientific information is crucial for social and economic development, the journal acts as a bridge between researchers and the academic community, ensuring that the most relevant and novel findings are accessible to all.

In line with the guidelines established by the Mission of Wise Men of the Ministry of Sciences, we encourage both disciplinary and multidisciplinary approaches that cover a broad spectrum of global knowledge. This diversity of perspectives is essential to address the complex challenges we face in the field of health and life sciences. Through this edition, readers will find articles that not only present original research results, but also invite reflection and debate on current and emerging issues.

In addition, the journal promotes collaboration between researchers, institutions and professionals from various areas, which contributes to enriching scientific dialogue and generating innovative solutions. We are convinced that shared knowledge is a driving force for progress, and therefore we will continue to work tirelessly to strengthen access and visibility of scientific production in our region and beyond.

In this issue, we have gathered six valuable contributions that address a variety of topics, mostly related to health. The articles include research on seasonal vaccines and their impact on community health, an analysis of the historical evolution of pharmacy, the use of medicinal plants in the indigenous community, the relationship between the work environment and employee satisfaction, the quality of patient care, as well as a study on the quality of water in the river and the labor guarantees of seafarers. Each of these works is distinguished by its high level of academic excellence and methodological rigor, contributing significantly to the advancement of scientific knowledge and presenting practical implications in various disciplines.

The articles included in this edition are:

The first one, entitled “Seasonal vaccines and community health: a literature review”, examines seasonal vaccination programs, such as influenza and COVID-19 vaccines, highlighting their crucial role in public health. The challenges faced by these programs, such as vaccine hesitancy and accessibility issues, are analyzed, emphasizing the need to implement policies that improve access and promote education about vaccination.

The second contribution, entitled “Historical evolution of pharmacy: from traditional remedies to modern pharmaceutical products”, offers a comprehensive analysis of how pharmacy has evolved throughout history, transforming from ancestral

practices based on natural remedies to the development of sophisticated pharmaceutical products based on scientific evidence. This study not only highlights the fundamental role of historical figures such as Dioskurides, known for his work "De Materia Medica", which documented the use of medicinal plants in antiquity, and Galen, whose theories and practices in Greek medicine laid the foundations for modern pharmacology, but also examines how the translation and dissemination of ancient medical texts contributed to the formation of pharmacy as a scientific discipline.

The research places special emphasis on the historical and sociocultural context in which these figures operated, as well as on the technological and scientific advances that facilitated the transition to modern pharmacology. Changes in the perception of health and illness, the professionalization of pharmacists, and the establishment of regulations that marked the beginning of industrial drug production are analyzed. This historical overview not only illustrates the evolution of pharmacy, but also provides a critical view on how traditional knowledge has been systematized and, in many cases, forgotten in the process of modernization.

The third article, meanwhile, focuses on the richness of the diversity of medicinal plants in the Kankuama Indigenous Community, a study that highlights the intrinsic relationship between ancestral knowledge and the use of biodiversity. This research not only documents the different species of plants used by the community, but also explores their therapeutic applications, the cultural practices that surround them and the deep traditional knowledge that has been transmitted from generation to generation.

In addition, the article addresses a critical issue: the factors that threaten the conservation of this cultural and botanical heritage. Threats such as habitat loss, globalization, and the lack of recognition and support for traditional knowledge are identified, which puts at risk both biodiversity and the continuity of medicinal practices that have been fundamental to the health and well-being of the community. Thus, the study not only highlights the importance of preserving this ancestral knowledge, but also advocates for policies that promote sustainability and respect for cultural traditions, as well as the need to integrate this knowledge into the field of modern health.

In the fourth investigation, a cross-sectional study is presented that comprehensively examines the interrelationship between the working conditions of nurses, their level of job satisfaction, and the quality of care provided to patients. This study underlines the importance of comprehensively addressing the existing problems in the work environment of nurses, since it has been shown that an adequate and satisfactory work environment not only promotes the well-being of employees, but also translates into higher quality care for patients. As working conditions are optimized, nursing staff motivation and engagement levels are expected to increase, which directly impacts patient experience and health outcomes. This finding highlights the need for policies that prioritize the health and well-being of healthcare professionals, in order to create a virtuous cycle that benefits both workers and patients.

In the fifth research, titled "Improving water quality prediction in the Yamuna River, Delhi," an innovative hybrid methodology is proposed that significantly improves the ability to predict the water quality index in this important river. By overcoming the limitations of traditional models, this new methodology has managed to achieve a remarkable accuracy of 95.2%. This advance is crucial not only for the protection of the aquatic ecosystem, but also for the sustainable management of water resources in a context of increasing pressure on these resources due to urbanization and industrialization. Accurate water quality prediction allows managers to implement more effective monitoring and control measures, thereby ensuring public health and environmental preservation in the region.

Finally, in the sixth and final contribution, the labor guarantees of seafarers in Colombia are analyzed, in a study entitled "Labor guarantees of seafarers in Colombia: analysis of legal application." This article focuses on the implementation of the ILO Convention on maritime labor of 2006, evaluating its impact on the working conditions of sea workers

in Colombia. A detailed examination of the current regulations and their adaptation to the current reality of the maritime sector is carried out, identifying the gaps between the law and its practical application. This analysis is essential to understand how labor guarantees can be strengthened, thus promoting a safer and fairer work environment for seafarers, who face unique challenges in their profession. Furthermore, the importance of updating and complying with regulations is emphasized to ensure that the rights of these workers are effectively protected, contributing to their well-being and labor dignity.

This edition of the Magna Sciencia UCEVA Journal reaffirms its commitment to the dissemination of high-quality scientific research, providing the academic and professional community with valuable contributions that not only expand knowledge in various disciplines, but also have a significant impact in key areas such as public health, occupational safety, and sustainable development. Each article addresses contemporary issues from rigorous and applicable approaches, contributing to scientific progress and improving the quality of life in different environments.

Through this publication, the Central Unit of Valle del Cauca reinforces its mission to promote and disseminate the results of research at a national and international level, consolidating its role as a reference in the generation of knowledge that transcends borders and provides innovative solutions to current global challenges. In this way, it reaffirms not only its commitment to academic excellence, but also the responsibility to contribute to social well-being and comprehensive development in multiple areas.

We invite our readers to immerse themselves in this edition, where research is at the service of the community and knowledge is transformed into a tool for progress and social well-being.

Magna Scientia UCEVA
Vol. 4 N° 2 (2024) - P.P. 12-19
ISSN:2805-6884 e-ISSN:2805-6701
DOI:10.54502/msuceva.v2n2a2

Original Research Articlew **Medicine**

Seasonal Vaccines and Community Health: A Literature Review

Vacunas estacionales y salud comunitaria: una revisión de la literatura

Abdullah Salim Alanazi – Ministry of National Guard Health Affairs, Saudi Arabia
Hind Zabn Alenazi – Ministry of National Guard Health Affairs, Saudi Arabia
Noor Falah Alenezi – Ministry of National Guard Health Affairs, Saudi Arabia

Open Access

Key words:
Seasonal Vaccines, Community Health, Literature Review

Palabras clave:
Vacunas estacionales, salud comunitaria, revisión de literatura

Abstract

Seasonal vaccination programs, including influenza and COVID-19 vaccines, are crucial to safeguard public health by decreasing both the incidence and severity of various infectious diseases. This literature review aims to provide a comprehensive overview of the impact and effectiveness of seasonal vaccines on community health. Through a comprehensive analysis of recent studies, the efficacy of these vaccines in reducing disease transmission, improving health outcomes, and alleviating the burden on health care systems is assessed.

The results obtained indicate that seasonal vaccines are essential to prevent disease outbreaks, especially in high-risk groups, which in turn contributes to a significant decrease in hospitalization and mortality rates. In addition, the review addresses the obstacles and challenges faced by vaccination programs, such as vaccine hesitancy, accessibility issues, and the spread of misinformation. These barriers can hinder the effective implementation of vaccination campaigns and, consequently, affect public health.

Furthermore, the policy implications of this review highlight the urgent need to improve access to vaccines, combat vaccine hesitancy through targeted education programs, and foster collaboration between community and healthcare organizations to increase vaccination rates. Ultimately, this analysis highlights the significant benefits that seasonal vaccination programs bring, not only in terms of promoting healthier communities, but also in mitigating the costs associated with healthcare. By prioritizing these efforts, we can move toward a future in which infectious diseases are more manageable and public health is more robust.

Resumen

Los programas de vacunación estacional, que incluyen las vacunas contra la gripe y la COVID-19, son cruciales para salvaguardar la salud pública al disminuir tanto la incidencia como la gravedad de diversas enfermedades infecciosas. Esta revisión bibliográfica tiene como propósito ofrecer una visión comprensiva sobre el impacto y la efectividad de las vacunas estacionales en la salud de las comunidades. Mediante un análisis exhaustivo de estudios recientes, se evalúa la eficacia de estas vacunas para reducir la transmisión de enfermedades, mejorar los resultados sanitarios y aliviar la carga que recae sobre los sistemas de atención médica.

Los resultados obtenidos indican que las vacunas estacionales son fundamentales para prevenir brotes de enfermedades, especialmente en grupos de alto riesgo, lo que a su vez contribuye a una disminución significativa en las tasas de hospitalización y mortalidad. Además, la revisión aborda los obstáculos y desafíos que enfrentan los programas de vacunación, tales como la reticencia hacia las vacunas, problemas relacionados con la accesibilidad y la propagación de desinformación. Estas barreras pueden dificultar la implementación efectiva de las campañas de vacunación y, en consecuencia, afectar la salud pública.

Asimismo, las implicaciones políticas derivadas de esta revisión resaltan la necesidad urgente de mejorar el acceso a las vacunas, combatir la reticencia mediante programas de educación dirigidos y fomentar la colaboración entre organizaciones comunitarias y de atención médica para incrementar las tasas de vacunación. En última instancia, este análisis destaca los beneficios significativos que aportan los programas de vacunación estacional, no solo en términos de promover comunidades más saludables, sino también en la mitigación de los costos asociados con la atención médica. Al priorizar estos esfuerzos, se puede avanzar hacia un futuro en el que las enfermedades infecciosas sean más controlables y la salud pública, más robusta.

1. Introduction:

The role played by seasonal vaccines in protecting public health has gained considerable relevance in recent years, especially in the face of challenges such as annual outbreaks of influenza and other pathogens that tend to circulate at specific times of the year. This situation contributes to the reduction of prevalence, transmission and severity of various diseases in communities [1]. Public health systems, through preventive measures such as vaccination, seek to minimize hospitalizations, reduce costs associated with medical care and protect the most vulnerable populations, such as the elderly, immunosuppressed individuals and health workers [2].

In the context of influenza, for example, the World Health Organization (WHO) estimates that annual vaccination can prevent thousands of deaths and hospitalizations globally. Research has shown that influenza vaccines can reduce the risk of severe disease by approximately 40–60% among vaccinated individuals, varying by season and the match between vaccine strains and the population receiving the vaccine [3]. Likewise, seasonal COVID-19 booster vaccines have been instrumental in reducing the number of cases, hospitalizations, and deaths, especially in the face of the emergence of new variants and the decline in immunity over time [4].

Despite the clear benefits they offer, seasonal vaccination programs frequently face obstacles that limit their reach and effectiveness. Vaccine hesitancy, motivated by misinformation, cultural beliefs, and concerns about potential side effects, represents a significant barrier to achieving optimal vaccination

rates. In addition, accessibility issues, including logistical difficulties in rural areas and financial constraints, prevent certain population groups from receiving vaccines in a timely manner [5]

This literature review aims to provide a comprehensive understanding of the impact and effectiveness of seasonal vaccines on community health. By analyzing recent studies, this review will describe the benefits associated with seasonal vaccination programs, examine factors that influence vaccine effectiveness, and explore barriers to vaccine uptake. In addition, policy recommendations aimed at improving vaccine accessibility and uptake will be discussed, with the goal of promoting healthier communities through effective vaccination strategies.

2. Methodology–Materials and Methods:

In this literature review, a systematic approach was adopted to identify, select, and analyze studies relevant to the impact and efficacy of seasonal vaccines on community health. The search for literature was conducted across major academic databases, including PubMed, Web of Science, and Google Scholar, covering a wide range of studies on seasonal vaccines like influenza and COVID-19 boosters. The search terms used were a combination of key phrases such as “seasonal vaccines,” “community health impact,” “vaccine efficacy,” and “vaccination programs,” aimed at gathering comprehensive and up-to-date literature on the topic.

Inclusion criteria were established to refine the selection process, focusing on studies published between 2016 and 2024 to ensure the data’s relevance. Studies were included if they addressed seasonal vaccines’ effectiveness in reducing disease incidence, improving public health outcomes, or influencing healthcare systems. Excluded were articles that primarily discussed non-seasonal vaccines, lacked measurable health outcomes, or were outside the scope of community health impacts. The selection process was complemented by a careful review of abstracts and full texts to confirm that studies met the research objective and contributed valuable insights.

Data extraction focused on gathering quantitative and qualitative information from each selected study. Quantitative data included metrics such as vaccine efficacy rates, reductions in hospitalization and mortality rates, and specific outcomes for high-risk groups like the elderly or individuals with comorbidities. Qualitative data emphasized insights into community- specific health improvements and barriers to vaccine uptake, including vaccine hesitancy and logistical challenges.

The methodology employed ensures that this review synthesizes findings from a diverse range of studies, providing a thorough analysis of how seasonal vaccines influence community health. This structured approach allows for a balanced exploration of the benefits of seasonal vaccines, the factors affecting their effectiveness, and the challenges that limit their impact on public health.

3. Resultados:

The findings from the reviewed studies emphasize the crucial role of seasonal vaccines in enhancing community health through disease prevention, reducing healthcare burdens, and improving overall public health outcomes. This section presents an analysis of the key impacts and efficacy of seasonal vaccines, particularly in relation to influenza, COVID-19, and other seasonal illnesses. The studies reviewed also highlight the challenges to achieving optimal vaccination rates, including barriers related to vaccine accessibility and hesitancy.

Seasonal vaccination programs have been shown to significantly reduce the incidence of infectious diseases in populations. For influenza, studies consistently demonstrate that vaccination reduces the risk of infection by approximately 40-60%, depending on the season and the vaccine’s match with circulating strains. A study by Iuliano et al. (2018) found that the influenza vaccine is responsible for preventing millions of cases of influenza each year, with significant reductions in hospitalizations due to influenza-related complications, particularly in high-risk populations (elderly, young children, and those with chronic conditions), Simi-

larly, COVID-19 vaccination programs have proven effective in reducing both the transmission and severity of the disease. Data from Andrews et al. (2022) suggest that the introduction of COVID-19 vaccines resulted in an 80-90% reduction in severe outcomes, including hospitalization and death. These findings underscore the importance of maintaining seasonal booster programs, particularly as new variants of concern emerge.

Table 1: Impact of Seasonal Vaccines on Disease Incidence and Transmission

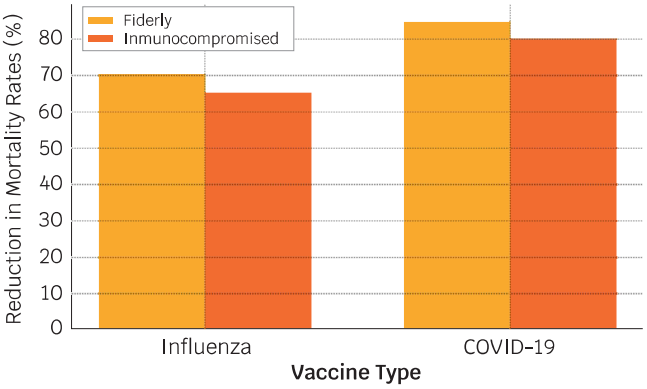
Vaccine Type	Disease Prevented	Vaccine Efficacy (%)	Reduction in Hospitalizations (%)	Population Impacted
Influenza	Influenza A & B	40-60%	40-70%	Elderly, children, highrisk groups
COVID-19	SARS-CoV-2	80-90%	80-90%	General population, elderly, immunocompromised
Pneumococcal	Pneumonia	60-70%	50-60%	Elderly, immunocompromised

Source: Data synthesized from multiple studies including Iuliano et al., 2018; Andrews et al., 2022.

A major benefit of seasonal vaccines is their ability to reduce mortality and improve health outcomes, especially among vulnerable groups. Influenza vaccination has been shown to reduce the mortality rate associated with influenza-related complications. According to Grohskopf et al. (2020), flu vaccines can reduce the risk of influenza-related deaths by up to 70% in high-risk groups such as the elderly. Similarly, COVID-19 vaccines have been instrumental in lowering mortality rates during the pandemic. A study by Iuliano et al. (2020) revealed that COVID-19 vaccination reduced mortality rates by approximately 85%, with higher efficacy noted in the elderly population [2, 3].

The mortality-reducing effect of these vaccines is not only beneficial in terms of public health but also alleviates the strain on healthcare systems, allowing resources to be directed toward other areas of care. The reduced burden on hospitals due to lower case severity and hospitalizations has significant economic implications as well, as it lessens the overall cost to the healthcare system

Figure 1: Reduction in Mortality Rates Following Seasonal Vaccination *(showing the reduction percentages for both elderly and immunocompromised populations across influenza and COVID-19 vaccinations. This visualization highlights the significant impact of seasonal vaccines in lowering mortality rates among vulnerable groups).*



Seasonal vaccines have demonstrated substantial benefits in reducing healthcare system burdens. One of the key outcomes of vaccination campaigns is the reduction in healthcare utilization, which includes fewer hospital admissions, outpatient

visits, and fewer cases of severe disease. For example, influenza vaccination has been associated with a 40-60% reduction in flu-related hospitalizations [3]. Similarly, the introduction of COVID-19 vaccines resulted in a dramatic decrease in ICU admissions and long-term care admissions due to COVID-19-related complications [4].

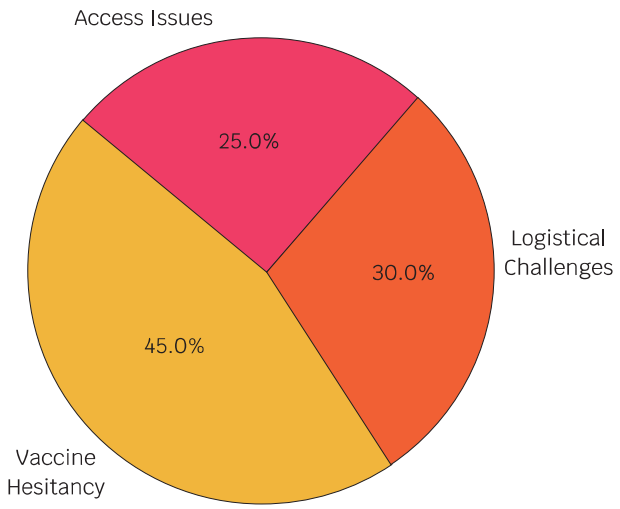
A report by the World Health Organization (WHO) in 2020 highlighted that influenza vaccination programs, if implemented universally, could reduce healthcare costs by billions of dollars each year, largely through the prevention of hospitalizations and outpatient visits. This economic benefit is most pronounced in settings with limited healthcare resources, where the avoidance of hospital congestion is critical.

Table 2: Healthcare System Benefits of Seasonal Vaccination

Vaccine Type	Hospitalization Reduction (%)	ICU Admission Reduction (%)	Healthcare Cost Reduction
Influenza	40-60%	30-50%	$1-3 billion/year (USA)
COVID-19	80-90%	70-80%	$10-20 billion/year (USA)
Pneumococcal	50-60%	40-60%	$500 million/year (USA)

Source: Data adapted from Iuliano et al., 2018; Grohskopf et al., 2020; WHO, 2020.

Figure 2: Barriers to Seasonal Vaccine Uptake (*represented as a pie chart showing the distribution of key barriers. Vaccine hesitancy accounts for the largest portion, followed by logistical challenges and access issues. This visual highlights the need to address each barrier to improve vaccination rates*).



Despite the benefits of seasonal vaccines, several barriers hinder the achievement of optimal vaccination coverage. Vaccine hesitancy remains one of the largest challenges, driven by misinformation, mistrust of healthcare systems, and concerns about vaccine safety. A study by Dubé et al. (2018) found that vaccine hesitancy is particularly pronounced in certain populations, including young adults and marginalized communities, where skepticism regarding vaccine safety and efficacy is high [5].

Additionally, logistical barriers such as limited access to healthcare facilities, high vaccine costs, and challenges in reaching rural or underserved populations further complicate the widespread adoption of seasonal vaccines. Strategies to overcome these barriers include improving public health messaging, increasing vaccine access through mobile clinics, and providing financial incentives for vaccination.

The impact of seasonal vaccines on community health is not uniform across all population groups. For instance, vaccination efforts are generally more

successful in urban populations with easy access to healthcare services. In contrast, rural areas often experience lower vaccination rates due to fewer healthcare resources and logistical challenges in vaccine distribution [2]. Studies also show that specific communities, such as the elderly and individuals with chronic health conditions, benefit the most from seasonal vaccines, with higher reductions in morbidity and mortality observed in these groups.

Targeted interventions are needed to address these disparities. Community-based vaccination campaigns, education on vaccine safety, and efforts to improve healthcare infrastructure in underserved areas can help mitigate these differences.

4. Discussion

The findings of this review underscore the essential role of seasonal vaccines in enhancing community health, preventing disease, and alleviating healthcare burdens. Seasonal vaccination programs, especially for influenza and COVID-19, have proven effective in reducing disease incidence, mortality, and healthcare system strain. However, the impact of these programs is often limited by several barriers, including vaccine hesitancy, logistical challenges, and access issues. In this discussion, we examine the variability in vaccine efficacy, the broader community health implications, the barriers to vaccine uptake, and policy recommendations to enhance vaccination programs.

Seasonal vaccines demonstrate substantial benefits, but their efficacy can vary depending on several factors, such as the match between the vaccine and circulating strains, population characteristics, and timing of vaccine administration. For instance, influenza vaccines have shown variable efficacy due to annual strain changes, with estimates of effectiveness ranging from 40-60% in preventing infection [3]. Similarly, COVID-19 vaccines, while highly effective, require regular updates or boosters to address evolving variants. This variability highlights the ongoing need for vaccine research, surveillance, and adaptation to ensure optimal effectiveness.

Furthermore, certain populations, including the elderly and immunocompromised individuals, may exhibit lower vaccine efficacy due to age-related immune decline or underlying health conditions [2]. These factors necessitate tailored approaches, such as high- dose vaccines or booster programs, to ensure that high-risk populations receive adequate protection. Addressing these challenges requires continuous monitoring of vaccine efficacy and targeted interventions to support those most vulnerable to infectious diseases.

Seasonal vaccines significantly contribute to the health and well-being of communities, reducing the spread of infectious diseases and protecting vulnerable populations. The benefits of herd immunity are particularly pronounced, as higher vaccination rates in a community can indirectly protect individuals who are unable to receive vaccines, such as those with specific medical contraindications. This indirect protection is critical for maintaining community health, as it reduces overall disease transmission and minimizes outbreaks.

The economic benefits of seasonal vaccination programs are also substantial, as they reduce healthcare costs associated with disease outbreaks, hospitalizations, and long-term health complications. By preventing severe illness and minimizing healthcare utilization, seasonal vaccines relieve pressure on healthcare systems, especially during peak seasons. This impact is even more significant in communities with limited healthcare resources, where the ability to prevent disease outbreaks can prevent system overload and enable more efficient use of healthcare facilities.

While seasonal vaccines provide considerable health benefits, several barriers prevent optimal uptake and impact. Vaccine hesitancy, for instance, is a major issue influenced by a variety of factors, including cultural beliefs, mistrust of healthcare institutions, and concerns about vaccine safety. The spread of misinformation on social media platforms exacerbates this issue, leading to misconceptions about vaccine efficacy and safety [5]. Found that vaccine hesitancy is more prevalent in certain demographics, particularly among young adults and individuals in marginalized communities.

In addition to vaccine hesitancy, logistical challenges and access issues limit the reach of seasonal vacci-

nation programs. Rural communities, for example, often face difficulties in accessing vaccination services due to geographic distance, lack of healthcare infrastructure, and limited transportation options. High vaccine costs can also pose a barrier, particularly in low-income populations. These challenges highlight the need for targeted strategies to improve vaccine distribution and accessibility.

To maximize the benefits of seasonal vaccination programs, policy interventions must address the barriers limiting vaccine uptake and expand efforts to enhance accessibility and acceptance. Improving public education on vaccine safety and efficacy is a crucial step in reducing vaccine hesitancy. Health authorities and community leaders should collaborate to deliver clear, science-based information and counteract misinformation, especially in high-hesitancy regions. Tailored communication strategies that resonate with specific cultural and demographic groups are essential for building trust and increasing vaccine acceptance.

Increasing access to vaccines through mobile clinics, community health centers, and workplace vaccination programs can help overcome logistical barriers. Financial incentives, such as subsidies or insurance coverage for vaccines, can also alleviate cost-related barriers, making it easier for low-income individuals to receive vaccines. In underserved communities, partnerships between healthcare providers, local organizations, and governmental agencies can help improve vaccine distribution and accessibility.

Another recommendation is to strengthen disease surveillance and data-sharing systems to monitor vaccine effectiveness and quickly adapt vaccination strategies to emerging strains or new public health challenges. Enhanced surveillance would allow for real-time adjustments to vaccination programs, ensuring that communities receive the most effective protection possible. Investments in data infrastructure would not only improve vaccine efficacy but also aid in identifying areas with low coverage rates, allowing for targeted interventions.

Further research is necessary to address several gaps identified in the literature. Studies examining the long-term efficacy of seasonal vaccines, the impact of booster programs on community health, and the effectiveness of tailored vaccination approaches in high-risk populations would be valuable for refining vaccination strategies. Additionally, research into interventions for reducing vaccine hesitancy, especially in diverse demographic groups, would support more effective public health campaigns.

5. Conclusion

This review highlights the significant role of seasonal vaccines in enhancing community health by reducing the incidence and severity of infectious diseases, lowering healthcare utilization, and ultimately saving lives. Vaccination programs for seasonal illnesses, such as influenza and COVID-19, have demonstrated marked benefits in protecting vulnerable populations, including the elderly, immunocompromised individuals, and healthcare workers, who are at heightened risk of severe illness. The findings confirm that seasonal vaccines reduce hospitalizations, alleviate healthcare burdens, and offer substantial economic benefits by preventing widespread outbreaks and minimizing healthcare costs.

However, despite these clear advantages, several barriers prevent optimal vaccine uptake, such as vaccine hesitancy, logistical challenges, and accessibility issues in underserved communities. These barriers limit the potential impact of seasonal vaccines and underscore the need for targeted strategies to improve access and acceptance. Addressing vaccine hesitancy through transparent, science-based communication, improving accessibility with mobile and community-based vaccination services, and enhancing affordability through subsidies or insurance coverage are essential steps toward maximizing the reach and efficacy of vaccination programs.

To ensure that seasonal vaccines achieve their full potential, policy makers and public health officials must collaborate on strengthening disease surveillance and data-sharing systems. Such improvements would enable the timely adaptation of vaccination programs to address new strains and emerging public health challenges, thus sustaining high levels of community protection.

In conclusion, seasonal vaccination programs are a cornerstone of preventive healthcare, providing invaluable protection for individuals and communities. By addressing existing barriers and optimizing delivery and access, seasonal vaccines can continue to play a transformative role in promoting healthier, more resilient populations and a more robust healthcare system.

Referencia

[1] Caini, S., Andrade, W., Badur, S., Balmaseda, A., Barakat, A., Bella, A., ... & Yu, H. (2018). "Temporal patterns of influenza B in tropical and temperate countries". *Vaccine*, 36(45), 6872-6879. DOI: 10.1016/j.vaccine.2018.06.052

[2] Grohskopf, L. A., Alyanak, E., Broder, K. R., Blanton, L. H., Fry, A. M., Jernigan, D. B. & Atmar, R. L. (2020). "Prevention and control of seasonal influenza with vaccines: Recommendations of the Advisory Committee on Immunization Practices-United States, 2020-21 influenza season". *MMWR Recommendations and Reports*, 69(8), 1-24. DOI: 10.15585/mmwr.rr6908a1

[3] Iuliano, A. D., Roguski, K. M., Chang, H. H., Muscatello, D. J., Palekar, R., Tempia, S., ... & Bresee, J. S. (2018). "Estimates of global seasonal influenza-associated respiratory mortality: a modelling study". *The Lancet*, 391(10127), 1285-1300. DOI: 10.1016/j.vaccine.2018.01.015

[4] Andrews, N., Tessier, E., Stowe, J., Gower, C., Kirsebom, F., Simmons, R., ... & Ramsay, M. E. (2022). "Duration of Protection against Mild and Severe Disease by Covid-19 Vaccines". *New England Journal of Medicine*, 386(4), 340-350. DOI: 10.1056/NEJMoa2119451

[5] Dubé, E., Laberge, C., Guay, M., Bramadat, P., Roy, R. & Bettinger, J. A. (2018). "Vaccine hesitancy: An overview". *Vaccine*, 36(15), 1825-1831. DOI: 10.1016/j.vaccine.2017.09.039

[6] Betsch, C., Böhm, R. & Chapman, G. B. (2015). "Using behavioral insights to increase vaccination policy effectiveness". *Policy Insights from the Behavioral and Brain Sciences*, 2(1), 61-73. DOI: 10.11

Publication consent:

The authors read and approved the final manuscript.

Conflict of interest:

The authors declare that they have no conflict of interest. This document only reflects their views and not those of the institution to which they belong.

Abdullah Salim Alanazi

Ministry of National Guard Health Affairs, Saudi Arabia

Hind zabn Alenazi

Ministry of National Guard Health Affairs, Saudi Arabia

Noor Falah Alenezi

Ministry of National Guard Health Affairs, Saudi Arabia

Magna Scientia UCEVA Vol.
4 N° 2 (2024) P.P. 20–31
ISSN:2805-6884e-ISSN:2805-6701
DOI: 10.54502/msuceva.v4n2a3

A journey through the evolution of pharmacy: from traditional remedies to modern pharmaceuticals.

Un viaje a través de la evolución de la farmacia: de los remedio tradicionales a los productos farmacéuticos modernos

Mohamed Ali Alshahrani – National Guard Health Affairs, Riyadh, Saudi Arabia
Abdulrahman Alshamrani – National Guard Health Affairs, Riyadh, Saudi Arabia
Majed Nahar Alahmadi Alharbi – National Guard Health Affairs, Riyadh, Saudi Arabia

Open Access

Key words:
Pharmacy, evolution of pharmacy, traditional remedies, modern pharmaceuticals.

Palabras clave:
Actividad física, aislamiento, alimentación, autocuidado, coronavirus.

Abstract

The evolution of pharmacy has been a continuous process dating back to the beginning of civilization, where the use of medicinal herbs marked the beginning of this discipline [1]. The general objective of this study is to analyze the transition from traditional remedies to modern pharmaceutical products, highlighting key milestones in their development. The method employed is based on a historical review of pharmaceutical practices since ancient civilizations, emphasizing the contributions of figures such as Dioskurides and Galen, as well as the crucial role of the translation of Greek texts into Arabic during the Middle Ages. The results indicate that pharmacy was consolidated as a science through the preservation and dissemination of knowledge in the Arab world, which allowed its subsequent translation into Latin and its influence during the Renaissance. This process culminated in the invention of the printing press, which facilitated the distribution of pharmaceutical works and marked a milestone in the professionalization of the field, evidenced by the formal separation between physicians and pharmacists in 1240.

Resumen

La evolución de la farmacia ha sido un proceso continuo que se remonta a los inicios de la civilización, donde el uso de hierbas medicinales marcó el comienzo de esta disciplina [1]. El objetivo general de este estudio es analizar la transición de los remedios tradicionales a los productos farmacéuticos modernos, destacando los hitos clave en su desarrollo. El método empleado se basa en una revisión histórica de las prácticas farmacéuticas desde las civilizaciones antiguas, destacando las aportaciones de figuras como Dioskurides y Galeno, así como el papel crucial de la traducción de textos griegos al árabe durante la Edad Media. Los resultados indican que la farmacia se consolidó como ciencia gracias a la conservación y difusión de conocimientos en el mundo árabe, lo que permitió su posterior traducción al latín y su influencia durante el Renacimiento. Este proceso culminó con la invención de la imprenta, que facilitó la distribución de obras farmacéuticas y marcó un hito en la profesionalización del campo, evidenciada por la separación formal entre médicos y farmacéuticos en 1240.

1. Introduction:

The evolution of pharmacy is a fascinating journey that dates back to the origins of humanity, where the collection of medicinal herbs was used to alleviate various health problems. This ancestral knowledge, initially transmitted verbally and through drawings, laid the foundations for what would later become a formalized and scientific practice. Iconic figures of antiquity, such as Dioskurides, who catalogued around 600 medicines from plants, and Galen, who developed pharmaceutical preparation methods, were key in the systematization of pharmacological knowledge. Throughout history, pharmaceutical knowledge experienced a remarkable renaissance thanks to the work of Arab scholars, who preserved and translated Greek texts, becoming the guardians of pharmaceutical science during the Middle Ages. This process not only facilitated the dissemination of knowledge, but also led to a clear separation between doctors and pharmacists in the 13th century, a milestone that cemented the foundations of modern pharmaceutical practice. The advent of the Renaissance and the invention of the printing press played a crucial role in the dissemination of this knowledge, leading to a remarkable evolution towards more sophisticated and scientifically sound pharmaceutical products today. Thus, this historical analysis not only reveals significant milestones in the trajectory of pharmacy, but also highlights the transition from traditional remedies to contemporary pharmaceutical science [1].

2. Methodology–Materials and Methods:

The methodological approach of this research focuses on an interpretative and qualitative perspective, which seeks an in-depth understanding of the phenomena studied. This research adopts a historical approach, analysing various documentary sources including written records from ancient civilisations such as the Sumerians, Babylonians and Egyptians. In addition, the works of classical authors such as Dioskurides and Galen, who have left a significant legacy in the field of pharmacology, are reviewed. It also examines the influence of the Arab world in the preservation and dissemination of pharmaceutical knowledge, a crucial aspect that has allowed the wisdom of these civilisations to endure over time. Attention is also paid to the impact of relevant historical events, such as the invention of the printing press and the Renaissance, which played a decisive role in the transformation and development of pharmacy as a discipline. These events not only facilitated the circulation of knowledge, but also promoted a change in the perception and practice of medicine and pharmacology, laying the foundations for significant advances in these fields.

3. Results and discussion

Traditional Healing Practices

Pharmacy, or the preparation and dispensing of medicinal drugs, has existed in various forms throughout human history. Archaeological findings in ancient Mesopotamia indicate that the Sumerians had developed herbal remedies as early as 3000 B.C. [2]. Similar evidence of traditional healing practices exists in ancient China, India, and Egypt. Over time, these traditional remedies formed the basis of modern pharmaceuticals, which grew out of the scientific examination and refinement of herbal cures. In general, traditional remedies consist of crushed herbs mixed with other substances, such as oils, fats, honey, salt, or alcohol, to enhance the delivery or effectiveness of the medicinal ingredients. In addition to these herbal preparations, many ancient civilisations recognised the importance of elemental and chemical remedies. For example, the Sumerians treated ailments using mineral salts, and the Egyptians developed elaborate pharmaceutical practices using natural minerals such as natron and malachite. These practices persisted in the ancient civilisations that succeeded them, most notably those of Greece and Rome. Throughout the Middle Ages, the pharmaceutical knowledge of these classical societies was preserved by Islamic cultures, until it was reintroduced to Western Europe during the Renaissance. Together with the recovery of classical learning, this laid the foundation for the rise of modern chemistry and the scientific approach to elemental and chemical remedies.

Herbal Medicine

The primitive man's curiosity to find out the edible and poisonous things in nature resulted in the discovery of herbal drugs. His habit of trial and error to pick up the eatables found in nature developed a sense of observation. The first step towards the evolution of science was observation. His observation must have been directed towards the effect of particular edible things on health. Likewise, he must have been observing the effect of some poisonous things on health. Observations on the feelings of ailing people must have induced him to think of the things which could restore good health to the diseased. This thinking capacity paved the way to the discovery of herbal drugs [1].

The development of drug information is considered as one of the significant steps towards the evolution of pharmacy. The effort to maintain the knowledge of drug information discovered by chance or observation might have induced some people to note it down in writing. The effort to maintain knowledge of medicinal herbs and its practical application has led to the writing of a large number of recipes books, while the aspiration to classify medicinal herbs has led to a large number of herbaria. A herbaria is a collection of preserved plant specimens along with details on their habit, habitat, location, and date of collection. The knowledge and description of plants in herbaria made it accessible to many and herbarium specimens assisted in the development of taxonomy. Descriptions of plants in herbaria and later in incunabula lead to the development of pharmacognosy.

Acupuncture and Acupressure

Acupuncture involves the insertion of needles into specific body points while acupressure uses manual finger pressure. Both are based on an energy network system called meridians affecting the flow of qi or vital energy. Contemporary research has largely focused on acupuncture and recently included laser acupuncture. Acupressure is also called acupoint massage or shiatsu in Japan. A combination of acupuncture and continuous finger pressure was found to improve hand functions of stroke patients. Acupressure was effective in postoperative patients with nausea as well as in relieving anxiety, depression, and sleep disorders in pregnant women. Laser acupoint stimulation was effective against hemorrhoid pain during pregnancy [3].

Acupuncture and moxibustion are two important components of traditional Chinese medicine. The former involves the stimulation of specific body points with needles while the latter involves the application of heat to specific body points through burning moxa. Acupuncture and moxibustion therapy has been used for thousands of years and more than one hundred million people receive acupuncture worldwide annually. Acupuncture and moxibustion manipulate meridians, qi, and blood to treat diseases. Research into acupuncture and moxibustion is important for further developing this medical tool and ensuring its safe use. Acupuncture and moxibustion historical literature clarifies the origin and development of acupuncture [4].

Homeopathy

Homeopathy belongs to the category of "alternative medicine." A multitude of therapeutic methods—some fairly extravagant—fall under this label, which enjoys great popularity with patients [5]. For supporters and exponents of these alternative methods, mainstream medicine is dogmatic, inflexible, and blinded by commercial interests—allegedly at the expense of the health of humanity. For critics, such as scientists and proponents of evidence-based medicine, alternative medicine is nonsense or worse: dangerous quackery. The controversy surrounding alternative medicine is rooted in a basic pattern of human behavior, learning, and understanding. Until the scientific method slowly began to spread in the seventeenth century, all therapeutic methods—from magic to folk remedies and to herbalism practiced by monks—were based on concepts on which the scientific method could not have any impact [6]. The emergence of scientific medicine from curiosity about the functioning of the organism and from the desire to have an effective remedy was accompanied by the disappearance of many pre-scientific methods applied by lay people. However, some therapeutic methods—including homeopathy—survived this dawning epoch of science and stuck to the pre-scientific notions.

The Birth of Modern Pharmacy

The roots of pharmacy started to the very beginning of human civilization, when people collected various medicinal herbs. Anatomy and the knowledge of therapeutic properties of herbs had ancient Egyptians who applied it in the practice, but this knowledge was well-kept secret [1]. The scientific foundations of pharmacy were set up in the antique period by the books of Dioskurides and Galen. Dioskurides was a physician in the army of Nero, and he wrote five books of Materia Medica. Dioskurides' book represented a review of knowledge in botany and pharmacology at that time. It was translated into many languages and had a great influence on the development of pharmacy. Galen was a physician in a gladiator hospital in Pergamum, and later he became a physician to the emperors in Rome. Galen's books were a review of his own experience in the preparation of medicinal drugs. Based on his knowledge, he introduced many forms of drugs that are still in use today. At the very beginning, drugs were prepared by the same people who prescribed them. In 1240, for the first time in history, came the separation of doctors and pharmacists, and thus the beginning of the pharmacy as an independent profession. At that time, in Munchen, the first pharmacy called "Brotze" was opened. The apothecary was also a doctor and the pharmacy was part of the hospital. In 1251, in Florence, the first pharmaceutical legislation was passed. In the beginning of the 13th century, the first pharmacy was opened in Paris. At that time, Paris was the world center of education with the oldest university. Everything that was done in Paris was a model for imitating other cities.

Emergence of Apothecaries

The roots of pharmacy started with people collecting medicinal herbs to alleviate health problems. Knowledge of plants with healing powers was passed from generation to generation. The scientific foundations of pharmacy were set up in the antique period by the books of Dioskurides and Galen. Dioskurides wrote a five-volume book «On the Materia Medica» about 60 plants that could treat many health problems. This book, along with Galen's writings, was used as a textbook for pharmacology for the following 1500 years. In the Middle Ages, monks cherished the knowledge of medicinal herbs. They cultivated healing plants in monastery gardens and prepared remedies from them. The first written recipes for remedies were found in a monastic book from the 9th century. In the 11th century, the first public gardens of healing herbs were opened in Italy. In the 12th century, the knowledge of healing herbs was brought to the West by the Moors. In medieval towns, apothecaries (from Greek: apotheca-storage) began to open, which sold medicinal herbs and prepared remedies from them. In 1240, the separation of doctors and pharmacists occurred. The law forbade doctors to prepare remedies and ordered them to take ready-made remedies from apothecaries. This law initiated numerous lawsuits between doctors and apothecaries over the right to prepare remedies. The first pharmacy opened in the early 13th century. Pharmacies spread throughout Europe in the 14th century [1].

Scientific Revolution and the Age of Enlightenment

With the renaissance and exploration of the world, new raw materials arrived in Europe from Asian countries. The development of pharmacy was most evident in Germany, where apothecaries had their own guilds. The first pharmacopoeia in Europe was printed in Nuremberg in 1542. The curative and poisonous properties of plants were widely researched during the 16th century, and the foundations of medicinal botany were set. Studies of many European plants were carried out, with herbalists describing their medicinal use [1].

With the scientific revolution and the age of enlightenment, pharmacy became an independent science. A discovery of the greatest importance for pharmacy was the invention of the microscope, which opened a new phase in the study of plants and plant extracts. A special place in the history of pharmacy in the 18th century belongs to the Liburnia region. There were many apothecaries in Zadar, Šibenik, and Trogir, who had their own pharmacy and pharmacopoeia. The Liburnia region was rich in medicinal plants, and many of them are still used today. The accession of the Liburnia region to the Habsburg Monarchy led to significant changes in the development of pharmacy.

Key Milestones in Pharmaceutical Development

Throughout history, public health has always been an imperative issue for society. The earliest records of health care providers around 4000 years ago, were physicians employed by rulers, who treated nobles and royalty. As societies evolved, so did the need for more organized health care systems. The foundation of countries' health care systems came with the establishment of hospitals. The first hospitals were built in the Roman Empire, providing free health care to all citizens, which continued during the Middle Ages, when Christianity spread across Europe. With the establishment of monasteries, learned monks took up the role of physicians, caring for the sick and the needy. During the Middle Ages in Europe, a period of stagnation for science and medicine, the knowledge of the ancient Romans and Greeks was preserved in the Islamic world. The establishment of the first pharmacy in 754 in Baghdad, for the first time in history separation of doctors and pharmacists in 1240 in Moorish Spain, and the translation of Galen's and Dioskurides' works into Latin in the 12th century, significantly contributed to the Renaissance and shaping modern pharmacy [1].

Isolation of Active Ingredients

The isolation of active ingredients from plants was a decisive step in the scientific maturation of pharmacy. Sydenham's success with the isolation of quinine laid the foundation for modern pharmacy, although it took another 205 years until the success in isolating morphine [1]. It was not until the 19th century that pharmacy began to be viewed as an independent branch of medicine. It became more scientifically founded, i.e., the ether extraction of spigol, the active principle of cooper's mouse poison, in 1825, marks the beginning of modern pharmaceutical chemistry. It is very often forgotten that pharmacy pursued the basic scientific disciplines, i.e., pharmacy guilds employed naturalists, mathematicians and astronomers. With the great geographical discoveries in the 15th century new plants with drug potential were brought to Europe, i.e., cinchona bark–from which quinine for treating malaria was later isolated. Cordus' herbal with drug plants from newly discovered lands is an important turning point in the development of pharmacy and pharmaceutics. The first public pharmacy was opened in 1221 in Baghdad, the Arabic capital (in Europe the first one was opened in 1140 in Palermo). Under the Arabs pharmacy reaches its greatest development in the Middle Ages, i.e., Al-Razi–200 drug monographs–the forerunner of pharmacopoeia, discoverer of alcohol. The first pharmaceutical regulation was laid down in 1240 by Emperor Frederick II in the document "De arte venandi cum avibus", which prescribed that one apothecary from each cathedral town should be employed.

Industrialization of Pharmaceutical Production

During the 19th century, attempts at the industrialisation of the ayurvedic system were initiated though with varied levels of success in different regions. The growth of large-scale production units is indicative of this proto-industrialisation phase. Unlike in Bengal, where mass production was the result of the entry of capital, in some regions, such initiatives were taken by physicians themselves. This was especially the case of kerala, where, after 1846, the ashtavaidyas of vaidyaratnam family started large-scale production of ayurvedic drugs. With the introduction of steam engines in 1874, the Oushadhalayam became the first mechanised factory in the kerala region. Though initially the drugs were prepared exclusively for home consumption, from the 1880s the factory began to market drugs outside kerala — a trend which the Kottakkal ashtavaidyas followed later in 1908 [7]. In Travancore, from the 1870s, the East India Company patronised the establishment of ayurvedic factories. The first factory was established at Kanattukara by Madhava Sastrikal in 1820. By the end of the nineteenth century, a number of ayurvedic factories were opened at various places, the most well-known being the Oushadhalaya at Thiruvalla, established by Vaidyadhiraja Ramakrishna Panicker in 1886. The incapacity of the modern system to cater to the health care needs of a large number of villages helped the indigenous systems to remain significant. Still, the ayurvedic community did feel the necessity to modernise the systems. The experiments at kochi represented

some attempts to catch up with the modern professionalisation. At other levels, the experiments with large-scale production systems might be viewed as efforts to professionalise the ayurvedic system.

Regulation and Standardization of Pharmaceuticals

Quality standards for pharmaceuticals are essential to protect public health but are generally a recent development [8]. For new medicines developed by the pharmaceutical industry, necessary quality standards are created by the originating company and assessed by the Drug Regulatory Authority of each country where marketing approval is sought. Only in later years, as patents expire, is a public pharmacopoeia monograph likely to be issued for the drug, often developed in collaboration with the manufacturer. For herbal medicines that are claimed to be traditional, the burden of proof is almost the opposite. A public pharmacopoeia monograph may be sought for the product, but usually only after the drug has been the subject of legal challenge. In the interim, companies rely on the public's ignorance of what traditional medicine involves, and of the fact that pharmacopoeia standards provide only safeguards for certain basic medicinal substances. Finished products are now increasingly included in many national pharmacopoeia volumes and are finding their way into the International Pharmacopoeia published by WHO. Procedures to license and inspect pharmaceutical factories have existed since the nineteenth century, but standards have greatly developed since the introduction of Good Manufacturing Practice (GMP). The GMP concept arose after 1963 when the United States FDA first introduced regulations for manufacturing, packaging, and storing medicines in its code of Federal Regulations. Since then, extensive GMP rules have been developed [9]. The Council of Europe began work on its GMP publication in 1964, with a first edition in 1971. Currently this provides guidelines for medicinal products, herbal medicines, and radiopharmaceuticals. WHO's GMP guidelines were first published in 1968, with a revised edition in 1975, and were intended for developing countries. GMP guidelines are also available for herbal medicines, and radiopharmaceuticals. Specific GMP provisions have been published for blood products, biotechnological products, and starting materials for API manufacturing. The GMP principles have been in various legal instruments since 1978, culminating in 2003 in the new Directive on Good Manufacturing Practice, which repealed former directives.

Formation of Regulatory Bodies

The formation of regulatory bodies was an important development in the evolution of pharmacy. As pharmaceutical companies began to produce a wider variety of drugs, there was a need to ensure the safety and efficacy of these drugs. Regulatory bodies were established to set and enforce standards for drug development and testing. At first, these regulatory bodies were often seen as a hindrance to progress. Many pharmaceutical companies argued that regulations stifled innovation and made it difficult to bring new drugs to market. However, over time, most companies came to accept the need for regulations. Indeed, by the late twentieth century, many firms regarded the approval of a drug by regulatory authorities as a badge of quality [10]. The story of drug regulation is not only about the wider regulation of commerce and its attendant problems. It is also about efforts to protect public health and safety through the regulation of drugs and related practices. The central legislation that regulates the import, manufacture, distribution and sale of drugs and cosmetics in India is the Drugs and Cosmetics Act, 1940. This Act was enacted during the British Rule in India. Prior to 1940, there were two separate legislations, the Dangerous Drugs Act, 1930 and the Indian Purchase of Drugs Act, 1938, to regulate drugs [9].

Development of Drug Approval Processes

As the pharmaceutical industry grew, so did the need for regulation. In the United States, the Pure Food and Drug Act of 1906 prohibited the interstate commerce of misbranded and adulterated foods and drugs. The Food and Drug Administration (FDA), initially called the Bureau of Chemistry, was charged with enforcing the new law [11].). The 1906 Act gave the FDA the power to oversee drug labeling but not to evaluate the safety or effectiveness of drugs before they were marketed.

Given the public and private resources expended in developing new therapies, it is important to understand the safety and efficacy evidence required for the development and approval of pharmaceutical products. During the period 1980–2022, there was a substantial increase in the number of marketing approvals of new drug products, particularly biologics, with the majority being antineoplastic and immunomodulating agents. A significant proportion of the newly approved drugs were granted approval through designations and expedited review procedures, which do not require the demonstration of addressing unmet medical needs or providing superior patient benefits compared to existing marketed alternatives.

Throughout the study period, the legislative objective of bringing more drugs to the US market more quickly has been accomplished; however, the regulatory basis for the quality of evidence for approval has lessened and not kept pace with the speed of approvals. Whether the new drugs approved via expedited pathways have enhanced patient outcomes or provided therapeutic advantages for unmet medical needs once introduced into clinical practice warrants further research.

Pharmacy in the Digital Age

Pharmacy services have been typically conducted within local establishments where pharmacists and patients could interact face-to-face. Because of their knowledge of drugs and medicines, pharmacists have traditionally played a vital role in improving public health by providing patient education. For many decades, pharmacy services have focused on paper based procedures. The advent of the new digital technologies largely ignored in the pharmacy sector, and the services have not changed much until now. However, the growing need for digital transformation is clear evidence of the drive for a more effective, transparent, and patient-centered healthcare [12]. Breakthroughs in mobile communications, cloud computing, advanced analytics, and the Internet of Things (IoT) have reshaped various sectors of the economy; these breakthroughs in technology and the service delivery have also great potential to improve patient care and pharmacy services.

A number of critical forces are fueling this digital transformation in the pharmacy sector. The frustration because of a lack of transparency and inefficiency in the design, development, and manufacture of medications has been driving the demand for greater transparency and efficiency. Other key drivers include a growing desire for patient-centered services, cost- effectiveness, improved patient care, and appropriate service delivery. Digital technology is propelling a massive worldwide shift in the pharmacy sector undertaken with the intention of enhancing productivity, efficiency, and flexibility in the delivery of care activities. In the implementation of pharmacy services, digital technologies such as automation, computerization, and robotics have become critically essential for reducing costs and improving treatment delivery.

Telepharmacy and Online Pharmacies

The telepharmacy program at CVS Pharmacy allows a pharmacist to remotely counsel and verify prescriptions for up to ten locations, primarily serving underprivileged communities without on-site pharmacists. E-prescribing software enhances prescription accuracy, while digital health apps help patients manage conditions like asthma. CVS is investigating blockchain technology for supply chain management, ensuring data integrity and security. Moodle enables continuous learning, networking, and discussion topic creation, while CPD platforms offer training program access. Telehealth and online health services provide easier access to health services, particularly for the elderly or disabled. Similar opportunities in pharmacy practice include telepharmacy services, which use technology for remote pharmacist and patient communication. Online pharmacies, a digital transformation, allow patients to order prescription or over-the-counter medications online, requiring a valid prescription. In the US, millions rely on online pharmacies for medication orders. The COVID-19 pandemic accelerated this digital shift globally. Recent studies reveal increasing consumer trust in online medication purchases from licensed pharmacies. Despite concerns about illegal online pharmacies, consumer behavior is shifting towards these platforms as reliance increases, indicating that perceived benefits

outweigh perceived risks [12]. This change in behavior highlights the growing importance of credibility for online pharmacies, necessitating the implementation of quality assurance system elements, particularly for low and middle-income countries.

Artificial Intelligence in Drug Discovery

The discovery and development of new medications involve a wide variety of technologies and expertise, and are generally termed as drug discovery. It is one of the most time- consuming and expensive tasks, taking approximately 10–15 years and around 2.6 billion USD to discover one new drug [13]. Traditionally, the biological method- based high-throughput screening (HTS) is employed to search for new bioactive compounds from natural product libraries or synthetic chemical libraries. To obtain a drug candidate from a hit compound, a series of optimization processes are required to improve the hit compound's efficacy, selectivity, and druggability. The iterative design-synthesis-bioassay cycle generally involves experimental data annotation, which is time-consuming, and data mining, which is usually done by using quantitative structure–activity relationship (QSAR) models. However, the low-efficacy and high-cost characteristics of conventional HTS and optimization methods have become the hurdles of drug discovery. Therefore, the necessity of high-throughput biology and chemistry techniques and the development of new data analysis methods to deal with such a time-consuming and expensive task has long been emphasized.

With the ongoing technology advancement in biological data generation, biological data have rapidly accumulated in public databases. The availability of multi-omics data, such as genome sequencing data, transcriptome data, proteome data, metabolome data, and protein– ligand interaction data, has provided great opportunities for the implementation of data mining methods in pharmaceuticals. In addition, the revolution in high-performance computer hardware, such as graphic processing units (GPUs), cloud computing, and supercomputers, has enabled high-throughput molecular dynamics (MD) simulations on millions of biomolecules or chemical compounds, which can generate vast amounts of simulated data. Due to the "large data, low knowledge" characteristic in drug discovery, data- driven knowledge discovery methods are in great demand. Artificial intelligence (AI) techniques, particularly machine learning (ML) methods, are able to discover knowledge from data and have been employed in diverse disciplines, such as astronomy, geography, climate change, human health, and systems biology. The successful application of AI techniques, particularly to biological data analysis, has attracted the attention of the pharmaceutical industry. As a result, AI technique implementation into drug discovery processes, including compound activity prediction, ADMET liability prediction, and drug design, has recently become a hot topic in both academia and industry.

Challenges and Opportunities in Modern Pharmacy

The profession of pharmacy is at a crossroads, facing challenges and opportunities shaped by societal needs, technological advancements, and environmental concerns. Addressing public health needs, such as advocate for patients and preventive interventions, is crucial as diverse roles in employment emerge. The appropriate use, development, and evaluation of medicines A 2030 vision considers what society expects from pharmacy and ensures development paths for desirable roles. It aims to identify key challenges and opportunities for pharmacy's future, articulating needed developments to achieve a desired future and emphasizing public understanding of pharmacy contributions. Focusing on significant challenges and opportunities for the profession as a whole over the next 10 to 20 years, commentators from various countries examine local contexts of worldwide changes affecting pharmacy. These include population aging, healthcare access equality, progress towards universal health coverage, health data digitization and analytics, emerging health technologies, and efforts to mitigate climate change.

Drug Resistance and Antimicrobial Stewardship

As drug resistance grows, discovery of new antibiotics must be balanced with stewardship of existing drugs. Rediscovered routine use in non-human mammals

of a pre-antibiotic era ecological balance curbs resistance in wild and livestock populations. Feedbacks emerging from cross-species transmission of antibiotic resistant bacteria complicate pro-development conservation. Nanobacterial medicinals evolved on the coattails of antibiotics in historical pre-experimental medical practices shaped by global politics, religion, and culture. Modern medicine misconceives nanobacterial medicinals as placebos even as the care, rites, and symbols of efficacy surrounding their use induce patient responses comparable to antibiotics and antivirals. Conveys a microscopic view of the evolution of drug resistance to antibiotics and other antimicrobials and its ecological balance beyond current pro-development conservations [14, 15].

Multidrug resistance (MDR) in microorganisms continues to be a global concern, particularly for pathogenic bacteria resistant to antibiotics, threatening the efficacy of current treatments. To address this crisis, the World Health Organization has prioritized the discovery and development of new antimicrobial agents, urging pharmaceutical companies to create novel classes of antimicrobials. However, progress has stalled, leading to calls for alternative therapeutic approaches against MDR bacteria. A rational strategy to overcome antibiotic resistance is to simultaneously inhibit a bacterium's resistance mechanisms while employing antibiotics against it. This review discusses the significance, threats, and challenges posed by MDR microorganisms, as well as success stories of natural product-derived compounds from plants investigated as modulators of MDR in microorganisms, which may guide future research efforts [16].

Personalized Medicine and Pharmacogenomics

Recent advances in pharmacogenomics research have identified polymorphic genes crucial for drug absorption, distribution, metabolism, excretion, and target action. Several pharmacogenomic tests are clinically used in various therapeutic areas, particularly oncology. Since the initial report on germline cytochrome P450 2D6-gene variants and tamoxifen response, the US Food and Drug Administration incorporated recommendations into drug labeling for multiple drugs targeting 2D6, 2C19, and thiopurine methyltransferase genes. Technological advances in pharmacogenomic testing are expected to improve drug efficacy and safety and reduce costs. Still, many challenges remain before translating pharmacogenomics into routine clinical practice [17].

Pharmacogenomic-guided drug therapy is based on the premise that a large portion of interindividual variability in drug response is genetically determined. While many clinicians and researchers agree that a personalized therapy tailored to an individual's genetic profile is feasible and desirable, it remains some years away [18]. Similarly, the Wide-Screen Pharmacogenomic Assay strategy is unlikely to result in commercially available tests in the near future. Any group considering pharmacogenomic testing should first ensure that a thorough plan addresses the issues discussed.

Ethical Considerations in Pharmacy Practice

Pharmacists, as the most accessible healthcare providers, bear the ethical responsibility of upholding professionalism and protecting the rights of patients. Unfortunately, several barriers have been reported in the practice of professionalism in pharmacies. Many patients needing pharmaceutical care services have been left unattended, highlighting the gradual erosion of professionalism within the pharmacy profession. To tackle these challenges, a multidisciplinary outlook involving pharmacists, authorities, and society is imperative to resurrect the profession's commitment toward better health for humanity. Many pharmacists expressed belief in the necessity of patient-centered pharmaceutical care, although the prevailing business models impose obstacles to its implementation. As such, a professional need must be addressed here to stimulate patient-centered practices and gather perspectives on how to overcome barriers impeded by standard business models [19].

The typical day in a high-volume community pharmacy often reflects a disconnect between the ideal of patient-centered pharmaceutical care and the reality. Pharmacists find themselves in an ethically challenging position where the clear conflict between one's professional obligations and the

ability to fulfill them is frustrating and disappointing [20]. Employment conditions sometimes change priorities to accommodate corporate focus, resulting in a situation that is unethical and needs to be changed. The endangerment of patient safety and wellbeing due to the inherent design flaws in the business model of community pharmacies begs the question: how could community pharmacies be restructured so that patient safety is not compromised? A good first step is to illuminate the conflicts that arise when standard business models are applied in healthcare settings.

Patient Confidentiality and Data Protection

The community pharmacy is a widely used health care service and an important point of access for consumers to members of the pharmacy profession offering professional services. A feature of these services is the need for pharmacists to ask consumers for medical and personal information to meet their health care needs. While all health professionals need to obtain private personal details, community pharmacy's consumer perception of privacy is complicated. Traditionally, pharmacies resembled retail spaces and community pharmacies still compete with retailers selling non-prescription products. Different consumer expectations of privacy may present a challenge for the delivery of professional services in community pharmacies.

Pharmacy consumers are generally accepting of pharmacists' roles requiring the gathering of personal health information, and the need for this information is understood. Some consumers think that without privacy, pharmacists cannot provide the service adequately. However, there are differences between these consumers in their expectations of privacy. Factors influencing privacy expectations include consumer trust in the pharmacist, an increased comfort level in longer established professional relationships, and a desire for unobtrusive but effective privacy. Sensitivity of the medical and personal information being disclosed impacts on consumers' expectations of privacy. Reluctance to disclose medical and personal information impacts on pharmacists' ability to provide medication management services. Community pharmacists' professional judgement is important in achieving privacy [21].

Conflict of Interest and Industry Influence

The increasing conflict of interest issues in academia are viewed in the context of the pharmaceutical industry's influence on education, research, and healthcare. The emergence of ethical codes in response to conflicts of interest in the drug culture is explored, including measures that have been taken in medicinal chemistry. The pharmaceutical industry's influence over education, research, and the healthcare of the public due to conflicts of interest is highlighted. Since the 1990s, the industry's marketing has expanded dramatically, especially its promotion of drug treatments. The share of promotional spending directed towards non-physicians has tripled, and this is now dominated by expenditure on patient marketing. Considering the public's expectations, most marketing can only be construed as propaganda [22].

Countering this simply with education about marketing's tactics ignores the systemic corruption that persists despite good intentions. The credibility of educated professionals is used to back the industry's marketing and education. The discipline of pharmacy has deep, multifaceted connections with the industry, invasively involving both education and research but potentially obscuring with good intentions systemic problems that can't simply be resolved by good conduct and good character. The ethical codes that have developed in response to conflicts of interest involving the pharmaceutical industry are considered. The implementation, compliance, enforcement, and limits of self-regulation in both academic and professional pharmacy are focused on, as well as the inadequacy of such self-regulation without accountability that comes from outside the discipline. Most attention is directed toward the professional side of pharmacy, seeking a balance between the discipline's necessary connections to industry and the need to avoid systemic corruption.

4. Conclusion and Future Directions

The present review provides a historical perspective on the evolution of pharmacy from traditional

herbal remedies to modern pharmaceuticals. The dawn of civilization is marked with the discovery of fire and the use of medicinal plants by humankind. The Greek civilization had a significant contribution in bringing herbs and spices from the East. As the Greco-Roman civilization waned, the Byzantine Empire preserved and expanded knowledge of the ancients. The establishment of monasteries was important for the preservation of manuscripts and healing. Islam was crucial in the advancement of science and brought pharmacy at the forefront as al-sina'a al-nabatiyyah. The Renaissance sparked interest in antiquity with the revival of Greek and Roman texts and the establishment of universities. Pharmacy as a distinct profession began in Europe with the emergence of pharmacy guilds. The discovery of the New World opened new frontiers for exploration and trade. The profession again fell in the hands of quacks and charlatans. The establishment of the United States of America heralded numerous experiments in democracy including that of pharmacy. The 19th century witnessed transformation of pharmacy from an art to a science and the subsequent establishment of regulatory bodies. The advent of modern technology and research chemists freed medicine making from the apothecaries [23]. The present-day pharmaceutical industry evolved during the 20th century from crude extract natural products to modern designer drugs and is still undergoing rapid changes. The pharmaceutical industry is at a crossroad as it moves from the blockbuster drug discovery model to that of drug repositioning, polypharmacology, and personalized medicine. The future of pharmacy as a profession and industry would depend on the new paradigms followed in drug discovery and development.

Epidemiological studies have shown that with advancements in the healthcare systems, the focus of pharmacy is shifting from infectious diseases to lifestyle or chronic diseases. This is even more alarming in developing nations where despite great progress in GDP and healthcare spending, the quality of healthcare remains poor and the focus is mainly on the contagious diseases [24]. Underdeveloped nations are plagued with a myriad of problems like poverty, illiteracy, corruption, and social inequality. Rapid population growth and urbanization have further strained healthcare systems. Emerging economies like BRICS which are expected to be the economic powerhouse of the world in the 21st century currently face similar challenges with respect to pharmacy. The present mathematical modeling and trend analysis across nations strive to outline the past, present, and future global scenario of pharmacy in general and pharmaceutical industries in particular with respect to population, economy, epidemiology, and drug consumption. The projections would help policy makers to devise short-term strategies at national levels to tackle the emerging pharmaceutical problems.

References:

[1] Zunic, L., Skrbo, A. & Dobraca, A. (2017). *Historical Contribution of Pharmaceutics to Botany and Pharmacognosy Development*. ncbi.nlm.nih.gov

[2] Kuchta, K. & Cameron, S. (2021). *Tradition to Pathogenesis: A Novel Hypothesis for Elucidating the Pathogenesis of Diseases Based on the Traditional Use of Medicinal Plants*. ncbi.nlm.nih.gov

[3] Litscher, G. (2012). *Integrative Laser Medicine and High-Tech Acupuncture at the Medical University of Graz, Austria, Europe*. ncbi.nlm.nih.gov

[4] Run-Ming, Y. (1985). *The origin and development of chinese acupuncture and moxibustion*. ncbi.nlm.nih.gov

[5] Borkens, Y., Endruscheit, U. & W. Lübbers, C. (2023). *Homeopathy-A lively relic of the prescientific era*. ncbi.nlm.nih.gov

[6] Bellavite, P., Conforti, A., Piasere, V. & Ortolani, R. (2005). *Immunology and Homeopathy. 1. Historical Background*. ncbi.nlm.nih.gov

[7] S. Harilal, M. (2008). *Home to market : responses, resurgence and transformation of Ayurveda from 1830s to 1920*. [PDF]

[8] Dukes, G. (2006). *Ensuring Quality, Safety and Efficacy*. ncbi.nlm.nih.gov

[9] Imran, M., K. Najmi, A., F. Rashid, M., Tabrez, S. & A. Shah, M. (2013). *Clinical research regulation in India-history, development, initiatives, challenges and controversies: Still long way to go*. ncbi.nlm.nih.gov

[10] Abraham, J. (2002). *Making regulation responsive to commercial interests: streamlining drug industry watchdogs*. [PDF]

[11] Seoane-Vázquez, E., Rodríguez-Monguio, R. & H. Powers, J. (2024). *Analysis of US Food and Drug Administration new drug and biologic approvals, regulatory pathways, and review times, 1980-2022*. ncbi.nlm.nih.gov

[12] Almeman, A. (2024). *The digital transformation in pharmacy: embracing online platforms and the cosmeceutical paradigm shift*. ncbi.nlm.nih.gov

[13] Chen, W., Liu, X., Zhang, S. & Chen, S. (2023). *Artificial intelligence for drug discovery: Resources, methods, and applications*. ncbi.nlm.nih.gov

[14] Papadopoulos, V., Goldman, D., Wang, C., Keller, M. & Chen, S. (2021). *Looking Ahead to 2030: Survey of Evolving Needs in Pharmacy Education*. ncbi.nlm.nih.gov

[15] Woon, S. A. & Fisher, D. (2016). *Antimicrobial agents – optimising the ecological balance*. ncbi.nlm.nih.gov

[16] Zhai, X., Wu, G., Tao, X., Yang, S., Lv, L., Zhu, Y., Dong, D. & Xiang, H. (2023). *Success stories of natural product-derived compounds from plants as multidrug resistance modulators in microorganisms*. ncbi.nlm.nih.gov

[17] W. Francis Lam, Y. (2013). *Scientific Challenges and Implementation Barriers to Translation of Pharmacogenomics in Clinical Practice*. ncbi.nlm.nih.gov

[18] De León, J. (2009). *The Future (or Lack of Future) of Personalized Prescription in Psychiatry*. [PDF]

[19] Javadi, M., Ashrafi, N. & Salari, P. (2018). *Assessment of Pharmacists Experiences and Attitudes Toward Professionalism and its Challenges in Pharmacy Practice*. ncbi.nlm.nih.gov

[20] T. Owens, C. & Baergen, R. (2021). *Pharmacy Practice in High-Volume Community Settings: Barriers and Ethical Responsibilities*. ncbi.nlm.nih.gov

[21] Laetitia Hattingh, H., Emmerton, L., Ng Cheong Tin, P. & Green, C. (2015). *Utilization of community pharmacy space to enhance privacy: a qualitative study*. ncbi.nlm.nih.gov

[22] Wolpe, P. R., Sahl, M. & Howard, J. R. (2007). *Bioethical Issues in Medicinal Chemistry and Drug Treatment*. ncbi.nlm.nih.gov

[23] Tripathi, S., Shariq Ansari, M., Ahmad, K., Ali, H., Tabassum, R. & K Patel, D. (2018). *Scope of Pharmacist on Future Aspect*.

[24] Azadi, A., Hossein Morowvat, M., Sakhteman, A. & Mohagheghzadeh, A. (2015). *Pharmacy or PharmaNBIC: Thinking about 50 years ahead of pharmacy*.

Consentimiento de publicación

Los autores leyeron y aprobaron el manuscrito final.

Conflicto de interés

Los autores declaran no tener conflicto de interés. Este documento solo refleja sus puntos de vista y no el de la institución a la que pertenece.

Mohamed Ali Alshahrani

Technician pharmacy mohamed.7033@gmail.com, National Guard Health Affairs, Riyadh, Saudi Arabia.

Abdulrahman Alshamrani

Technician pharmacy, dehmee2009@hotmail.com National Guard Health Affairs, Riyadh, Saudi Arabia.

Majed Nahar Alahmadi Alharbi

Technician pharmacy, National Guard Health Affairs, Riyadh, Saudi Arabia

Magna Scientia UCEVA
Vol. 4 N° 2 (2024) - P.P. 32 - 44
ISSN:2805-6884 e-ISSN:2805-6701
DOI:10.54502/msuceva.v4n2a4

Original Research Articlew **Medicine**

Medicinal Plants in the Kankuama Indigenous Community: Traditional Knowledge and Sustainability

Plantas medicinales en la comunidad indígena Kankuama: conocimiento tradicional y sostenibilidad

Hermes Emilio Martínez Barrios – Universidad Popular del Cesar

Open Access

Key words:
Medicinal Plants, Kankuama Indigenous Community, Traditional Knowledge.

Palabras clave:
Plantas medicinales, comunidad indígena Kankuama, conocimiento tradicional.

Abstract

The Kankuama indigenous community has developed extensive knowledge about medicinal plants, essential to their traditional health system and identity. The research focused on identifying and documenting the variety of medicinal plants used by the Kankuamos, their applications and related traditional knowledge. The factors that threatened the conservation of this cultural and botanical heritage were explored, seeking to contribute to the preservation of their medicinal practices.

The methodology used was interpretive and qualitative, using the ethnographic method. The results revealed that the Kankuamos use more than 50 species of medicinal plants to treat various conditions, highlighting the transmission of their ancestral knowledge. The diversity of medicinal plants not only reflected the biological richness of the region, but also the link of the Kankuamos with their environment. The protection of this knowledge became vital. The conclusions point out the importance of integrating biodiversity conservation with the strengthening of indigenous knowledge to ensure the sustainability of their medicinal practices and cultural heritage.

Resumen

La comunidad indígena Kankuama ha desarrollado un extenso conocimiento sobre plantas medicinales, esenciales para su sistema de salud tradicional y su identidad. La investigación se centró en identificar y documentar la variedad de plantas medicinales utilizadas por los kankuamos, sus aplicaciones y el saber tradicional relacionado. Se exploraron los factores que amenazaban la conservación de este patrimonio cultural y botánico, buscando contribuir a la preservación de sus prácticas medicinales.

La metodología empleada fue interpretativa y cualitativa, utilizando el método etnográfico. Los resultados revelaron que los kankuamos utilizan más de 50 especies de plantas medicinales para tratar diversas afecciones, destacando la transmisión de su conocimiento ancestral. La diversidad de plantas medicinales no solo reflejó la riqueza biológica de la región, sino también el vínculo de los kankuamos con su entorno. La protección de este conocimiento se volvió vital. Las conclusiones señalan la importancia de integrar la conservación de la biodiversidad con el fortalecimiento del conocimiento indígena para asegurar la sostenibilidad de sus prácticas medicinales y su patrimonio cultural.

1. Introduction

Traditional medicine goes beyond being a simple set of practices; it represents a valuable cultural heritage that has been transmitted throughout generations. Indigenous communities have used native plants since time immemorial as tools for healing, understanding the environment and establishing a meaningful link with nature. This relationship is not limited to a spiritual aspect; it is also based on extensive and deep knowledge about the healing properties of various plants. Over the years, these communities have developed ancestral knowledge that combines observation, experimentation and collective wisdom, allowing them to recognize the medicinal benefits of the plant species that surround them. Thus, traditional medicine stands as an integral system that encompasses not only physical health, but also emotional and spiritual well-being, reflecting a worldview in which the human being is an inseparable part of nature.

The Kankuama indigenous community, located in the Sierra Nevada de Santa Marta region in Colombia, is an example of the country's cultural and biological diversity. This ethnic group has developed a vast knowledge of medicinal plants, which are an integral part of their traditional health system and cultural identity. This research seeks to identify and document the diversity of medicinal plants used by the Kankuama community, as well as their applications and associated traditional knowledge. In addition, the factors that threaten the conservation of this botanical and cultural heritage will be addressed, with the aim of contributing to the preservation of their medicinal practices and promoting the sustainability of their use over time.

This indigenous community faces the threat of the loss of its medicinal plant diversity due to urbanization, climate change and especially the lack of intergenerational transmission of knowledge. This puts at risk not only their health and well-being, but also their cultural identity and traditional practices.

This research article aims to identify the diversity of medicinal plants in the Kankuama indigenous community, taking into account their uses, traditional knowledge and the factors that threaten their conservation, in order to contribute to recommendations for the preservation of their cultural heritage and the sustainability of their medicinal practices.

2. Theoretical reflections (search for authors)

Origins of Indigenous Herbalism

Indigenous herbalism has a rich history that dates back thousands of years, during which various indigenous cultures of the Americas have used medicinal plants as an essential element in their healing practices. These ancestral traditions have been transmitted from generation to generation, enriched by empirical knowledge and a deep spiritual connection with nature [1, 2].

Since pre-Columbian times, indigenous civilizations such as the Mayans, Aztecs and Incas, among others, developed a remarkable understanding of the healing properties of the plants that surrounded them. This knowledge was documented in codices, cave paintings and oral traditions that have survived to the present day, preserving the wisdom of healers and shamans [2].

Indigenous herbalism not only focuses on the treatment of physical illnesses, but also considers spiritual and emotional aspects of health. The interconnection between body, mind and spirit is a fundamental pillar in indigenous herbal medicine, which seeks to restore balance and harmony with nature and the universe.

The history of herbal medicine in Colombia dates back to ancient indigenous civilizations, such as the Muiscas and the Tayronas, who possessed a deep knowledge of the healing properties of local plants. These ancestral practices have been perpetuated through oral transmission between generations. Shamans and healers, respected figures in their communities, continue to play a fundamental role in preserving this knowledge [1, 2].

With the arrival of the Spanish in the 16th century, an enriching exchange of botanical knowledge took place, which broadened the herbalist panorama of

the country. Chroniclers and naturalists documented native plants, thus systematizing knowledge about their uses and properties. Recent studies highlight the relevance of these records to understand pre-Columbian herbal medicine and its evolution after European contact. [2, 3]

Today, academic research and community initiatives are crucial for the revalorization and protection of ethnobotanical heritage in Colombia. Universities and research centers are dedicated to scientifically validating the traditional uses of medicinal plants, promoting their sustainable integration into contemporary health practices. This renewed interest in traditional medicine responds to a global search for sustainable and effective health alternatives that respect both human well-being and the environment.

The Spiritual and Healing Value of Plants

The spiritual and medicinal relevance of plants is fundamental in indigenous cultures, where their value transcends healing properties. For many indigenous peoples, plants are considered sacred beings that contain the wisdom of ancestors and nature spirits. Indigenous herbal medicine is not limited to the treatment of physical conditions; it also advocates the healing of the soul and connection with the divine. Each medicinal plant is seen as a gift from Mother Earth, functioning as a link between human beings, their ancestral roots and the cosmos. Healing rituals that employ these plants include not only the preparation and administration of remedies, but also the invocation of plant spirits and the performance of sacred ceremonies, with the aim of restoring balance and harmony. Thus, the use of medicinal plants encompasses a holistic approach to health that integrates the physical, spiritual, emotional and social [4].

The transmission of knowledge about medicinal plants

The transmission of knowledge about medicinal plants in indigenous cultures of the Americas is carried out through deeply meaningful intergenerational learning. This practice is based on the transfer of ancestral wisdom, which flows from grandparents to grandchildren, establishing a link that connects communities with their roots. Grandparents, in their role as guardians of traditional knowledge, share their experiences, stories and knowledge about the healing properties of plants with new generations. This process not only includes teaching about the plants themselves, but also highlights the importance of respecting and preserving nature, as well as the spiritual and cultural connection between indigenous peoples and their environment. Through this exchange of knowledge, generational ties are strengthened and the continuity of ancestral medicinal practices, essential for the health and well-being of communities, is ensured, integrating a holistic approach to health [5, 6].

Guardians of Ancestral Knowledge

In indigenous communities, shamans and healers play an essential role as custodians of ancestral knowledge about medicinal plants. These spiritual leaders and healers possess a deep understanding of the healing properties of various plant species and the techniques necessary for their effective use in rituals and treatments. They are recognized for their ability to communicate with the spiritual world, which allows them to receive guidance on the proper application of medicinal plants to heal community members. [5,6] Through ceremonies and healing practices, they transmit their wisdom to new generations, ensuring the continuity of indigenous medicinal traditions. In addition, they act as intermediaries between the physical and spiritual world, facilitating the connection between individuals, plants and nature spirits, which is essential to maintaining balance in the community.

Kankuama medicinal plants.

From a scientific perspective, medicinal plants are defined as those that contain a quantity and quality of active ingredients that have been shown to have therapeutic properties beneficial to human health [7]. These properties are based on the traditional use of various species and in different preparations, in order to prevent and treat various conditions.

Researchers such as Guzmán et al. (2017), from the National Institute of Forestry, Agricultural and Livestock Research of Mexico, state that "the use of medicinal plants through traditional medicine is ancestral." In this context, different parts of the plant are used depending on the ailment or the specific recipe. Generally, leaves and flowers are used, although sometimes the stem or root are used. Medicinal plants can be consumed directly or prepared in infusions and homeopathic presentations, with each part of the plant being intended for specific uses according to the desired benefits [8].

Bruneton (1991) indicates that the use of these plants is intended to alleviate illnesses that affect people, offering accessible alternatives to the difficulty of acquiring patented medicines. Therefore, their main function is to act as medicines that attenuate the effects of various diseases that impact human health [7].

Additionally, the use of remedies made from plants is a common practice in the Kankuamo people, where traditional medicinal plants are grown in the courtyards of houses and in agricultural fields along the Sierra Nevada de Santa Marta. For this community, the use of medicinal plants is fundamental, since it provides benefits to the health of the Kankuamos and their neighbors. The relevance of these practices lies in the transmission of ancestral knowledge, which has been maintained throughout generations, constituting a cultural legacy. Among the most recognized medicinal plants in this community are cinchona and cat's claw, which are used in the preparation of medicines.

3. Methodology – Materials y Methods:

A research was carried out with the aim of identifying the diversity of medicinal plants in the Kankuama indigenous community, considering their uses, traditional knowledge and the factors that threaten their conservation. To do so, a qualitative approach was adopted within the interpretive paradigm, which allowed for a deeper understanding of the relationship between the community and its medicinal practices.

Ethnography was used as the main method, which facilitated immersion in the cultural context of the community. Through this methodology, the aim was to capture the richness of social interactions and the meanings that community members assigned to medicinal plants. Information was collected through non-participant observation, which allowed the researcher to naturally document the practices related to the use of plants, as well as the environment in which these activities were carried out.

Additionally, semi-structured interviews were carried out with community members, which made it possible to collect stories and knowledge about medicinal plants, their uses and associated traditions. These interviews were designed to foster an open dialogue, allowing participants to share their experiences and perspectives freely and in detail.

The analysis of the information collected focused on identifying recurring patterns and themes that emerged from the data, allowing for a deeper understanding of the diversity of medicinal plants and the traditional knowledge that underpins them. Factors affecting the conservation of this cultural heritage were also considered, including the influence of external factors and changes in the socioeconomic environment.

This comprehensive methodology seeks not only to identify the diversity of medicinal plants in the Kankuama Indigenous community, but also to contribute to the preservation of their cultural heritage and promote the sustainability of their medicinal practices in the face of contemporary threats. The results of this research are expected to benefit both the community and the academic field at large.

4. Resulted

Traditional knowledge and the sustainability of Kankuama medicinal plants constitute an invaluable cultural legacy and a comprehensive orientation towards health and well-being. The Kankuama community, part of the indigenous people of the Sierra Nevada de Santa Marta in Colombia, has cultivated over generations a deep understanding of the local flora and its healing properties. This ances-

tral knowledge is based not only on experience and observation, but is also closely related to their worldview and spiritual practices.

The sustainable use of medicinal plants is crucial to preserve both the biodiversity of the region and the knowledge that has been passed down from generation to generation. By implementing sustainable practices in the collection and use of these plants, the Kankuama community not only guarantees the availability of resources for future generations, but also fosters a harmonious relationship with nature. In a context where globalization and industrialization threaten numerous local traditions, the study and valorization of traditional Kankuama knowledge emerge as essential tools for cultural conservation and the promotion of sustainable health.

The results were achieved through the application of the ethnographic method, which was established as a fundamental methodological tool for the interpretation of the data. Through participant observation, semi-structured interviews and the analysis of documents and cultural elements, the perceptions and experiences of the Kankuama community were collected in relation to the various dynamics of traditional knowledge and the sustainability of medicinal plants in their context.

4.1. Traditional knowledge

According to Carrillo (2019), the Kankuamo people have accumulated, over the centuries, extensive knowledge derived from ancient wisdoms that have managed to endure despite years of intense violence. Today, in a process of recovery, their traditional medicine is no longer hidden. On the contrary, their healers, who are recognized as experienced botanists, are available to care for the sick before they reach a hospital [9].

In Atánquez, which is the capital of the Kankuamo reservation located north of Valledupar, as well as in Guatapuri, Chemesquemena, Los Haticos and other nearby towns, valuable ancestral knowledge is preserved through the practice of botanical doctors and healers. Among them are figures such as Rafael Andrés Carrillo Montero, Faustina María 'la Tina' Cáceres Mendoza, Rafael Antonio 'Makoko' Rodríguez Arias, Adel Segundo Cáceres Urrutia, and Diógenes Segundo 'Segundito' Arias Montaño. These people are guardians of traditional knowledge that has endured over time, offering treatments and remedies based on popular wisdom and the rich biodiversity of the region.

In relation to the above, some interviewees say:

I learned to heal with healing plants from my mother, and I do it when someone asks me to help them with their health problem, I strive to offer them a solution. I have managed to heal people that doctors have not cured; the most common ailments are dizziness, kidney infections, and complications with menstruation (Arias, personal communication, January 19, 2019).

I have been healing with plants for more than 35 years. I learned to heal from my grandmother and an aunt. In the Haticos, people have been curing with plants and chirinche for centuries. The mamos cure all illnesses this way, from toothache to high fevers and more. In our community, we learn in every home what plants are for and we use them according to the illness. For example, aloe is used to reduce inflammation, marijuana leaves to soothe pain, chamomile for stomach pain, and so on (Arias-Villazon, personal communication, January 2, 2024).

The testimony shared by the interviewees reveals a deep knowledge and a rich tradition of alternative medicine based on the use of healing plants, passed down from generation to generation. This practice not only highlights people's connection with their natural environment, but also the value of ancestral wisdom that has been preserved in their communities over time.

4.1.1. Variety of healing plants

The Kankuama community is known for its rich cultural tradition and deep knowledge of the regional flora. Medicinal plants play a fundamental role in their daily life, not only as remedies for various ailments, but also as an integral part of their worldview and spiritual practices. The diversity of

plants they use reflects a close bond with nature and ancestral knowledge passed down from generation to generation. Through the collection and use of these plant species, the Kankuama not only seek to maintain their health, but also to preserve their cultural identity and strengthen their connection with the environment. In this context, the variety of medicinal plants becomes an invaluable treasure that deserves to be recognized and studied, both for its therapeutic value and for its cultural relevance.

Below, the reader is presented with a list of 37 healing plants used by the Kankuama community, including their traditional name, scientific name, and use in the community. This list was compiled from semi-structured interviews and the analysis of general documents (pages and non-formal brochures).

1. Achiote (Bixa orellana): Used for skin problems and as a natural dye.
2. Garlic (Allium sativum): Used for its antibacterial and antiviral properties.
3. Basil (Ocimum basilicum): Used for digestive problems and as an anti-inflammatory.
4. Arnica (Arnica montana): Used for bruises and muscle pain.
5. Anise (Pimpinella anisum): Used for digestive problems.
6. Anamú (Petiveria alliacea): Has anti-inflammatory, analgesic and antimicrobial properties. To treat respiratory conditions.
7. Cocoa (Theobroma cacao): Used in rituals and for its antioxidant properties.
8. Calendula (Calendula officinalis): Used to treat wounds and skin problems.
9. Chestnut (Castanea sativa): Used for respiratory problems.
10. Barley (Hordeum vulgare): Used for digestive problems and as a diuretic.
11. Onion (Allium cepa): Used to treat colds and respiratory problems.
12. Horsetail (Equisetum bogotense): Used as a diuretic and in the treatment of kidney problems.
13. Dandelion (Taraxacum officinale): Used as a diuretic and for liver problems.
14. Eucalyptus (Eucalyptus spp.): Used for respiratory problems and as an anti-inflammatory.
15. Guava (Psidium guajava): Used to treat gastrointestinal problems.
16. Peppermint (Mentha spicata): Used to relieve headaches and digestive problems.
17. Ginger (Zingiber officinale): Used for digestive problems and nausea.
18. Jasmine (Jasminum spp.): Used in rituals and for skin problems.
19. Chamomile (Matricaria recutita): Used to relieve digestive disorders and insomnia and anxiety.
20. Mint (Mentha spp.): Used to relieve stomach pains and digestive problems.
21. Moringa (Moringa oleifera): Used for its nutritional and medicinal properties.
22. Nance (Byrsonima crassifolia): Used for digestive problems.
23. Noni (Morinda citrifolia): Used for its anti-inflammatory and antioxidant properties.
24. Oregano (Plectranthus amboinicus): Used to treat respiratory and digestive problems, as well as to relieve sore throat.
25. Paico (Dysphania ambrosioides): Used to treat digestive problems, such as intestinal parasites.
26. Parsley (Petroselinum crispum): Used as a diuretic and for digestive problems.
27. Quina (Cinchona spp.): Used for digestive problems and as a tonic.
28. Rue (Ruta graveolens): Used as an abortifacient and to treat respiratory conditions.
29. Sage (Salvia officinalis): Used for digestive and respiratory problems.
30. Aloe vera: Used for wounds and skin problems.
31. Tamarind (Tamarindus indica): Used for digestive problems.
32. Thyme (Thymus vulgaris): Used for respiratory conditions.

33. Toronjil (Melissa officinalis): Used as a tranquilizer and for digestive problems.
34. Tutumo (Crescentia cujete): To treat digestive and respiratory problems.
35. Valerian (Valeriana officinalis): Used for anxiety and sleep problems.
36. Yanten (Tropaeolum tuberosum): This plant has anti-inflammatory properties to treat respiratory and digestive conditions.
37. Marijuana (Cannabis sativa): Used in the treatment of various conditions, such as chronic pain, anxiety, and nausea.

The research findings revealed that the Kankuama community employs an extensive and diverse repertoire of medicinal plants, with a significant number of species identified and catalogued. These plants are used to treat a variety of conditions, ranging from gastrointestinal and respiratory problems to dermatological disorders, among others. In addition, the deep traditional knowledge associated with the use of these species has been documented and passed down from generation to generation, thus underlining the relevance of ancestral wisdom in indigenous medicine.

4.1.2. Most Commonly Used Plant Species

Characteristics, properties and medicinal uses in the Kankuama indigenous community of: Eucalyptus, Peppermint, Toronjil, Anamú, Calendula, Rue, Chamomile, Oregano, Ginger, Horsetail and Marijuana.

Eucalyptus (Eucalyptus grandis)

This plant is native to temperate regions extending from Europe to the Himalayas. Its height can vary between 10 and 90 centimeters. The leaves are simple, with lengths ranging from 2 to 6.5 centimeters and widths of 1 to 2 centimeters; in addition, they have a hairy texture and closed edges. The flowers can be purple, white or pink, and grow at altitudes ranging from sea level to 2,500 meters [10].

Among the medicinal plants most used by the Kankumos, is this species, which is used to relieve stomach pains. When combined with chamomile, amaranth and lemon balm, it becomes an effective remedy to calm the nerves, regulate blood pressure and treat heart problems. In the morning, its infusion with chamomile helps eliminate gases, while when boiled with milk and paico it is used to combat parasites. In addition, it is cooked over low heat with basil, and its decoction can be ingested or applied in poultices on the head to improve intelligence. It is also used in sweet baths, especially for the well-being of infants.

Peppermint (Mentha arvensis)

Peppermint is a plant native to the Mediterranean, which can reach heights that vary between 60 centimeters and 2 meters. Its stems are cylindrical, robust and have a slight channeling. The leaves have an intense green color, are elongated and thin, with sharp tips that harden on the outside during the summer. The flowers of the mint plant are grouped in bunches that can contain from ten to forty small flowers of an attractive golden yellow color, each with five petals. The fruit, approximately 5 millimeters long, has a dark brown color. This plant develops in temperate and warm temperate climates, and its reproduction occurs through seeds [10].

As for its uses, mint infusion is used to help mothers who have difficulties with breastfeeding, often sweetened with panela. It is also mixed with fennel and lemon juice to apply it on the forehead or crown, in order to relieve headaches. In addition, this plant strengthens the immune system and contributes to fighting anemia, as it helps eliminate toxins from the body. It acts as an expectorant, relieving dry cough, and is also effective in reducing cholesterol levels and lowering fever. It also improves urinary infections and digestive disorders, relieving the accumulation of gases.

Melissa (Melissa officinalis)

Melissa is a plant that originates from the Mediterranean basin and Asia Minor. In Greek, it is called “melissa”. Today, this plant has been introduced into various temperate climate regions around the world, both as an ornamental plant and for medicinal purposes. [10]

It is said that the infusion of lemon balm is beneficial for relieving cold in the ovaries, contributes to

visual and bone health, and helps cleanse the uterus and other internal organs. In addition, it is attributed with antioxidant properties.

Anamú (Petiveria alliacea)

It is a herbaceous plant with a vascular system and produces seeds. It belongs to the same family as anise, fennel, wild fennel and carrot. It is native to the Mediterranean, the Caucasus and the Himalayas. It can reach a height of 1 meter. It has elongated stems that form a thick stalk [10]

In the Kankuma community, this plant is used to relieve gas build-up, reduce abdominal fat, control high blood pressure, alleviate menstrual pain, and improve vocal disorders. In addition, it is credited with the ability to eliminate uric acid and it is claimed that its juice can increase sexual desire. When presented in dried and crushed form, it is effective in treating mouth sores and gum problems. Poultices made from it are beneficial for healing. Also, the infusion of its stem and leaves is used to regulate cholesterol levels. This herb is characterized by having a neutral flavor.

Calendula (Calendula officinalis)

It belongs to the Verbenaceae family, which includes both quick-relief and verbena. This plant is native to South America and was introduced to Europe for cultivation. It is a shrub that can reach up to 3 meters in height. Its leaves, which are grouped in one place, can measure up to 7 cm and are lanceolate in shape, with smooth or serrated edges. In addition, it has an intense aroma reminiscent of lemon, [10].

Kankuamo healers maintain that this plant is beneficial for improving the quality of sleep. It is used to release air accumulated in the body. In addition, it has antioxidant and digestive properties, which makes it an effective remedy for relieving stomach pain, nausea, diarrhea and flatulence. It is also able to reduce muscle discomfort caused by physical activity and mitigate allergy symptoms. This herb facilitates the expulsion of phlegm and contributes to the health of the respiratory system. It also fights the bacteria responsible for bad breath and is characterized by its sweet taste.

Rue (Ruta graveolens)

Rue is a plant that is mainly used to add aroma to various dishes. Indigenous women who are pregnant incorporate it into their diet in order to address anemia problems. In addition, its infusion is used to promote fat burning and relieve stomach ailments. The extract of this plant is also used in the treatment of acne, [11].

This species belongs to the Labiatae family and is characterized by being a small shrub, which can reach approximately 60 cm in height. It has a robust stem and tiny, elongated leaves, which emanate a distinctive smell. Rue thrives in semi-tropical regions.

Chamomile (Matricaria recutita)

Chamomile has its origin in Africa, although it is currently cultivated in various regions of the world. This plant can reach a height of up to 100 centimeters. Its leaves are oval, fleshy and have a velvety texture, with star-shaped edges. They measure between 5 and 10 centimeters long and 4 to 8 centimeters wide. The flowers grow in clusters that vary between 10 and 30 centimeters, presenting colors ranging from pale blue to lilac or pink. It is cultivated at altitudes ranging from 0 to 2,500 meters above sea level [10, 12].

Chamomile is used to combat parasites and worms; it is prepared kneaded and consumed with lemon. In addition, it helps regulate cholesterol and eliminate fat. To treat dizziness, it is recommended to drink it blended in water. It is also used in cleaning the home using incense, in infusions to relieve coughs and in treatments for nervous disorders. When applied to the face, it can help in the treatment of acne, and in case of insect bites it is used in poultices on the affected area. It has been observed that it stimulates memory and is beneficial for ear inflammation, since it is cooked and a few drops are applied to the area, [5]. The Kankuamo community frequently uses it to relieve stomach pain. It is suitable for people with high levels of uric acid.

Oregano Plectranthus amboinicus

Oregano is a plant that belongs to the Labiatae family. Its oval-shaped leaves range in size from 6 to 8 millimeters. This plant thrives in humid environments, which explains its frequent presence on the banks of rivers. The aroma of its leaves is intense, and its stems have a creeping growth [10, 13].

In addition, oregano is used as a medicinal plant, recognized for its properties to relieve flu, facilitate the expulsion of phlegm, purify the body and treat digestive problems. By boiling milk and adding this herb, a remedy is obtained that helps combat insomnia. Horsetail (Equisetum bogotense)

Horsetail belongs to the Crassulaeae family, which mainly groups succulent plants capable of storing water in their leaves or stems. Its origin is found in southern Africa and Madagascar. The leaves of this plant are fleshy, reaching lengths between 5 and 20 cm, as well as widths that range between 2 and 12 cm. Its color varies between green and yellowish green, occasionally presenting purple edges. The leaves are wide and have a scalloped edge, and between one and three leaves can emerge from each node. The plant has robust stems and its flowers, which appear in hanging, bell-shaped clusters, can be greenish yellow to pinkish red and measure up to 7 cm long. Its growth varies between 30 cm and 200 cm, and it develops at altitudes ranging from sea level to 2600 meters above sea level [10, 14].

As for its medicinal applications, it is used in infusions to treat tumors, abscesses, colic, kidney problems and diarrhea. To combat hypertension, it is consumed in combination with lemon, and for headaches, it is crushed and applied to the affected area, [7]. In addition, it can be used cooked, raw or in the form of juices to help in the fight against cancer. It is also attributed with properties to attract good luck.

Ginger (Zingiber officinale)

This is a perennial herbaceous plant that is distinguished by developing a bulbous and branched rhizome underground, which is used for its properties. These rhizomes can reach up to 10 centimeters in length. The flavor of ginger is particular, with spicy, peppery and aromatic notes, as well as a hint of lemon and pepper. As the cooking time is prolonged, ginger becomes spicier. Its leaves are elongated and have simple venation, while it produces yellow flowers grouped in clusters [8].

Ginger is appreciated for its anti-inflammatory and digestive properties. Several studies have corroborated its effectiveness in relieving nausea and digestive discomfort. Peer-reviewed research has shown that bioactive compounds present in ginger, such as gingerols and shogaols, have a significant impact on reducing inflammation and may be beneficial in the treatment of chronic inflammatory diseases, such as arthritis, [15, 16].

Marijuana (Cannabis sativa)

Marijuana is a plant known for its content of several bioactive compounds, among which tetrahydrocannabinol (THC) and cannabidiol (CBD) stand out. These compounds are responsible for generating relaxation, well-being and euphoric effects, [17]

Various scientific studies have shown that the consumption of marijuana can offer a variety of therapeutic benefits. In this sense, its active substances, especially CBD, have been integrated into medicine to address various conditions. Therapeutic uses include the relief of chronic pain related to arthritis, fibromyalgia or migraines; Reducing inflammation in diseases such as irritable bowel syndrome, psoriasis, Crohn's disease, and rheumatoid arthritis; alleviating nausea and vomiting caused by chemotherapy treatments; stimulating appetite in patients suffering from AIDS or cancer; treating seizures in people with epilepsy; decreasing muscle stiffness and neuropathic pain in individuals with multiple sclerosis; relieving pain in terminally ill cancer patients; and improving sleep quality in cases of insomnia, among others. [17, 18].

4.2. Sustainability

Despite the cultural wealth and valuable knowledge they possess, multiple factors have been identified that threaten the conservation of these medicinal

practices. Among them, the loss of natural habitat, the introduction of exotic species that compete with native plants, and the lack of recognition and support at the institutional level stand out. These challenges not only put the biodiversity of the region at risk, but also threaten the continuity of an invaluable cultural legacy that has been fundamental to the health and well-being of the Kankuama community. It is therefore imperative to implement conservation and valorization strategies that guarantee the preservation of these ancestral practices and the associated knowledge, thus ensuring their legacy for future generations.

Current challenges in the Preservation of the use of indigenous healing plants

Modernization and the loss of territories have had a profound impact on the herbal medicine practices of indigenous peoples. As industrialization advances and urban development expands, many communities have experienced a drastic reduction in their natural spaces, resulting in a significant decrease in the availability of traditional medicinal plants. Phenomena such as deforestation, environmental pollution and the exploitation of natural resources have contributed to the decline in biodiversity, putting the preservation of these ancestral practices at serious risk.

Furthermore, the growing influence of Western medicine, coupled with the lack of recognition of indigenous herbal medicine as a legitimate health system, has endangered many of these traditions. The lack of access to resources, the discrimination suffered by indigenous communities and the absence of government support have complicated the transmission of this ancestral knowledge to future generations. This situation not only threatens the continuity of these practices, but also weakens the connection of indigenous peoples with their cultural and spiritual roots.

It is imperative that effective measures be implemented to protect indigenous territories, promote the conservation of biodiversity and ensure respect for and preservation of the herbal medicine practices of indigenous peoples. Collaboration between indigenous communities, government agencies and international organizations is essential to address these challenges and ensure the continuity of this invaluable cultural legacy. Promoting intercultural dialogue and strengthening policies that recognize and value indigenous herbal medicine are crucial steps toward safeguarding this intangible heritage, which not only enriches indigenous communities, but also contributes to cultural diversity and global health.

Biopiracy and the Protection of Intellectual Rights of Indigenous Communities

Biopiracy stands as a significant threat to herbal medicine practices that have been developed and preserved by indigenous peoples over the centuries. This phenomenon is characterized by the unauthorized appropriation of traditional knowledge and genetic resources by external companies or institutions, which act without the consent or fair compensation to the indigenous communities that have maintained and transmitted this valuable wisdom over generations, [19, 20].

In this context, indigenous peoples are immersed in a constant struggle for the recognition and protection of their intellectual rights, which include control over the use and commercialization of medicinal plants and their derivatives [19]. The lack of effective regulations, as well as the weakness in the implementation of protection mechanisms, have facilitated the exploitation and misuse of these resources, often without providing equitable benefits to the original communities that are the true guardians of this knowledge.

It is therefore essential to strengthen legal mechanisms and international agreements that safeguard the traditional knowledge of indigenous peoples. In addition, it is vital to promote appreciation and respect for herbal medicine, considering it as an integral part of the cultural heritage of these communities. Public awareness, education and international solidarity are key elements to support the struggle of indigenous peoples to defend their rights and preserve their rich medicinal heritage, [20].

In this sense, there is a need for institutions and society as a whole to recognize the intrinsic value of herbal medicine and the fundamental role played by indigenous peoples in its conservation. Failure

to consider this knowledge not only undermines social justice, but also implies an irreversible loss of cultural and biological diversity. Therefore, it is imperative that public policies and legal frameworks be oriented towards inclusion and respect for ancestral knowledge, fostering an intercultural dialogue that recognizes the importance of this knowledge in collective health and well-being. Thus, defending the rights of indigenous peoples in the field of biopiracy is not only a matter of justice, but also an ethical imperative that seeks to preserve the cultural diversity and natural resources of the planet. Cooperation and commitment by all parties involved are essential to achieve a fair balance that benefits both indigenous communities and society as a whole, ensuring a future in which herbal medicine and traditional knowledge are recognized, respected and protected.

5. Discussion

Traditional knowledge and sustainability of Kankuama medicinal plants constitute an invaluable cultural legacy and a comprehensive orientation towards health and well-being. The Kankuama community has cultivated a deep understanding of the regional and local flora over generations, as well as experienced healing practices. This ancestral knowledge is based not only on experience and observation, but is also closely related to their worldview, spiritual practices and the interconnection between humans and nature [2, 5, 6].

The sustainable use of medicinal plants is crucial to preserve both the biodiversity of the region and the knowledge that has been passed down from generation to generation. By implementing sustainable practices in the collection and use of these plants, the Kankuama community not only guarantees the availability of resources for future generations, but also fosters a harmonious relationship with nature [5]. Sustainable practices include responsible collection, which respects the growth and reproduction cycles of plants, as well as the promotion of crops that do not harm the local ecosystem. In a context where globalization and industrialization threaten numerous local traditions, the study and valorization of traditional Kankuama knowledge emerge as essential tools for cultural conservation and the promotion of sustainable health.

The diversity of medicinal plants in the Kankuama community not only reflects the biological richness of the region, but also the deep bond that the Kankuamos maintain with their natural environment. This bond is manifested in their relationship with the land, in which each plant is not only seen as a resource, but as an entity with which a spiritual connection is established. The transmission of knowledge about the use of these plants is fundamental for the preservation of their culture and their health system. Through rituals, stories and teachings, the elders of the community share their knowledge with the younger ones, ensuring that practices and wisdom are not lost over time. [5, 8].

However, external factors that put both the species and the associated knowledge at risk are worrying. Habitat loss due to agricultural expansion and urbanization, together with the lack of effective conservation policies, threaten the continuity of these practices. Deforestation and the use of agrochemicals not only compromise the health of the ecosystem, but also directly impact the quality of medicinal plants that have been used for centuries. Therefore, it is essential to promote the valorization of this traditional knowledge, promoting education and awareness programs that involve new generations and the community in general.

In addition, the creation of support networks that integrate the Kankuama community with researchers, non-governmental organizations and public policies can be fundamental to strengthen their capacity to preserve and promote their ancestral knowledge. These alliances can contribute to the development of initiatives that recognize and protect community intellectual property over traditional knowledge, thus encouraging its responsible and sustainable use.

Finally, it is important to recognize that traditional knowledge not only has intrinsic value for the Kankuama community, but also offers valuable lessons for the modern world in terms of holistic health and environmental sustainability. The integration of these practices into contemporary medicine

could provide effective and sustainable alternatives to address various health problems, while respecting and valuing the wisdom of indigenous peoples. In this sense, the Kankuama legacy becomes a beacon of hope and a model to follow in the search for a life more balanced with nature.

6. Conclusions

Research on the diversity of medicinal plants in the Kankuama indigenous community has highlighted the relevance of this cultural heritage to the health and well-being of its members. Through the identification and documentation of these plants, not only the richness of their traditional knowledge has become evident, but also the urgency of acting against the factors that threaten their conservation. To ensure the sustainability of medicinal practices, it is essential to implement strategies that integrate biodiversity conservation with the strengthening of indigenous knowledge. In this way, it will contribute not only to the preservation of the cultural heritage of the Kankuama community, but also to the promotion of a more holistic approach to health that respects and values ancestral traditions.

The conclusions derived from this qualitative and ethnographic study can be summarized in the following key statements. First, it is highlighted that medicinal plants play an essential role in indigenous cultures, where they are used both in traditional treatments and in healing rituals.

Secondly, it is observed that the transmission of knowledge about medicinal plants occurs from generation to generation, mainly through oral tradition and direct observation of nature. This teaching and learning process is vital for the preservation of this knowledge.

In addition, it is highlighted that in the indigenous worldview, medicinal plants are considered sacred, since their use is not only limited to healing the body, but also has an impact on strengthening the spirit and maintaining balance with the natural environment.

Likewise, it is evident that ancestral knowledge related to medicinal plants is protected through selective transmission within the community. In certain cases, this is complemented by the use of collective intellectual property mechanisms, which seek to safeguard this traditional knowledge.

Finally, indigenous communities face various challenges, such as cultural appropriation, deforestation and the lack of recognition of their traditional knowledge in the area of the use of medicinal plants. These challenges put at risk the continuity of their ancestral practices and knowledge, as well as their relationship with nature.

References

[1] Mayo-Mayo, S., Cruz-León, A., Wilson-García, C. Y. & Cervantes-Herrera, J. (2024). "Herbolaria y alternativas al desarrollo en pueblos indígenas Mé´pháá y Tu´un savi en Guerrero, México". *Estudios sociales. Revista de Alimentación Contemporánea y Desarrollo Regional*, 34(63): 1-28]. Epub, 2024 Dec 09.

[2] Martínez, A. (2023). *La herbolaria medicinal y la interacción entre españoles e indígenas en la provincia de México, según las relaciones geográficas del siglo XVI*. [Trabajo de grado profesional]. Medellín: Universidad de Antioquia.

[3] Barquero Andrea, A. (2007). "Plantas sanadoras: pasado, presente y futuro". *Revista Química Viva*, Número 2, año 6, agosto 2007. Departamento de Química Biológica. Facultad de Ciencias Exactas y Naturales. Universidad de Buenos Aires. Buenos Aires. Argentina.

[4] Virgili, L. G. (2017). *Guía medicinal y espiritual de plantas tropicales*. Copyright de la edición: Angels Fortune Editions.

[5] Mejía, A. (14 de enero de 2003). "El conocimiento tradicional sobre plantas medicinales y su relación con el conocimiento científico". *Revista Semillas*.

[6] Rodríguez-Zúñiga, J., Marín-Togo, M. & González-Guillén, M. (2023). "Transmisión del conocimiento herbolario y sus beneficios en la comunidad mazahua otomí, estado de México (2023)". *Agricultura, Sociedad y Desarrollo*. https://doi.org/10.22231/asyd. v20i3.1537

[7] Bruneton, J. (1991). *Elementos de fitoquímica y farmacognosia*. Zaragoza, España: Acribia S.A.

[8] Guzmán, A., Díaz, R. & González, M. (2017). *Plantas medicinales: la realidad de una tradición ancestral*. Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias de México. Número 1: https://vun.inifap.gob.mx/VUN_MEDIA/BibliotecaWeb/_media/_folletoinformativo/1044_4729_Plantas_medicinales_la_realidad_de_una_tradici%C3%B3n_ancestral.pdf

[9] Carrillo-Mendiola, H. (2019). *La medicina ancestral que se mantiene en el pueblo kankuamo*. https://www.radionacional.co/cultura/la-medicina-ancestral-que-se-mantiene-en-el-pueblo-kankuamos

[10] Fundación Gases de Occidente, Programa Mundial de Alimentos [PMA] y Fundación Escuela Taller Buenaventura. *Herbolaria de la plaza de mercado. Conocimiento vivo, tradición oral*. Buenaventura-Colombia ISBN: 978-958-57232-3-8. [Consultado el 10 de octubre de 2024]. https://www.gdo.com.co/Documents/Fundacion-GdO/La_Herbolaria.pdf

[11] Vázquez, J. Y. (23 de enero de 2020). *Toronjil: características, hábitat, propiedades, cultivo, cuidados*. [Internet]. Lifeder. [Citado en octubre de 2023]. Disponible en: https://www.lifeder.com/toronjil/

[12] Gómez, U., Reyes, S. & Paredes, L. (2015). "La manzanilla y sus propiedades medicinales". *Revista de Investigación e Información en Salud*, 10(23): 54-58. ISSN 2075-6194.

[13] Arcila-Lozano, C., Loarca-Piña, G., Lecona-Uribe, S. & González, E. (2004). "El orégano: propiedades, composición y actividad biológica de sus componentes". *ALAN*, 54(1): 1-28.

[14] Berdonces-Serra, J. (1985). "La cola de caballo en fitoterapia". *Natura Medicatrix*, verano: 25-28.

[15] Acuña, O. & Torres, A. (2010). "Aprovechamiento de las propiedades funcionales del jengibre (*Zingiber officinale*) en la elaboración de condimento en polvo, infusión filtrante y aromatizante para quema directa". *Revista Politécnica*, 29(1): 60-9. Escuela Politécnica Nacional.

[16] SICA (2001). *Jengibre (Zingiber officinale L.: Ginger Root)*. [Internet]. [Citado en octubre de 2009]. Disponible en: http://www.sica.gov.ec/gronegocios/Biblioteca/Convenio%20MAG%20IICA/productos/jenjib_mag.pdf

[17] Santos, A. B. (2019). "Eficácia do canabidiol no tratamento de convulsões e doenças do sistema nervoso central: revisão sistemática". *Acta Brasiliensis*, 3(1): 30-34.

[18] MacCallum, A., Lo, A. & Boivin, M. (2021). "Is medical cannabis safe for my patients? A practical review of cannabis safety considerations". *European Journal of Internal Medicine*, 89: 10-18.

[19] Barreda, A. (2001). "Biopiratería y resistencia en México". *El Cotidiano*, 18: 21-39.

[20] Sobrevilla-Solís, J. A. & López-Herrera, M. (2013). *La biopiratería y los derechos de propiedad intelectual en la biodiversidad. Estudios científicos en el estado de Hidalgo y zonas aledañas*. Volumen II. Editores Griselda Pulido-Flores y Scott Monks, Lincoln, NE: Zea Books.

Publication consent:

The author read and approved the final manuscript.

Conflict of interest:

The author declares that he has no conflict of interest. This document only reflects your views and not that of the institution to which you belong.

Hermes Emilio Martinez Barrios:

Doctor in Language and Culture, Master in Territory, Conflict and Culture, Specialist in Education with Emphasis in Educational Evaluation. Sociologist. Teaching at the Universidad Popular del Cesar, Colombia.

Contact: hermesmartinez@unucesar.educ.co
ORCID: https://orcid.org/0000-0002-6932-157X

Magna Scientia UCEVA
Vol. 4 N° 2 (2024) - P.P. 45 - 57
ISSN:2805-6884 e-ISSN:2805-6701
DOI:10.54502/msuceva.v4n2a5

Influence of the Work Environment on Employee Satisfaction and Quality of Patient Care: A Cross-Sectional Study

Influencia del entorno laboral en la satisfacción de los empleados y la calidad del cuidado al paciente: un estudio transversal

Mohammad Atyan A – National Guard Health Affairs
Abdulmajeed Abdullah A – National Guard Health Affairs

Open Access

Key words:
Work Environment, Employee Satisfaction, Quality of Patient Care.

Palabras clave:
Entorno laboral, satisfacción de los empleados, calidad del cuidado al paciente.

Abstract

Job satisfaction is a central concept in the professional field and has become crucial in the context of healthcare workers, who face high levels of stress due to the demanding nature of their work. The satisfaction of healthcare providers not only affects their personal well-being but also influences the quality of care they provide to patients. This study focuses on how working conditions impact nurses' job satisfaction and, consequently, the quality of patient care.

A cross-sectional research was conducted in which healthcare personnel from different types of hospitals were surveyed. With a sample size of 328 participants and a response rate of 98.81%, the relationship between nurses' perceptions of their working conditions and patient care was analyzed. Inclusion criteria ensured that only those who had minimal experience in their positions and were informed and in agreement with the study were considered.

The results showed that nurses' job satisfaction is strongly related to their work environment. Among the working conditions evaluated, workload management, psychological protection, and physical safety were found to be significant determinants in providing quality and safe care. Although 58.1% of nurses reported that the quality of care was low, 69.7% indicated that most of their shifts featured behaviors that could lead to incidents related to patient care. This finding suggests that, despite the challenges, nurses have a high commitment to patient safety.

The study also highlighted that the intention to leave the current position is positively related to job satisfaction. Therefore, policy makers and managers in the health field should focus on reducing nurses' workload and promoting a work environment that allows them to take breaks and participate in social activities. This would not only contribute to improving their job satisfaction, but would also positively impact the quality of care they provide.

However, the study design has limitations as it is based on data collected at a single point in time and cannot establish direct causal relationships. The measurement of quality of care is based on subjective reports from nurses, which could introduce bias.

In conclusion, the research highlights the importance of working conditions in nurses' satisfaction and their effect on the quality of patient care. Job satisfaction is a determining factor that can influence the efficiency of healthcare systems. Addressing issues related to the work environment of nurses is essential to improve both their well-being and the care they provide to patients.

Resumen

La satisfacción laboral es un concepto central en el ámbito profesional y se ha vuelto crucial en el contexto de los trabajadores de la salud, quienes enfrentan altos niveles de estrés debido a la naturaleza demandante de su trabajo. La satisfacción de los proveedores de atención médica no solo afecta su bienestar personal, sino que también influye en la calidad de atención que brindan a los pacientes. Este estudio se centra en cómo las condiciones laborales impactan la satisfacción laboral de las enfermeras y, por ende, la calidad de atención al paciente.

Se llevó a cabo una investigación transversal en la que se encuestó a personal de atención médica de diferentes tipos de hospitales. Con un tamaño de muestra de 328 participantes y una tasa de respuesta del 98,81 %, se analizó la relación entre las percepciones de las enfermeras sobre sus condiciones laborales y la atención al paciente. Los criterios de inclusión aseguraron que solo se consideraran a aquellos que tenían una experiencia mínima en sus puestos y que estuvieran informados y de acuerdo con el estudio.

Los resultados mostraron que la satisfacción laboral de las enfermeras está fuertemente relacionada con su entorno de trabajo. Entre las condiciones laborales evaluadas, la gestión de la carga de trabajo, la protección psicológica y la seguridad física resultaron ser determinantes significativos para ofrecer una atención de calidad y segura. Aunque el 58,1 % de las enfermeras reportaron que la calidad de atención era baja, el 69,7 % indicó que la mayoría de sus turnos presentaban comportamientos que podían derivar en incidentes relacionados con la atención al paciente. Este hallazgo sugiere que, a pesar de los desafíos, las enfermeras tienen un alto compromiso con la seguridad del paciente.

El estudio además destacó que la intención de dejar el puesto actual está positivamente relacionada con la satisfacción laboral. Por lo tanto, los responsables de la política y la gestión en el ámbito de la salud deben centrarse en reducir la carga laboral de las enfermeras y promover un ambiente laboral que les permita realizar descansos y participar en actividades sociales. Esto no solo contribuiría a mejorar su satisfacción laboral, sino que también impactaría positivamente en la calidad de atención que brindan.

Sin embargo, el diseño del estudio presenta limitaciones, ya que se basa en datos recopilados en un solo punto en el tiempo y no puede establecer relaciones causales directas. La medición de la calidad de atención se basa en informes subjetivos de las enfermeras, lo que podría introducir sesgos.

En conclusión, la investigación resalta la importancia de las condiciones laborales en la satisfacción de las enfermeras y su efecto en la calidad de atención al paciente. La satisfacción laboral es un factor determinante que puede influir en la eficiencia de los sistemas de atención médica. Abordar los problemas relacionados con el entorno laboral de las enfermeras es esencial para mejorar tanto su bienestar como el cuidado que proporcionan a los pacientes.

1. Introdución

The relationship between work environment and job satisfaction is multifaceted. There is evidence indicating that the work environment is a key determinant of job satisfaction, including both the physical environment as well as the interpersonal work environment [1]. Previous research in various settings has suggested substantial impacts of environment on outcomes including job satisfaction amongst employees. Among healthcare workers, evidence has demonstrated that work environment impacts not only individuals, but also influences the quality of patient care.

1) Random sampling was used to recruit 800 full time nursing workers from care units. They completed five item Likert scale questionnaires. Dependent variables were job satisfaction and quality of patient care. Independent variables included items related to work environment. Path analysis was performed to test a hypothesized model where work environment has an impact on job satisfaction and the quality of patient care, loaded through job satisfaction. Evidence supports the relationships proposed in the model. Managerial strategies to enhance job satisfaction and the quality of patient care are discussed.

There has been increasing research interest regarding job satisfaction amongst healthcare workers, as it is related to quality of care, as professional practitioners.

2. Methodology – Materials and Methods:

Job satisfaction of healthcare workers is an important factor in the success of healthcare services. The present study aimed to assess the impact of the work environment on the job satisfaction of health care workers among the health sector in Saudi Arabia and its consequences on thequality of the provided care. The statistical models showed that there was a positive direct relationship between job satisfaction and teamwork within units and a negative direct relationship between workload and burnout. Conversely, there were no direct relationships between job satisfaction and teamwork across units, participatory management, management's ability, and support, and quality of patient care [1]. In addition, there was a direct positive relationship between quality of care and support from physician colleagues and a direct negative relationship between quality of care and perceived autonomy.

The provision of high-quality patient services has become a global priority for countries, healthcare organizations, and policymakers. The quality of health care is associated with the relationship between health care providers and patients. It was reported that medical errors are unintentional whereas health care professionals do not perform the care within a hospital organization and care not received by the patient due to service failure. It was also noted that in the near future, there would be an increase in competition among health care providers, as well as an aging, demanding, and informed population. With such changes, high-quality health services are expected from hospitals that anticipate and meet the demand of patients. Satisfaction with the quality of health services received is also expected to increase. Given that health services are characterized by credence attributes, the perceived quality of care is observable to a limited extent [2]. This explains patients' tendency to assign salient signals of quality care such as, for example, patient sites, laboratory findings, surgical operations. Similarly, these signals are considered by health care providers to be an incomplete manifestation of the quality of care they have provided.

The quality of patient care may indeed rely more on unobservable interactions among health care professionals during diagnosis and treatment processes. The outcomes of care in a hospital are highly contingent on the collective contribution of all health care providers who have direct or indirect contact with the patient within the care unit.

The National Development Plan 2018-2030 highlighted that the maintenance of a healthy workforce through an enabling work environment will contribute to maintaining health care system resilience. It proposes that the Standard Operating Procedures for Positive Workplace Health and Safety be implemented, including standards for the development of a conducive work environment. The Public Health Sector Workplace Work Environment Strategic Plan highlighted the need for improvements in workplace safety, infection control, and the work environment to support a sense of well-being.

Job satisfaction has been a focus of research in healthcare and nursing given its potential to impact the quality of patient care, staff recruitment and retention, management of health care workforce, absenteeism, and burnout. The work environment is one of the most important factors that have both direct and indirect relationships with nurse job satisfaction. The work environment could improve through a coordinated effort of governments, health services, labor organizations, professional nursing organizations, and others. The nurse's professional organization envisions a work environment that respects health, safety, and well-being of staff and fosters quality patient care.

Mortalities and morbidities can be reduced by ensuring facilities are equipped and functional, there is always a skilled health worker available, and the health worker attends courteously and attends to the needs of the patient and there is no unofficial payment at health facilities. Staff absenteeism and poor work attitudes have been addressed through

the provision of housing, enhancing conditions of service and retiring staff after attaining the age of 60 years; but scant attention has been given to workplace work environments. Staff influencing factors such assalary, working environment, mechanisms of customer care, positive attitude of health workers towards clients, availability of facilities, and the duration spent on waiting in the hospital until they are seen by a healthcare provider were found to be potential quality improvement areas. The quality of services that are provided by health staff can be used as an assessment of performance.

2.1. Study Design

A cross-sectional e-mailed questionnaire-based survey will be utilised in this study. The surveys willbe sent electronically to the e-mail of the healthcare workers. This survey research will focus on examining and understanding the impact of workplace environment (WPE) on job satisfaction (JS) as well as the impact of JS on the quality of patient care (QoPC) provided by healthcare workers (HCW). HCWs consist of nurses, nursing technicians, laboratory technicians, and radiology technicians. The most contentious issue regarding the quality of healthcare services is whether there is a direct effect of JS on the service provided, or it depends on the impact of JS on other indicators of QoPC, such as safety culture, handling of complaints, interpersonal relationships, and the work environment. The focus of this study is specifically on the last of these, namelythe quality of the work environment of the hospital in which HCWs are employed. JS is defined as a positive emotional state that reflects the appraisal of one's job as enjoyable, and that it is accompanied by a sense of fulfilment, whereas, despite the increased interest in how JS can affect the QoPC, there is still a lack of consistency as to which factors determine QoPC [1].

To contribute to addressing this gap, this study aims to describe the definition of WPE that matters for job satisfaction and to determine the effect of WPE on the quality of care provided in hospitals by means of a large-scale cross-sectional study. The hospital patient care WPE is defined in terms of the thing around healthcare workers (HCWs) during work that may influence their emotional and functional wellbeing –i.e. the physical conditions of the work environment and social context that characterizes the interactions and relations with other HCWs and patient/customers.

One of the most important factors in nurse job satisfaction is the work environment [1]. An allegation has been made that senior nurses acted without authorisation in response to a complaint by an employee. Accordingly, the union requested all email correspondence between the nurse unit managers and human resources in the days following the complaint, as notification of disciplinary action would be expected in written form. Furthermore, the allegation claimed the employee would be prevented from continuing to work with a particular colleague. No necessary knowledge or advice relating to training requirements was sought from Operations-Low Level Waste in pursuit of illegal containment or transport of low-level waste to landfill. It was therefore admitted that all correspondence, including that of Cox, White, and Hallet, be disclosed forthwith. Additionally, Slater was invited to supply details concerning co-contributions and remuneration associated with the Safety Forum process, including any in-kind agreements such as consultancy services, catering, or training. This list is by no means exhaustive, with the right to further relevant documentation being reserved.

It was further advised that in preparation for the hearing, it would be wise to seek formal legal counsel, particularly on the matter of conflicts of interest.

2.2. Data Collection and Analysis

This cross-sectional study conducted from 122 nursing staff of 2 hospitals in a big city of Indonesia aimed to analyze the impact of workplace work environment on job satisfaction and quality ofpatient care. A survey with demographic and work environment evaluation tools was used to detect a correlation among the studied variables. Hospital A had a significantly better mean score for autocracy in comparison to Hospital B. Multitasking was significantly and negatively correlated with the mean

score for easy communication. The results of factor analysis for work environment evaluation showed a one-factor structure that is still under debate. In addition, there is a long way to go to improve Hospital A and make it a safe, professional, and caring health center. Cross-Sectional Study with Constant Nature is good to carry out a study with an exploration and description nature, like a study to analyze the health status of a population, which presents a clear picture of particular health conditions. For the purpose of a study to observe the correlation among variables in a single time of observation that are presumed to influence one another. The impact of an independent variable on a dependent variable can be observed in this kind of study, which simplifies the research work by engaging with data that has been collected on research objects. This study investigated the mutually causal relation among job satisfaction, workplace work environment, and qualityof patient care. Job satisfaction, workplace work environment, and quality of patient care are major concerns in the current hospital service industry. Unhealthy work environments in hospital services, such as excessive workload and interpersonal conflict, may lead to nurse burnout. Feedback to the delivery of care by the hospital to portray perceptions of the ward and concern for the patient. It widely defines how nursing staff tackles their job, prefers swift promotion and task accomplishment, and showcases less nurse burnout. This study provided a mirror understanding for the hospital management in order to stimulate the welfare of hospital fixed staff.

A cross-sectional study was conducted to assess the impact of workplace quality of care and safety according to nursing care on job satisfaction among nurses in British Columbia, Canada. Workplace quality of care and security was stratified based on nurses' patient care locations. The study involved a nurse survey study for a major period of time, which consisted of all nurses registered in the province. A modified weighted version of the survey was given to 6000 nurses. It comprised 23 items related to workplace quality of care and safety according to nursing care. In addition, the survey contained demographic and workplace items. Nurses were also requested to identify which items describe their primary locations of patient care. Approximately 29% of the participants were hospital nurses, and 40% were aged 50 and older. Practice setting significantly stratified workplace security according to nursing care, with hospital nurses reporting significant worse condition [3].

Improved workplace conditions must be a top priority for hospitals regardless of location prior to a hospital consultant. Due to their patient care location, nurse practitioners cannot be assumed to be universal means of compliance with nursing workplace security. Introduction: Nurses are the largest health care professional group in British Columbia (BC) and provide the vast majority of daily health care. Since only nurses can detect sudden changes in patient status and assess the appropriateness of treatment, their unique perspective is essential in order to provide high-quality and safe patient care. For many factors that relate to lack of process, tools or resources, health care professionals may not be able to provide the high quality of care required [3].. Given the implications of patient care security, it is essential to understand the quality and safety of care delivered to nurses in their environments.

3. Background and Rationale:

Background: The Impact of Workplace Work Environment on Job Satisfaction and Quality of Patient Care.

The overall quality and safety of the services provided may have negative effects on patient health outcomes. Although a range of factors affect the quality and safety of patient care, workplace work environment has been an area of growing focus. A desirable work environment is essential for promoting job satisfaction among healthcare providers and improving patient care outcomes. Previous studies have shown that effective management support, participation in hospital affairs, and staffing and resource adequacy will result in nurse job satisfaction and improvements in the quality of patient care. The work environment of nurses in Jordan is unfavorable, and thus, effective interventions are critically needed. These interventions should specifically focus on participating in hospital affairs and ensuring job security and a safe workplace

Rationale: The Impact of Workplace Work Environment on Job Satisfaction and Quality of Patient Care.

Workload management, psychological protection, and engagement and physical safety are among the most crucial determinants of the provision of quality and safe patient care. The majority of workplace predictors are associated with care provision through their strong connection with nurse satisfaction and intent to stay among nurses, which is essential for providing quality care to patients. The sample of this study is of high importance because it contains information related to Jordan a nation that lacks empirical studies. The data was collected using tools that are specifically designed for the nursing workforce and were carefully translated and validated using a formal process. Furthermore, the research design involves state-of-the-art methodologies that permit the study of complex relationships with large samples of nurses in Jordan. From this study, clinical and policy changes may be suggested, focusing on the work environment as a means for increasing patient care quality.

In recent years, nursing job satisfaction has become a popular research area among health researchers because it is an important factor that impacts the quality of patient care delivery [3]. A variety of factors or predictors have been tested in relation to nurse job satisfaction, such as age, gender, years of experience, educational level, and work environment. Some researchers report that the quality of the nurse work environment, type of unit, and type of hospital are good predictors of job satisfaction among registered nurses.

Additionally, health care organizations have had increasing interest in working conditions and their consequences on nurses because it has been apparent that they can affect the performance of health care organizations. Traditionally, besides job stress, working conditions in health care settings have also been associated with nurse job satisfaction, nurse-patient relationship, and the quality of nursing care.

Most of the previous studies were conducted in high-income countries, but the situation in Azerbaijan is not the same. Although in European countries the workingenvironment has been the subject of various studies, the scientific evidence base on work environment and job satisfaction in the nursing profession is limited. Despite the significant efforts implemented in the process of improvement of working conditions and combating corruption in the medical system of Azerbaijan after gaining independence, its outcomes are not so significant. Because among the physicians and medical staff working in hospitals, including nurses, there are frequent violations of the workschedule: they work more than 24 hours, attend to more patients, and have over congested job duties.

In the nursing care settings, where registered nurses work, the quality and safe patient care provisions are strongly impacted by workplace work environment and job satisfaction, highlighting the important need of quality workplace conditions, in terms of optimizing nurse outcomes and patient care provisions. However, it is revealed that a significant number of hospital work settings do not meet the essential and persisting standards and requirements of quality workplace conditions, which may be linked to a reduction in nursing accessibility, safety and resource development, and a critical increase in patient care misuse and premature mortality. Moreover, improvement in physical and psychological safety and safety of the patients: nursing work settings, issues, diagnosis, and nutrition. This key workforce problem, concerning many nations around the world, also includes a situation in Jordan, with a reasonably high nurse-to-population rate, but limited and insufficient posts for registered nurses in healthcare. This may have been related to the country's relatively low resource deciding skills and the limited quality nursing teaching is completed currently. In the important location of service to building up the reference health expansion, the country faces a high disease burden. In the Jordan hospital care settings, a poor nursing job satisfaction rate has been affected, which may result from unfavourable nursing work surroundings.

3.1. Literature Review

A review of the English language literature was performed to discover validated instruments that could be applied to research settings to measure the

work environment experienced by hospital healthcare professionals. In 10 databases, a search was conducted of English language literature published up to mid-September 2018 that presented a validated instrument or provided results from entirely valid instruments that evaluate a set of aspects thought to contribute to the assessment of the work environment experienced by hospital healthcare professionals. Seven instruments were discovered, that have been judged as valid and e.g. all subscale level coefficients are reported by factors or dimensions therein. It was also found that the content of these instruments is exhaustive: the seven instruments collectively include all but five of the 41 aspects thought to constitute the work environment of hospital healthcare professionals [4]. Background: Research instruments created to measure the work environment of healthcare professionals working in hospitals are often not presented in the scientific literature and/or are often not developed following established psychometric procedures. That hinders evidence based promotion of healthcare professionals being employed in hospitals in a conducive work environment, which in turn could enhance the healthcare professionals' well-being and job satisfaction, a consideration essential for the attraction and retention of skilled staff in hospitals. Chaos and ill-being in the work environment of hospital healthcare professionals may have a low-value care and camaraderie negative effect on the well-being of the healthcare professionals which in turn may have a detrimental effect on the quality of patient care eventually delivered by the healthcare professionals.

In the current study, workplace work environment (WWE) is defined as the physical, psychosocial, and organizational aspects in the workplace that influencethe well-being of healthcare professionals, including nurses. Various studies show the strong relationship between WWE and patient outcomes. A qualitative systematic review found that environmental, staffing, and organizational factors, as well as high quality of team-based care, were found to be very important for the quality of patient care. An integrative review concluded that the quality of nursing care was related to the safety and support of the work environment. There are also several studies related to the direct relationship between WWE and quality of patient care. A study confirmed that RCA was positively associated with employee performance and job quality, and performance management and organizational culture played a mediating role.

In healthcare organizations, the quality and availability of care are not only affected by the professionals working in these healthcare services but are also significantly influenced by their work environment. To improve this quality of care and to guarantee thesafety and health of the patients, it is important that the work environment of healthcare professionals is optimal. This study is conducted in three different hospitals in the west of Turkey and goes beyond the hospital to obtain a complete inventory of the hospital work environment. Healthcare services are correlated with job dissatisfaction, burnout, and an increased number of errors. In addition, a suitable hospital work environment can result in professionals who have greater job satisfaction, are more engaged in their work, and hence supply better patient outcomes. The hospital work environment consists of nine multi-item scales: sufficient staffing, balanced staffing level, culture of team work, leadership, support for professional development, autonomy, workload manageability, work-life balance, and work pressure. High healthcare services are frequently complex, demanding emotional effort, and personal responsibility, in return for a relative lack of control over the job. Management of these hospitalcharacteristics, and of protective aspects of the hospital work environment, gives aspects high conscientiousness and dedication as well as lesser burnout and depersonalization.

3.2. Conceptual Framework

Public hospitals in Thailand have 78,850 nurses working in clinical practice. However, there are no current research addressing workplace work environment, job satisfaction, and quality of patient care. The aim of this study was to investigate the relationship between workplace work environment variables of transforming leadership and quality of support for learning, job satisfaction, and quality of patient care.

To whom the care of people with some illness falls, i.e. patient care, is the primary duty of a treatment facility. The quality of patient care enabled by system, standard, and plan for patient health care. Other activities for care must be suitable for the patients' need and must be achieved a particular standard, must avoid harm and abuse, and performed with kindness, courtesy, and respect for thepatients dignity. These activities were performed by trained professional, i.e. by nurses. If a treatment facility does not have nurses to take care of the sick person, so there are not enough patient care by the nurses. People and nurses should be considered the quality of patient care is the effect of the treatment result according to the needs of the patients suitable for the principles and standards of patient health care. Good quality of patient care can help speed up recovery, prevent complications, and reduce the duration of illness or admission. Do not harm the patient and the chance to return to suffer from the disease.

Ample evidence supports the psychometric properties (primarily reliability and content and predictive validity) of Instruments at the individual level, but still lacking are Instruments that measure key work environment variables at the organizational level for use in larger scale research. A variety of research instruments have been developed to measure phenomena relevant to work environment in the hospital setting. These instruments primarily focus on the impact of organizational characteristics on nurse outcomes (e.g. job satisfaction) and patient outcomes (e.g. quality of care). The work environment variables assessed by such instruments generally include a set of 22 single items, reflecting nurse perceptions of management and organizational support, nurse-physician relationships, collegial nursing team, autonomy, and staffing resources; these 22 single items have sound empirical support. Less clear is the psychometric soundness of these instruments when used in other countries, and much less clear is the factor structure of these 22 items on key work environment constructs. Clarifying the factor structure of these 22 items item sets could offer a research tool to investigate the relationship between work environment and a variety of nurse and patient outcomes, thereby facilitating results that are comparable across international samples. Consequently, Issues of workplace work environment on female may likely affect quality of patient care [5]. There are also potential social, medical and nursing professional areas to exploration about this nursing research. However, because it is not yet clear whether the Organization of Transformed healthcare work environment affects the likelihood of experiencing nursing workplace work environment stress leading to adverse resulting in female Thai nurses and Literature Review of the same work environment, but in another clinicunder the same policy platform, suggest a different risk factor, it is apparent that female Thai nurses should be analyzed. The results of this study will help demonstrate the organization of care factors that can be controlled to create a positive work environment for female Thai nurse and quality of care patient.

The current research is conceptualized within Donabedian's structure-process-outcome model (SPO model) modified by Aiken and colleagues. This framework suggests that work environment (structure)plays a role in explaining processes (nurse staffing, work hours, burnout) and in turn impacts patient outcomes. Work environment is defined as the organizational, instrumental, and relational characteristics of a job that facilitate or inhibit its physical, social, and psychological nature. Nurse practice environment is a specific dimension of work environment that includes both middle-range and global concepts (organizational and instrumental attributes of work). The condition of the practice environmentaffects the ability of a nurse to apply knowledge and participate in sound decision making. Having a positive practice environment has been linked to increased job retention, decreased burnout, lower probability of making an error, and improved quality ofpatient care [5].

The current study uses the Practice Environment Scale of the Nursing Work Index (PES-NWI) to measure nursing practice environment. The PES-NWI consists of 31 items. Workforce factors (nurse staffing and burnout) are chosen to reflect Aiken et al.'s extended version of the SPO model. Burnout is a set of three psychological conditions characterized by emotional exhaustion, deperso-

nalization, and reduced personal accomplishment. There is a strong association between work environment, nurse staffing, patient outcomes, and a lower quality of care. The overall working conditions of a nurse, when poor in quality, contribute to the onset of burnout. For nurses, poor working conditions may lead to a decrease in the quality ofcare and a subsequent increase in adverse patient outcomes. Nurse staffing is the organizational structure of the workforce that plays a key role in determining the amount and quality of process that can be enacted. Staffing variables should reflect either the degree of low literacy of the patient or the ability of the nurse workforce to interact effectively with the patient. Staffing should be one unit-based variable and one shift-based variable. Shift hours reflect extended working periods that alter theautonomy of a nurse to work effectively and productively, and unsafe working hours prevent a nurse from applying knowledge in the working place. Short and long work hours pose a safety threat to patients and disadvantage some quarter of nurses. Inconsistent work hours among nurses on a team make decision-making more difficult and block effective handoff communication. Shift hours should be measured by two variables: the proportion of a nurse unit working a 12-h shift and the proportion of a nurse unit working on the evening or night shift (3-11 and 11-7).

Working in a hospital environment can be very challenging for nurses since they often work in emotionally difficult situations under time pressure. Task-related relationships are a complex task as the nurse's work is multifaceted. The nurse's professional knowledge is broad and nurses need to navigate in a large network of people around the patient. However, there have been indications that job satisfaction is positively related to the care outcome, and positive relationships have been found between practice environment and job satisfaction. The practice environment is support factors, such as the hospital organization's leadership, the cooperation with physicians, the learning opportunities, and the chancesnurses have to have a direct say in shaping their work situation. Other important factors are the ability to balance work and private life, workload, and patient safety [5].

Increased life expectancy in combination with an increase in the number of chronic patients constitutes a continuously increasing part of the demands on healthcare services. Going through a major organizational change can affect the care outcome. While a new organization may bring a fair amount of novelty to the workplace, many employees are likely to perceive the new circumstances as a threat, e.g., the job security could be affected, a cooling off in the desired intimacy between colleagues, or a loss in the professional status of the occupation. One of the cornerstones in both the care organization and the nursing practice is nursing information. Changes affecting the work with nursing information may thus affect nursing practice. What is more, complexity may be introduced by the fact that a part of the nursing information is patient specific and therefore is subject to strictly enforced norms concerning how and to whom patient information may be communicated; further, the fear of being reported missing warnings may have changed one's behavior.

4. Results and Findings

A positive work environment promotes the successful implementation of client-centric services and interventions in psychiatric care settings. Therefore, negative perceptions of job satisfaction and work environment among nurses may reduce the quality of client care. The objective of the present study was to explore whether workplace work environment factors predict job satisfaction levels among nurses in psychiatric clinics, consequently influencing the quality of patient care. Although studies have considered the impact of work environment on job satisfaction, studies that link job satisfaction with the quality of patient care are lacking. Participants in this cross-sectional study consisted of a convenient sample of 361 nurses from psychiatric clinics. Data on the workplace work environment, job satisfaction and quality of patient care were collected using validated instruments. The results of multiple parallel-mediational analysis (MPMA) revealed that quality of patient care was fully mediated by job satisfaction and workplace work environment. However, the workplace work environment had a direct and significant relationship with the quality of patient

care in the absence of job satisfaction. In summary, a healthier work environment and higher job satisfaction in the nursing profession lead to the quality of patient care [3].

Nurses' reports of healthier workplaces, particularly workload management, psychological protection, physical safety, and engagement, were associated with higher ratings of quality and safe patient care [3]. Considerable work pressure and inadequate professional growth opportunities were factors that statistically significantly impacted nurses' well-being and subjective ratings of care quality. This research suggests health care administrators invest in nurse-supportive organizational strategies in light of impending workforce shortages and persisting patient care demands. Nurses are a critical professional group in the delivery of patient care. This is especially the case since nursing is the largest health profession in most industrialized countries. Nurses not only provide hands-on care to patients but advocate and care for them as a whole. Nursing has also been identified as indispensable in leading patient care toward successful patient outcomes. Patient care quality and safety have been, thus, firmly linked to nursing practice. Consistent with this affirmation, nurses assess patient conditions, communicate with physicians, give medications, and provide physical and emotional care to address patients' multidimensional needs. However, nurses often experience stressful conditions at work which can impede their optimal professional practice and affect the quality of patient care. Studies suggest that the quality and safety of patient care may deteriorate under such circumstances and thereby negatively affect patient outcomes. Nursing is a highly stressful occupation which may be partially attributed to the nature of their work and the work environment of healthcare settings in general. In particular, nurses are exposed to considerable work pressure due to an increased workload, staffing shortages, and numerous extra-tasks. While being engaged in numerous concurrently ongoing tasks, they are often required to make split-second decisions that carry substantial risks. Such stressful conditions in the delivery of patient care can hamper nurses' optimal practice and consequently diminish the quality and safety of care. Working in such pressurized circumstances overtime may also exacerbate nurses' perception of work strain and lead to burnout. The latter, in turn, has been shown to reduce job satisfaction, exacerbateoverall psychological distress, and may even result in lower patient care quality and safety as evidenced by the negative impacts on critical patient outcomes.

5. Discussion

There is limited research in cardiology specifically among cardiovascular technologists (CVTs) pertaining to the impact of workplace and demographic factors both on job satisfaction and the overall quality of patient care delivered. Statistical analysis was performed using ordinary least squares regression between workplace and demographic predictors on the outcomes of job satisfaction rating and patient care quality rating. Data analysis aims to further the understanding of the interplay between workload, stress, management support, workplace physical hazards, and demographic factors in association with job satisfaction rating and mostly quality patient care delivery rating in cardiology. There were a total of N = 353 responses analyzed in this data survey.

Regarding overall results, workload and job satisfaction share four significant interactions. The top predictive interaction was between the stress construct and the stress construct. The main effect for the workplace stress level is significant and positive on the job satisfaction rating, so too is the three-way interaction of workplace stress level, management support, and physical hazards. Additionally, overall patient care quality and patient care quality share four significant interactions. The most substantial interaction was between patient care quality rating and the nurse construct. Further detailed causal analysis on the understanding and intelligibility revealed that the model explained 24% of the variance in the job satisfaction rating, this agglomeration of predictors explaining the most variance in the job satisfaction rate. In parallel, 26% of the variance in the patient care quality rating is explained by these predictors, which likewise understands the most variance in the patient care quality rating. As anticipated, demographic embed-

dedness and the remaining workplace factors generally have weak to no main effects or mediating effects on job satisfaction rating and patient care quality rating [3]. Akin, the patient care quality delivery model illustrates that the education level and year effects are significant predictors of cardiovascular technologists on 11 of the 17 constructs associated with patient care quality.

The profession of caregiver professions is among the most stressful professions in the world. In fact, a recent study concluded that 44% ofdoctors and especially nurses and auxiliary personnel who work in hospitals have high levels of psychological symptoms. Workload, lack of resources, lack of recognition, conflicts, sense of unfairness, and interpersonal relationships all alter health carepersonnel and impair the quality of patient care. Since the nurse is the person who stays with the patient the most in the hospital, the care and treatment of the patient is their responsibility. The satisfaction of health care personnel, which takes on such a large responsibility, is seen as an important issue in terms of job performance and employee health [6].

Unhappy employees decrease their performance and withdraw from their jobs. There is a negative relationship between patient satisfaction and mortality and morbidity when the quality of health care provided is insufficient. Nurses' reports of healthier workplaces, notably workload management, meaning, psychological protection, physical safety, and engagement, were corresponded with higher ratings of quality and safe patient care. Cardiology and CCU view findings were equivalents with other departments, as workload management in addition to decisions concerning assignment of patients came earliest. Except for outpatient, overall means for nurse units below ends from the 7% point. Too, stat means for LPN positions nearly all fell below ends from 6% point.

This cross-sectional study of nurses in British Columbia found that nurses' reports of healthier workplaces were associated with higher ratings of quality and safe patient care. High demand will be placed in the next decade on healthcare services, as the population of older adults grows. There may be further stress on nurses because of the increasing comorbidities. Thus, understanding what hinders or promotes nursing quality and safe patient care is beneficial in terms of predicting the measures that can be put in place to improve patient safety and nurses' working conditions. Healthcare workers will deliver safer and more consistent treatment if the work environment is adequate. The results indicate that safer management and work environments of nurses were closely connected to higher patient care safety ratings. Steps that could enhance the health and wellbeing of nurses and the safety and quality of patient care in hospitals are listed below [3]. All of this might have an impact on the process of protecting patient safety and nurses' wellbeing. Random Forest's algorithms may be employed on a bigger dataset or applied to other job categories to recognize additional state-approved interdisciplinary nursing strategies worth incorporating.

5.1. Implications for Healthcare Management

This is the first study to investigate the relationship between the workplace work environment, job satisfaction, quality of patient care and stress. The high-quality datasets in this study were collected from complete pairs of registered nurses and warranted registered nurses across the United States of America [3]. A nationwide survey was conducted in 2018 and 2019 using the validated questionnaire. The study found that job satisfaction is positively associated with quality of patient care and negatively associated with stress. Quality of patient care is positively associated with job satisfaction and negatively associated with stress. Stress is negatively related to job satisfaction and quality of patient care. Therefore, by providing a good working environment, health nurses can improve the quality of patient care and job satisfaction and reduce stress.

The quality of patient care is most authoritative in healthcare and refers to the provision of health care that is safe, effective, and respects and cares for patients. Job satisfaction among healthcare personnel is imperative and is considered as an essential parameter where it affects their productivity and the quality of their work. Because it could lead to decreased productivity and negative implications

for the quality of the services they provide. Some patients experience increased demand for facilities and better patient care. As a result, there is a better understanding between nurses and patients. Not only the educational process should be improved, but the working conditions of the hospital should also get better.

In this study, the impact of the healthcare work environment on job satisfaction among the health-care providers (doctors, nurses, and administrative workers) was investigated in a Saudi University hospital. This research was conducted to examine how the various dimensions of the work environment can affect the job satisfaction of the health-care providers. The effects of job satisfaction on the quality of the patient care provided by the health-care providers were also examined.

5.1. Implications for Healthcare Management

In the literature, it has been extracted that the environment in which health care providers work is as important as the equipment they use, the financial resources they have, or the skills they have. However, the work environment in health-care has not yet become an essential part of the strategies for health-care services. This work-exploring the impact of the work-environment on job satisfaction displays that hospitals and other health-care institutions should be attentive to administrative measures in healthcare management to boost job satisfaction and enhance working conditions in need to offer the high quality of patient care. It also suggests that signals the policy-makers in health-care services should be considering strategies to enhance job-satisfaction by developing work-environment, which could have a straight impact on patient care quality and patient health [2].

6. Conclusion and Recommendations

Having good workplace work environment conditions can led to increase satisfaction in general and in concerning work satisfaction that reflects the nurse pleasure of work [7]. The change of job satisfaction can led to poor quality patient care delivery, thus it is important to maintain job satisfaction of nurses in order to get the patient satisfied with the quality of care delivery. The caring of nursing work environments was an important factor in making hospitals a competency-based hospital, so that nursing staff would deliver excellent care that paid attention to the need for patient care services. Safe and conducive occupational health situation work environments are needed to improve work for health services, this is to obtain optimal working conditions and to facilitate and improve nurse competence and performance [3, 8]. High rate of job satisfaction will led to a greater expected nurse commitment to be more responsible for the tasks to be completed so that it became on time and right target as well as avoiding unfavorable possibilities for patients. Therefore, high rate of job satisfaction can led to good and optimal care provided as well as increasing patient satisfaction in the provision ofhealth care quality at teaching hospitals through the role of caring nursing work environments. In addition, nurse quality and safe patient care provision must be considered in the process of giving care to patient outcomes that must be accounted for in improving patient safety in healthcare facilities so that hospital institutes can be free of patient safety problems. Often patient care by nurses is merely the task to keep patient safety while the quality of care is not attended to tend to be neglected. There were still shortcomings in prevention and reduction of service errors that potentially or have had an impact on the safety of service recipients.

The quality of patient care and job satisfaction in healthcare settings are linked to the work environment. Insufficient attention in previous research has been paid to workplace specifics, particularly in the healthcare sector, and no studies have addressed such specifics simultaneously and synthetically. The findings indicate that improvements in the following workplace conditions may enhance nurses' provision of quality and safe patient care: workload management, psychological protection and engagement, and physical safety. These findings offer insights to practitioners, suggesting several evidence-based interventions for improving the work environment of nurses in healthcare settings. The National Standard of Canada for Psychological Health and Safety

in the Workplace (the Standard) and a corresponding assessment tool, the Guarding Minds at Work (GM@W), were developed to foster awareness and promote action for addressing the negative psychosocial factors that are present in the workplace. A comprehensive instrument evaluation facilitated the development of a validated and globally applicable measure of workplace conditions that considers several important domains. The existing evidence suggests that the surveyed work environment creates a threatening and burdensome situation for patient care professionals. It reveals that nurses' workload management, psychological protection and engagement, and physical safety are the most important determinants of quality and safe patient care in units. Collectively, overall workplace conditions have a substantial impact on nurse-related patient care outcomes. This study emphasizes that in order to excel the quality and safeness of patient care, clinical units should prioritize workplace-specific interventions, particularly those of systematic nature and using the newest techniques [2].

References:

[1] M. Nelson, A. (2011). *Nurses' job satisfaction in the work environment*.

[2] Aiman Halawani, L., Aiman Halawani, M. & Mohammed Beyari, G. (2021). *Job satisfaction among Saudi healthcare workers and its impact on the quality of health services*. ncbi.nlm.nih.gov.

[3] Havaei, F., Ryan Ji, X. & A. Boamah, S. (2022). *Workplace Predictors of Quality and Safe Patient Care Delivery Among Nurses Using Machine Learning Techniques*. ncbi.nlm.nih.gov.

[4] Maassen, S. M., Marie, J. W., Weggelaar Jansen, A., Brekelmans, G., Vermeulen, H. & JVan Oostveen, J. C. (2020). *Psychometric evaluation of instruments measuring the work environment of healthcare professionals in hospitals: a systematic literature review*. ncbi.nlm.nih.gov

[5] Van Bogaert, P., Van Heusden, D., Timmermans, O. & Franck, E. (2014). *Nurse work engagement impacts job outcome and nurse-assessed quality of care: model testing with nurse practice environment and nurse work characteristics as predictors*. ncbi.nlm.nih.gov

[6] Pimenta Lopes Ribeiro, O. M., Oliveira Coimbra, V. M., De Abreu Pereira, S. C., Da Conceição Alves Faria, A., Figueiredo Cabral Teles, P. J. & Gomes da Rocha, C. (2022). *Impact of COVID-19 on the Environments of Professional Nursing Practice and Nurses' Job Satisfaction*. ncbi.nlm.nih.gov

[7] Abdou, H. A., Ali Alalawi, F., Ali Abdulsalam, E. & Ali Alzahrani, T. (2019). *Effect of Perceived Nursing Work Environment on Nurses Job Outcomes at Primary Health Care Centers-Jeddah*.

[8] Al-hamdan, Z., Manojlovich, M. &Tanima, B. (2017). *Jordanian Nursing Work Environments, Intent to Stay, and Job Satisfaction*.

Publication consent:

The authors read and approved the final manuscript.

Conflict of interest:

The authors declare that they have no conflict of interest. This document only reflects their views and not those of the institution to which they belong.

Mohammad Atyan A,

Helth Information Technican, National Guard Health Affairs

Abdulmajeed Abdullah A,

Helth Information Technican, National Guard Health Affairs

Magna Scientia UCEVA
Vol. 4 N° 2 (2024) - P.P. 58 - 73
ISSN:2805-6884 e-ISSN:2805-6701
DOI:10.54502/msuceva.v4n2a6

Improving Water Quality Prediction in the Yamuna River, Delhi (India)

Perfeccionamiento de la predicción de la calidad del agua en el río Yamuna, Delhi (India)

Neetu Guptaa – Career Point University, Kota – India
Surendra Yadavb – University, Jaipur – India
Neha Chaudharyc – Manipal University, Jaipur – India

Key words:
Yamuna River Water Quality Index (WQI), Hybrid approach, Latent Semantic Analysis (LSA), Extreme Gradient Boosting

Palabras clave:
Río Yamuna, índice de calidad del agua (WQI), enfoque híbrido, análisis semántico latente (LSA), Extreme Gradient Boosting.

Abstract

The Yamuna River, crucial for the water supply of several cities, faces a serious pollution problem due to industrial discharges, threatening both the health of ecosystems and the well-being of communities that depend on this resource. Current methods for assessing water quality, especially the quality index, are expensive and require considerable data collection time. In turn, traditional predictive models often fail to adapt to environmental changes, underlining the need for more advanced approaches that enable accurate and timely predictions of the water quality index, critical for effective water resource management.

In this research, machine learning techniques are used to make predictions on the water quality index, highlighting the limitations of existing models. The potential of various approaches is examined and an innovative hybrid methodology is proposed that combines Latent Semantic Analysis (LSA) for dimensionality reduction with Extreme Gradient Boosting, with the aim of improving the accuracy of predictions.

To conduct the study, water samples are collected from nine locations along the Yamuna River, focusing on industrial areas, and various parameters are analyzed. The calculated water quality index is then evaluated using various machine learning models as well as the proposed hybrid methodology. The evaluation criteria focus on accuracy, responsiveness, and the ability to predict the water quality index using limited but meaningful parameters.

The research results demonstrate the effectiveness of the hybrid methodology in predicting the water quality index, achieving a remarkable maximum accuracy of 95.2%, which is higher than other advanced models and techniques. This study provides valuable insights for water quality assessment, presenting an efficient and accurate data-driven approach essential for sustainable water resource management.

Resumen

El río Yamuna, crucial para el abastecimiento de agua de varias ciudades, se enfrenta a un grave problema de contaminación debido a los vertidos industriales, lo que amenaza tanto la salud de los ecosistemas como el bienestar de las comunidades que dependen de este recurso. Los métodos actuales para evaluar la calidad del agua, especialmente el índice de calidad, son costosos y requieren un considerable tiempo de recopilación de datos. A su vez, los modelos predictivos tradicionales a menudo no logran adaptarse a los cambios ambientales, lo que subraya la necesidad de enfoques más avanzados que permitan predecir de manera precisa y oportuna el índice de calidad del agua, fundamental para una gestión eficaz de los recursos hídricos.

En esta investigación, se utilizan técnicas de aprendizaje automático para realizar predicciones sobre el índice de calidad del agua, destacando las limitaciones de los modelos existentes. Se examina el potencial de diversos enfoques y se propone una metodología híbrida innovadora que combina el análisis semántico latente (LSA) para la reducción de la dimensionalidad con Extreme Gradient Boosting, con el objetivo de mejorar la precisión de las predicciones.

Para llevar a cabo el estudio, se recopilan muestras de agua en nueve ubicaciones a lo largo del río Yamuna, centrándose en áreas industriales, y se analizan diversos parámetros. Posteriormente, el índice de calidad del agua calculado se evalúa mediante varios modelos de aprendizaje automático, así como la metodología híbrida propuesta. Los criterios de evaluación se centran en la precisión, la capacidad de respuesta y la habilidad para prever el índice de calidad del agua utilizando parámetros limitados pero significativos.

Los resultados de la investigación evidencian la efectividad de la metodología híbrida en la predicción del índice de calidad del agua, alcanzando una notable precisión máxima del 95,2 %, superior a la de otros modelos y técnicas avanzadas. Este estudio proporciona valiosas perspectivas para la evaluación de la calidad del agua, presentando un enfoque basado en datos que resulta eficiente y preciso, esencial para la gestión sostenible de los recursos hídricos.

1. Introduction:

Water, as a vital component of our environment, plays a critical role in sustaining life and supporting various ecosystems. In an era marked by rapid urbanization, industrialization, and agricultural expansion, ensuring the availability of clean and safe water has become an imperative for global well-being. Proximity to rivers has been advantageous, providing water for various purposes. However, balancing river water use is crucial for sustainable resource management and protecting ecosystems. Pollution sources, including industrial discharges, agriculture, and sewage, vary by región [1, 3]. The River Yamuna faces severe pollution from industrial units in Delhi, Faridabad, Mathura, and Agra, with around 359 units releasing untreated wastewater. The Yamuna River in the Uttarkashi district of Uttarakhand. It's vital for several cities supporting drinking water, irrigation, and industries. Efforts are underway to address pollution through measures such as wastewater treatment, environmental regulations, and public awareness [4, 5]. Preserving the Yamuna River requires effective pollution control, wastewater treatment, and public involvement for sustainable use. Different regions have developed water quality indices tailored to their needs, essential for summarizing data and guiding pollution control measures.

The Water Quality Index (WQI) serves as a critical numerical index that assesses overall water quality conditions, to implement pollution control measures for safeguarding the Yamuna River ecosystem and human health. A crisp knowledge of water quality is essential, thus playing a pivotal role in evaluating

the state of various water bodies to improve their management. Computation of the Water Quality Index involves considering multiple parameters such as pH, dissolved oxygen, turbidity, chemical oxygen demand (COD), biochemical oxygen demand (BOD), temperature, and the presence of pollutants, necessitating on-site data collection. However, the earlier method of computing various parameters through samples was labor-intensive, and was associated with high financial costs [6]. Therefore, the WQI is indispensable for ensuring the repeated and effective monitoring of water body quality, especially in regions prone to frequent pollution. So, for early identification of such sources [7] and to predict WQI is the one of the majors concerned of the researcher in the past.

This work endeavors to explore several techniques to predict Water Quality Index, focussing on addressing the limitations of current models. Machine learning, a subfield of artificial intelligence, has demonstrated its efficacy in pattern recognition, data analysis, and prediction across diverse domains. By leveraging the capabilities of machine learning, this study aspires to enhance the accuracy and timeliness of WQI predictions, contributing to more effective water resource management strategies [8].

This research aims to evaluate quality of water in the surroundings of industrial areas along the Yamuna River in Delhi, employing various parameters. The collected data is then utilized to compute WQI by employing numerous models namely, logistic regression (LR), Decision Tree (DT), Support Vector Machine (SVM), Naïve Bayes (NB), and XGBoost. To enhance the results, a novel hybrid methodology is proposed, integrating Latent Semantic Analysis and Extreme Gradient Boosting. Latent Semantic Analysis performs dimensionality reduction on the dataset features through singular value decomposition, enhancing feature representation. The improved features are then fed into the Extreme Gradient Boosting technique for further prediction. Extreme Gradient Boosting (XGBoost) is an optimized approach that takes inputs from multiple weak models to yield a robust prediction. The proposed hybrid approach achieves a maximum accuracy of 95.2%, outperform other state-of-the-art techniques. Notably, this high accuracy is achieved using only three of the most significant parameters, showcasing the efficacy of the proposed methodology.

The main contribution of this work includes:

- Last 8 years' data (2013- 2021) is gathered from CPCB and converted into machine readable format for the further processing.
- WQI is calculated on 9 sites of Delhi on four parameters such as pH, DO, BOD, COD.
- Various models such as LR, NB, SVM, DT and XGBoost are applied.
- A hybrid approach based on LSA (Latent Semantic Analysis) and XGBoost is proposed based on various parameters of water.

Related work

This section presents the work done on prediction of WQI.

Ahmed et.al. [6] explored various techniques based on Four input parameters. The results depict that gradient boosting was most efficient in prediction of WQI, and the multi-layer perceptron attains highest WQC classification accuracy at 85.07%. This proposed methodology achieved significant accuracy using minimal parameters set.

In another work, Wang et.al. [9] Focused on model stacking approach. Microbial contamination in beach water poses risks to swimmers due to exposure to harmful pathogens. An ensemble approach known as model stacking was proposed for water quality assessment for beaches. Outputs from five machine learning models were fed as an input to another model. In this, accuracy rankings for the stacking model remained consistent for first two years, with average accuracy of 78%, 81%, and 82.3% respectively. Silberg et al. [10] utilized an approach that combined attribute-realization with SVM algorithm for Chao Phraya River. The study, based on a historical dataset spanning 2008 – 2019 and encompassing various parameters, followed a four-step process: data pre- processing, attribute evaluation, exploration of mathematical functions. The study observed that different combinations of attributes and mathematical functions resulted in

varied performance. Validation of the approach confirmed that proposed method proved to be a robust method for classifying river water quality, achieving an accuracy range of 0.86 to 0.95 when using three to six attributes. This underscores the effectiveness of the AR-SVM approach in accurately categorizing the Chao Phraya River's water quality based on diverse attributes.

Yilma et al. [11] sought to present a comprehensive assessment of pollution levels in The Little Akaki River. The approach employed neural network on twelve parameters gathered from 27 sites. The results indicated that, with the exception of one upstream site, all sampling locations were classified under the poor water quality category.

In their study, Bui et al. [12] employed both standalone algorithms and data-mining algorithms on Iran Water Quality Index using six years of monthly data (2012 to 2018) in the Talar catchment. Hybrid algorithms demonstrated an enhancement, although this improvement was not uniform across all cases.

In their work, Ding et al. [13] introduced a hybrid intelligent algorithm. The initial application of PCA serves to reduce data dimensionality by compressing 23 factors into 15 indices following by Genetic algorithm to enhance the dimensions of the BPNN. The results attain an overall prediction rate of approximately 91%.

In their study, Azad et al. [14] explored nature inspired and fuzzy systems to predict water quality in Gorganroud River water. ANFIS-DE model in accurately predicting Electrical

Conductivity and Total Hardness in Gorganroud River water.

Zhang et al. [15] introduced a hybrid model named HANN, to anticipate the overall performance of Drinking Water across China. The approach utilized monthly data from 45 DWTPs. The resulting HANN model demonstrated excellent performance in simulating training datasets, exhibiting enhanced predictive accuracy.

Further, Hassan et al. [8] employed several techniques to classify water quality across diverse locations in India. The previous studies are compared and are presented in Table 1.

Table 1. Comparative analysis of existing state-of-the-art techniques

Author and Year	Machine learning model used	Dataset Used	Water_ Parameters	Evaluation Metrics	Results
Ding et.al., 2014, [13]	PCA GA ,BPNN	River water	Total 23 Factors aggregated into 15 parameters.	Accuracy	Total Overall prediction rate =91%
Yilma et.al., 2018 [11]	ANN	Little Akaki River	12 water parameters	R2	R2 of 0.95 was attained
Azad et.al. 2018. [14]	GA, Ant Colony Optimization and Differential Evolution	Gorganroud River water	Electrical Conductivity, Sodium Absorption Ratio,Total Hardness	R2, RMSE, MAPE	ANFIS exhibited the best performance
Ahmed et.al., 2019, [6]	Polynomil regression, GB, MLP	-	Temperature, Turbidity, pH, TDS	MAE, Accuracy	MAE of 1.9642 and 2.7273 for WQI Accuracy= 85.07%
Zhang et.al., 2019 [15]	Hybrid Statistical Model HANN, Integrating, ANN and GA	DWTPs across China	Temperature, Chemical Oxygen EC,CE	Mean Squared Error	Results indicated a close connection between DWTP water production and wáter quality and operational parameters

Author and Year	Machine learning model used	Dataset Used	Water_ Parameters	Evaluation Metrics	Results
Bui et.al., 2020 [12]	RF, M5P, Data-Mining Algorithms	Talar catchment of Iran	All wáter quality parameters	Pearson correlation coefficients	FC and TS had the greatest and least impact.
Wang et.al. 2021 [9]	Model Stacking	Beaches Dataset	Dissolved Solid, pH, Temperature, BOD	Accuracy	Accuracy of 78%, 81%, and 82.3% respectively.
Solberg et.al., 2021, [10]	AR and SVM	Chao Phraya river	NH3-N, TCB, FCB, BOD, DO, and Salanity	Accuracy	Attained an accuracy of 0.86-0.95.
Hassan et.al., 2021, [8]	RF, NN, MLR, SVM, and BTM	Various locations in India	DO, BOD, EC	Kappa coefficient, Accuracy	The results highlighted several influencing factors.

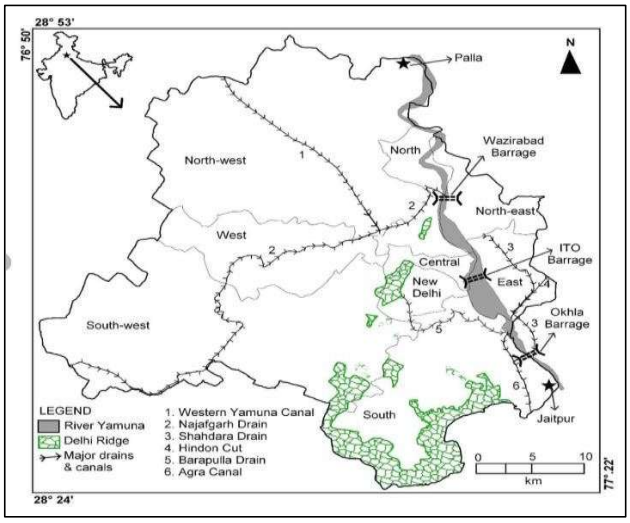
2. Methodology

The proposed methodology is divided into various steps. Steps are explained below in detail;

Dataset Collection

To perform the data analysis, data is gathered from the government Central Pollution Control Board for different locations of Delhi Region. Data is provided for 9 regions/area for 4 parameters for the years 2013 to 2021. Various location is represented trough L1 to L9. The 9 locations of Yamuna River are presented in fig 1.

Fig 1. Yamuna River Water Stations



Data Preprocessing

For the collected dataset, data is pre-processed by checking for missing values. Then, all the water quality parameters are normalized using min-max normalization approach. Then, normalized parameters are passed further for computation of Water Quality Index and further processing [16-17].

Water Quality Index (WQI)

Based on these four parameter presented in Table 2, WQI is calculated at each location from year 2013-2021 [18-19]. WQI is calculated using equations (1)-(4).

$$\text{Water Quality Index(WQI)} = \frac{\sum_{i=1}^{i=n} Wiqi}{\sum qi} \quad (1)$$

$$\text{Normalized value of each parameter} = \left(\frac{Measured\ Value - Min\ Value}{Max\ Value - Min\ Value}\right) * 100 \quad (2)$$

$$\text{Sub Index of each Parameter} = (Normalized\ Value * Weight) \quad (3)$$

$$\text{WQI} = \frac{\sum Sub\ Index\ of\ Each\ Parameter}{\sum weights} \quad (4)$$

The standard values the WQI is as per CPCB Delhi depicted in Table 2.

Table 2. WQI values and its Classification

WQI Range	WQI Classification
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
Above 100	Not fit for Drinking

Fig.2 presents the framework of the proposed approach and various components of the framework are that are explained further

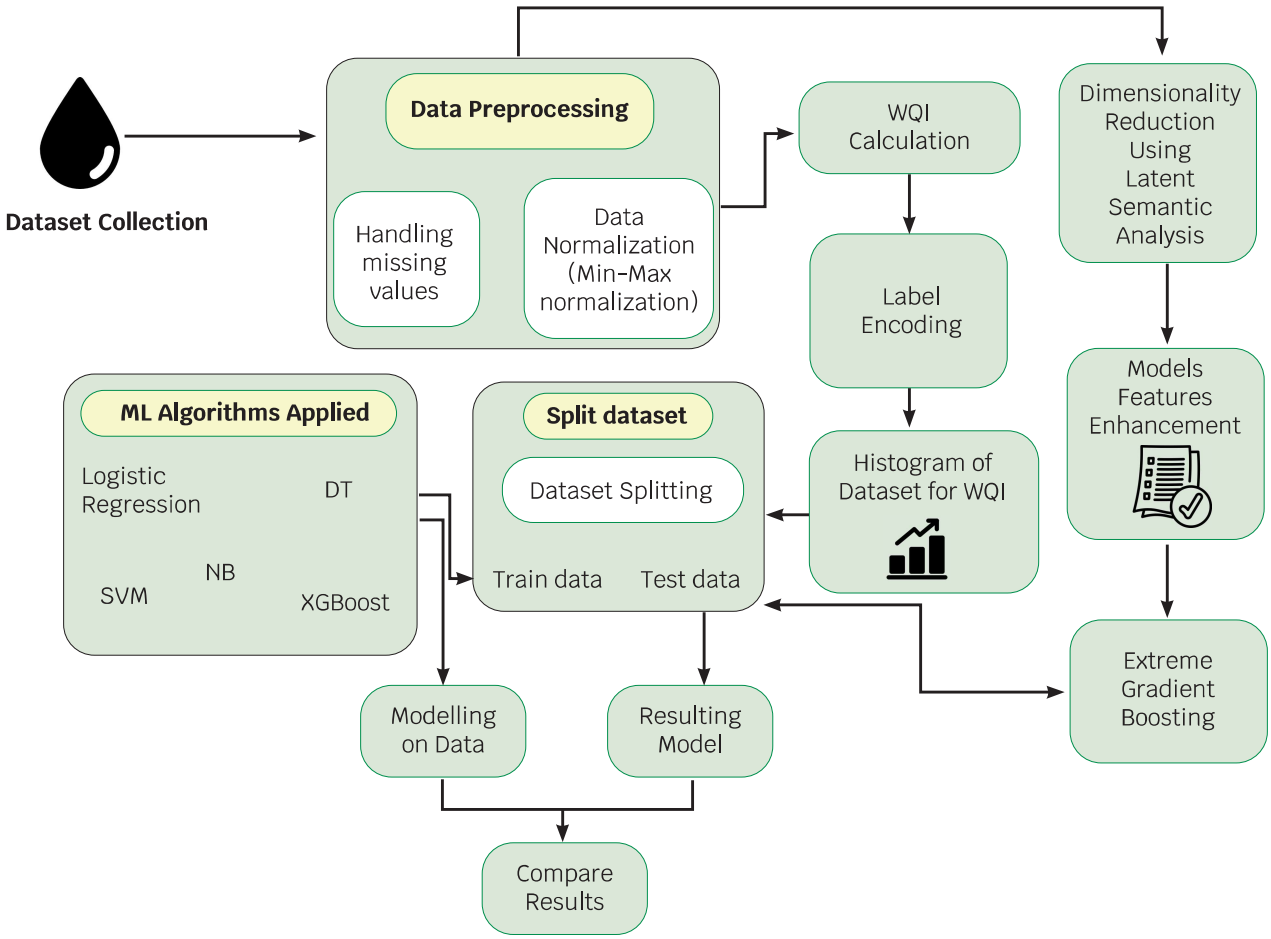


Fig. 2. Framework of the proposed methodology

Machine Learning Models

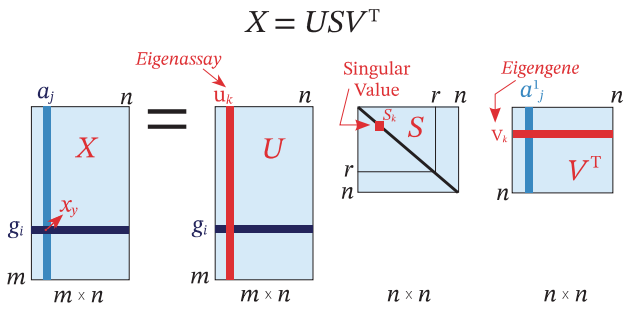
The dataset is now further split based on 70:30 ratios. On the train data, several models namely are applied. After Training the models on train data, the models are tested and WQI values are predicted. Further, the results are compared based on various evaluation metrics.

Proposed Methodology

After prediction of Water Quality Index, a new hybrid approach is proposed for improved results. In this hybrid methodology, after pre-processing of data, Laten Semantic Analysis is applied. Latent Semantic Analysis is used for Dimensionality reduction, which will further enhance the features or parameters of water i.e., BOD, COD, pH and Temperature. Latent Semantic Analysis works on the principle of Singular Vector Decomposition (SVD). It is applied to numerical parameters that involves leveraging the technique's ability to identify and enhance latent patterns, leading to a more informative feature representation. This enhanced representation can contribute to better insights and improved performance in prediction tasks. To ensure consis-

tency in scale, the numerical data undergoes normalization before the application of Latent Semantic Analysis (LSA). Normalization is a critical step to enhance the effectiveness of LSA. Subsequently, Singular Value Decomposition is implemented on the term-document matrix. Following SVD, only the top k singular values and their corresponding columns in U and V matrices are retained. This selective retention reduces the dimensionality of the data while preserving the most. The working of LSA is represnted in Fig.3.

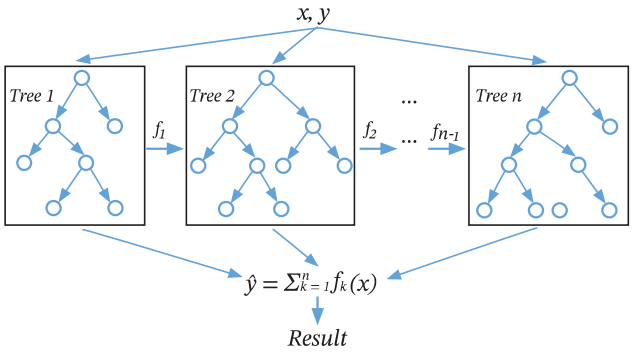
Fig.3. Process of Latent Semantic Anlaysis



In this, the reduced U matrix serves as a transformed representation of the original features, capturing latent semantic relationships between them, thus, an enhanced set of features is created that encapsulates the underlying structure and relationships within the numerical data. These features may highlight latent patterns or relationships in the numerical data that were not apparent in the original feature set. After feature enhancement, the data is reconstructed by multiplying the reduced U, Σ, and V^T matrices. The reconstructed matrix represents an approximation of the original data with the enhanced features [20-22].

Therefore, the improved features obtained through Latent Semantic Analysis (LSA) can be utilized for the subsequent training of Extreme Gradient Boosting which is an ensemble learning technique and constructs a robust predictive model. The mathematical model behind the XGBoost involves the iterative addition of weak learners to the ensemble while optimizing an objective function as shown in fig 4.

Fig.4. Working of Extreme Gradient Boosting



The objective function is the sum of the loss function over all training instances and a regularization term as depicted in Fig. 4. The dataset with enhanced features (X_enhanced) is splitted. An XGBoost model is initialized with parameters like the objective (classification), number of boosting rounds (n_estimators), maximum tree depth (max_depth) and learning rate [23-25].

Pseudocode of the proposed approach

Algorithm1: For WQI and Class Assignment

Input: A numerical dataset represented as a matrix X havingn parameters ***Output*: *WQI*, *Target Variable y* (*class*)**
Step 1: Read the matrix f *matrix = read_csv("sample matrix.csv")*
Step 2: Handle missing values *X_processed = handle_missing_values(matrix)*

Input: A numerical dataset represented as a matrix X havingn parameters ***Output*: *WQI*, *Target Variable y* (*class*)**
Step 3: Calculate Sub Index *sub_index_values calculate_sub_index(X_processed*
Step 4: *Calculate Water Quality Index (WQI) based on sub-indexwqi_values = calculate_wqi(sub_index_values)*
Step 5: *Assign class labels based on standard WQI val* class_labels = assign_class_labels(wqi_values) ***Function***
Function handle_missing_values(X): # Handle missing values (emedian) X_processed = impute_missing_values(X) return X_processed ***function calculate_sub_index(X): sub_index_values*** = (Normalized Value*Weight) return sub_index_values *function calculate_wqi(sub_index_values):* $\sum Sub\ Index\ of\ Each\ Parameter$ *return Wqi_values*
function assign_class_labels(wqi_values) # Assign class labels values *class_labels = classify_wqi(wqi_values)* *return class_labels*

Algorithm 2: Hybrid Approach and Class Assignment for unknown parameters

Input: Assume a numerical dataset represented as a matrix X having parameters and a Class label y ***Output:Target Varible y (class)for unknown parameters***
Step 1: Read the matrix *matrix = read_csv("matrix1.csv")*
Step 2: *Pre-processing and Normalize the data X_normalized = normalize(matrix)*
Step 3: Apply Singular Value Decomposition (SVD) *U, Sigma, Vt = svd(X_normalized)*
2.1. Step 4: Choose the number of components (k) to retain *k = choose_k()*
2.1. Step 5: Retain the top k components *U_k = U[:, :k]* *Sigma_k= Sigma[:k] Vt_k = Vt[:k, :]*
2.1. Step 6: Feature enhancement *X_enhanced = U_k * Sigma_k * Vt_k*
Step 7: Split the data into training and testing sets *X_train, X_test, y_train, y_test = train_test_split(X_enhanced, y, =42)*
Step 8: Initialize and configure the XGBoost model **xgb_model = XGBClassifier** **(objective='binary:logistic', num_rounds=100, max_tree_depth=3, learn_rate=0.1, sampling_rate=0.7, tree_cols-ample=0.7, seed_value=42)**
Step 9: Train the XGBoost model on the training data **xgb_model.fit(X_train, y_train)**

Input: Assume a numerical dataset represented as a matrix X having parameters and a Class label y ***Output:Target Varible y (class)for unknown parameters***
Step 10: Make predictions on the test set y_pred = xgb_model.predict(X_test)
Step 11: Evaluate the performance of the model accuracy = accuracy_score(y_test, y_pred) precision = precision_score (y_test, y_pred) recall = recall_score(y_test, y_pred)
Step 12: Predict for new parameters **Class_label= label_class(parameters)**

3. Implementation

The primary intent is to evaluate quality of water by considering multiple parameters in the proximity of industrial areas and along the course of the Yamuna River in Delhi. samples from various points along the river were collected, with a specific emphasis on locations near industrial establishments. The gathered water samples undergo comprehensive analysis for key water quality parameters. Following the data collection and analysis phase, the WQI is computed [26-27]. Subsequently, various machine learning models are employed to further refine the WQI calculations. Additionally, a novel hybrid approach incorporating Latent Semantic Analysis (LSA) and the XGBoost machine learning model is proposed to enhance predictive accuracy.

To ensure a robust dataset, information is sourced from the Central Pollution Control Board (CPCB), a governmental body, encompassing different locations within the Delhi región [26]. The data spans nine distinct regions or areas, denoted as L1 to L9, and covers four essential parameters for the years 2013 to 2021[27]. This meticulous approach allows for a comprehensive understanding of variations across the specified regions and parameters, facilitating a nuanced analysis of the environmental dynamics in this critical area. The Sample data given by the authority in image form which was converted into excel/csv format for further processing as presented in Table 3.

Table 3. Various parameter of water pollution at 9 locations of Yamuna River Delhi in March 2023

Location	Location_ Represented As	pH	COD(mg/l)	BOD (mg/l)	DO (mg/l)
Palla	L1	8.3	8	2	9.0
Surghat	L2	8	12	2.5	3.8
Khajori Paltoon	L3	7.9	112	28	NIL
Kudesia Ghat	L4	7.8	80	24	NIL
ITO Bridge	L5	8.1	72	24	1.3
Nizamaadin Bridge	L6	8.0	72	23	1.2
Agar Canal (Okhla)	L7	7.9	96	32	NIL
Shahdara Drains (Downstream Okhla Drain)	L8	7.8	112	36	NIL
Agra Canal	L9	8	96	30	NIL

WQI is computed by considering these parameters. The reference values for Wi and Qi for the Yamuna River are obtained from the Central Pollution Control system, as outlined in Table 4. The minimum and maximum values for the nine locations, according to the CPCB, are presented in Table 5. Utilizing these parameters, the WQI is computed and presented below.

Table 4. Standard values of various water quality parameters

S.No	Parameter	Standard Value	Weighted Value
1.	pH	6.5-8.5	0.2272
2.	COD	0-3	0.0077
3.	DO	5	0.3862
4.	BOD	3	0.3213

Table 5. Lowest and Highest values of 9 locations of Yamuna River

Location	pH		COD		BOD		DO	
	Min	Max	Min	Max	Min	Max	Min	Max
L1	6.7	8.6	1	6	1	14	3.9	9.6
L2	7.3	8.5	1.2	6.7	2.5	11	4.6	14
L3	6.6	7.4	1.6	7.2	8	10	1.9	8.3
L4	7.2	7.5	1.4	6.8	34	38	0.3	1.6
L5	7.4	7.6	2	6.5	26	62	0.3	1.8
L6	7.3	8	2.1	6.3	22	48	0.3	3.2
L7	7.4	7.9	2.3	6.9	22	56	0.3	2.9
L8	7.4	8	1.9	7	38	83	0.3	2.2
L9	7.3	8.1	2.0	7.1	37	76	0.28	2.1

Fig 5. Box plots for all the water quality parameters

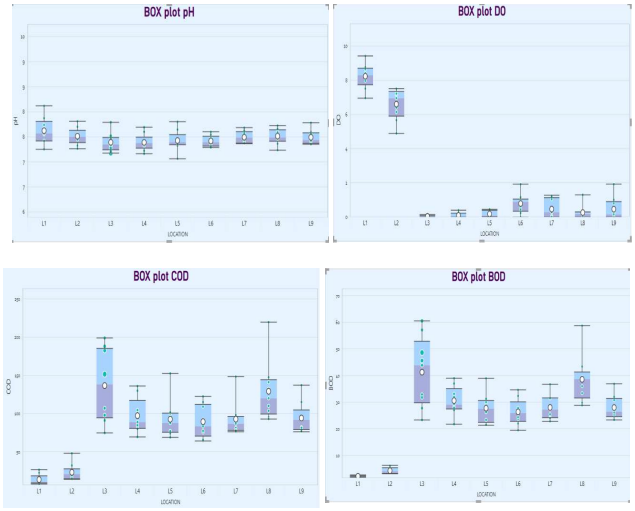


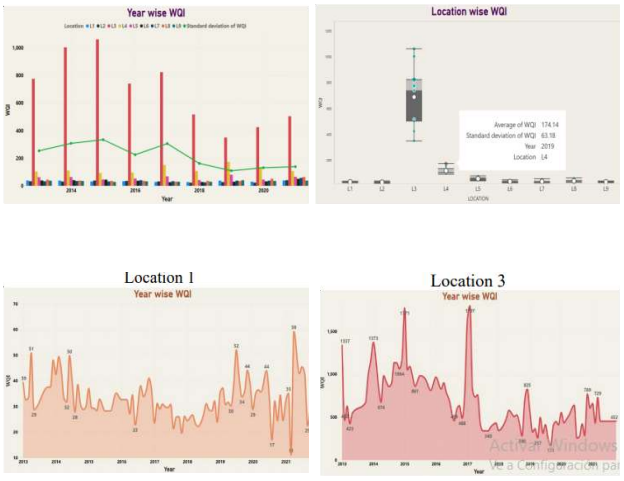
Figure 5 illustrates the Box plot representing various parameters. Upon thorough analysis of the Box plot, it is evident that L1 and L2 exhibit the most favorable water quality parameters. While Location 1 (Palla) displays slightly elevated COD levels, all other parameters conform to standard observations. Conversely, at Location 2, COD levels are higher compared to L1. In contrast, Location 3 exhibits the least favorable water quality parameters among all locations, featuring a pH value below the standard threshold of 7.5, no recorded Dissolved Oxygen, an average BOD of 55.3, an average COD of 134, and a maximum COD value of 198.

In comparison, Location 8 and Location 9 demonstrate relatively superior water quality parameters when contrasted with Location 4, Location 5, and Location 6. The authors calculated the Water Quality Index for each location from 2013 to 2021 based on these four parameters, using equations 1, 2, 3, and 4. The average values of WQI for each year are calculated, and Table 6 presents the average WQI based on the year for each location. To facilitate better comprehension and analysis, a bar graph and box plot are provided in Fig.6.

Table 6. Average WQI for 8 years for all locations

Year	LOCATIONS								
	L1	L2	L3	L4	L5	L6	L7	L8	L9
2013	38.53	32.91	776.42	103.17	62.49	38.68	32.40	44.67	36.94
2014	37.88	30.83	1004.09	110.44	63.64	40.75	34.66	38.24	34.95
2015	31.09	38.31	1062.12	93.18	45.56	44.72	31.17	35.48	27.91
2016	33.00	35.31	741.36	95.42	52.35	36.48	40.96	35.85	32.03
2017	27.67	31.47	824.33	151.54	67.85	26.20	33.14	29.87	29.39
2018	26.56	22.68	517.39	106.71	41.86	27.42	24.96	35.75	29.09
2019	37.62	26.91	350.23	174.14	80.43	29.59	37.45	33.43	40.41
2020	29.81	23.13	425.34	135.34	44.74	31.78	36.99	51.48	35.32
2021	38.78	40.58	504.05	107.32	65.08	50.55	57.70	63.82	37.77

Fig. 6 Bar graphs and line charts representing WQI



The examination underscores that the water quality in the National Capital Region (NCR) falls short of meeting acceptable standards. While there has been

a marginal enhancement in water quality post the COVID-19 pandemic, it still does not align with the prescribed standard value of Water Quality Index (WQI). Based on classifications given by table 2, further classes are grouped into three classes to enhance the accuracy as depicted in Table 7.

Table 7. Classification of WQI Range

WQI Range	WQI Classification
0-50	1
51-100	2
Above 100	0

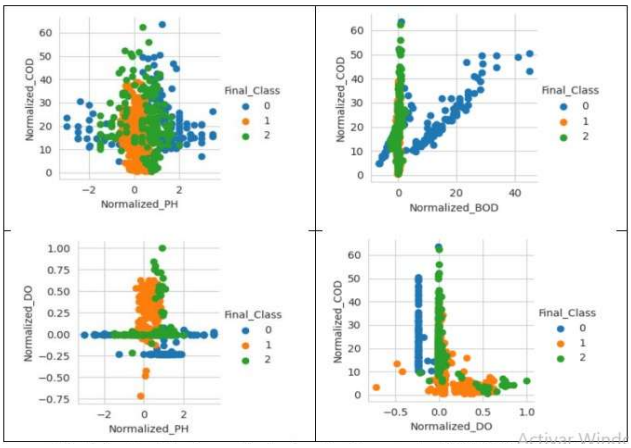
For further processing the sample data is prepared having 4 parameters and class label as shown in Table 8.

Table 8. Sample data for processing into machine learning models

Month	Location	pH	COD	BOD	DO	Quality	Class
1/1/2013	L1	7.2	32	3	10.2	Good	1
2/1/2013	L1	7.4	20	2	8.8	Good	1
3/1/2013	L1	7.4	24	2.4	8.5	Good	1
4/1/2013	L1	7.7	32	3	11.5	Poor	2
5/1/2013	L1	7.4	16	2.2	7.7	Good	1
10/1/2013	L1	8	20	2.1	7.7	Good	1
11/1/2013	L1	7.5	16	2.6	9.5	Good	1

Subsequently, the data is normalized, and a scatter plot is presented in Fig. 7 to illustrate the correlation between the normalized values and the class labels across various classes.

Fig. 7. Scatter plot of normalized values for all parameters BOD, COD, DO, Ph



These normalized values presented in Fig. 8 are subsequently condensed to three components through the application of the SVD and LSA model. The values for these components are presented in Fig.9. Three components are defined as [0,1,2] and first five values are shown.

Fig.8. Normalized values for all four water quality parameters BOD, COD, DO, pH

	0	1	2	3	4	5	6	7
normalized_PH	0.263158	0.368421	0.368421	0.526316	0.368421	0.684211	0.421053	0.578947
normalized_COD	6.200000	3.800000	4.600000	6.200000	3.000000	3.800000	3.000000	3.800000
normalized_BOD	0.153846	0.076923	0.107692	0.153846	0.092308	0.084615	0.123077	0.092308
normalized_DO	0.623762	0.485149	0.455446	0.752475	0.376238	0.376238	0.554455	0.752475

4 rows x 840 columns

Fig. 9. Enhance features obtained after applying LSA

	0	1	2
0	-0.891675	-0.231559	0.388967
1	-0.891886	-0.287322	0.349263
2	-0.894477	-0.285546	0.344056
3	-0.868946	-0.334442	0.364803
4	-0.897484	-0.294297	0.328498

Then these normalized and reduced values are passed to XG BOOST machine learning models for further predication

4. Results

To implement the machine learning model, as elaborated earlier, the samples are partitioned into three distinct classes. Class 1 signifies good water quality, Class 2 denotes poor quality, and Class 0 indicates water unfit for drinking. In total, we have 840 samples containing Date, location, pH, DO, BOD, COD, and Class label information. Colab, a Google Python environment, is employed for file reading and applying machine learning models. The authors utilized various libraries, including NumPy, Pandas, Scikit-learn, and Seaborn for plotting. The dataset consists of 465 records for Class 1, 199 records for Class 2, and 176 records for Class 0, displaying a roughly balanced distribution. The authors trained the model based on this data.In the proposed hybrid approach, all data parameters are initially normalized, and Latent Semantic Analysis (LSA) is employed for dimension reduction. While the authors used four parameters in this instance, dimension reduction can be extended to include more parameters. Following normalization and LSA, the parameters undergo training for machine learning models. Various algorithms, such as Logistic Regression [28-29], Decision Tree [30], Support Vector Machine, Naïve Bayes, and XGBoost, are applied, alongside the proposed hybrid method. The data is splitted and 10-fold cross- validation is implemented across all algorithms. The applied models are validated through Precision, Recall, and Accuracy metrics. Precision, Recall and accuracy is computed using these equations [31-33].

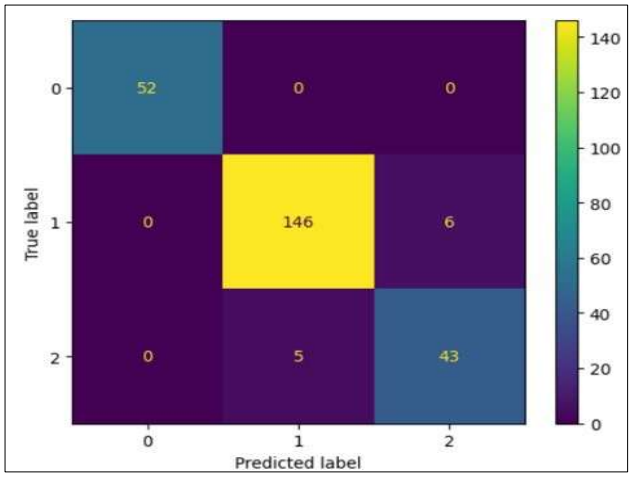
Confusion Matrix for the proposed approach is attained in Fig. 10.

$$\text{Precision} = \frac{True\ Positive}{True\ Positive + False\ Positive} \quad (5)$$

$$\text{Recall} = \frac{True\ Positive}{True\ Positive + False\ Positive} \quad (6)$$

$$\text{Accuracy} = \frac{Number\ of\ Correct\ Predication}{Total\ Number\ of\ Predication} \quad (7)$$

Fig.10. Confusion matrix attained for the proposed approach



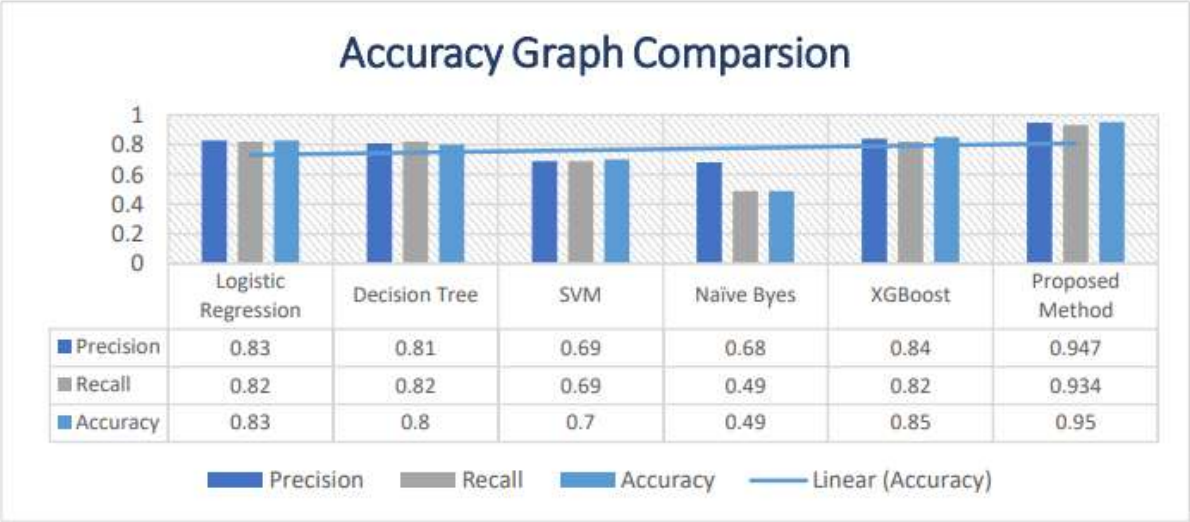
The conclusive outcomes are presented in Table 10. Notably, the proposed approach achieves the highest accuracy at 0.95 [34]. The results are depicted in Fig.11.

Table 10. Comparison of various techniques based on evaluation metrics

Algorithm	Precision	Recall	Accuracy/NOR Accuracy
Logistic Regression	0.83	0.82	0.83
Decision Tree	0.81	0.82	080
SVM	0.69	0.69	0.70
Naïve Byes	0.68	0.49	0.49
XGBoost	0.84	0.82	0.85
Proposed Method	0.947	0.934	0.95

Precision, Recall, and Accuracy metrics. Precision, Recall and accuracy is computed using these equations [31-33].

Fig.11. The comparison of machine learning models and proposed approach



5. Discussion

In our constant search for innovative and efficient approaches in the field of machine learning, we have identified a recurring pattern in various researches addressing water quality index (WQI) prediction. Researches such as Ahmad et al. [6], Sakizadeh [9], Gazzaz et al. [11], Parmar and Bhardwaj [35] and Adnan et al. [36] have adopted machine learning methods that use large sets of parameters to make these predictions. While this approach can be effective in obtaining results, it presents significant challenges in practice. In particular, the complexity and cost of implementing systems that handle multiple parameters in real time can be prohibitive, limiting their applicability in environments where economic efficiency is crucial [35].

Given this situation, we have developed a unique methodology that significantly simplifies the prediction process. Through data normalization and the implementation of latent semantic analysis (LSA) for dimension reduction, we have managed to make accurate predictions using only four water quality parameters. This distinctive approach has allowed us to achieve a peak accuracy of 95%, a result that not only rivals, but surpasses, the performance of the most advanced methods available in the literature. For example, historical results show that the best accuracy obtained by a multilayer perceptron, which used ten parameters, was 91%. This comparison highlights not only the superiority of our methodology in terms of accuracy, but also its ability to optimize water quality prediction models.

Furthermore, our strategy not only focuses on improving accuracy, but also addresses the need for practical solutions for real-time water quality monitoring systems. The reduction in the number of parameters required to make accurate predictions opens the door to the implementation of more affordable and sustainable systems. Consequently, our approach not only contributes to the advancement of knowledge in the field of machine learning applied to water quality, but also facilitates the creation of monitoring tools that are accessible and efficient, thus driving positive change in the way water resources are managed and monitored. This development therefore marks a significant step towards the integration of more effective monitoring technologies in the environmental field.

6. Conclusion:

This research delves into the intricate nexus between water quality, environmental health and ecosystem

vitality of the Yamuna River, an essential water resource facing serious threats. The alarming levels of pollution, predominantly driven by industrial discharges and urban waste, underscore the urgent need for robust and effective measures to safeguard this vital resource. Water quality not only impacts aquatic biodiversity but also has direct implications on the health of communities that depend on it for their livelihoods.

The traditional approach of calculating the Water Quality Index (WQI), while critical to understanding the current situation, presents significant challenges such as time-consuming data collection processes and the associated rising financial costs. These limitations can hamper rapid and effective response to the water quality crisis. Recognizing these constraints, the study embarks on a pioneering journey into the realm of machine learning, a field that presents unprecedented opportunities to improve our predictive capabilities in this context.

The proposed hybrid approach, which integrates Latent Semantic Analysis (LSA) and Extreme Gradient Boosting, emerges as a beacon of innovation. By reducing the dimensionality of the data and improving the representation of relevant features, this methodology not only streamlines the WQI prediction process but also achieves an impressive accuracy of 95.2%. This result is a testament to the potential of advanced predictive models to address the evolving complexities of water quality dynamics.

The major contributions of this work include eight years of exhaustive data collection, water quality index calculations at critical sites, and the introduction of a novel hybrid approach that improves our understanding of the water status in the Yamuna River. Furthermore, this approach sets a precedent for future research in this domain by providing a model that can be adapted and applied to other threatened water bodies. As we face the challenges of an ever-changing environment, this research serves as a guiding light, illuminating the path towards sustainable water management and the preservation of vital aquatic ecosystems such as the Yamuna River, thereby promoting a healthier and more balanced future for all.

7. References

[1] Mohtar, W. H. M. W., Maulud, K. N. A., Muhammad, N. S., Sharil, S. & Yaseen, Z. M. (2019). "Spatial and temporal risk quotient based river assessment for water resources management". *Environmental Pollution*, 248, 133-144.

[2] Meybeck, M. (1976). "Total mineral dissolved transport by world major rivers/Transport en sels dissous des plus grands fleuves mondiaux". *Hydrological Sciences Journal*, 21(2), 265-284. https://doi.org/10.1080/02626667609491631

[3] Sunil, C., Somashekar, R. K. & Nagaraja, B. C. (2010). "Riparian vegetation assessment of Cauvery River basin of South India". *Environmental Monitoring and Assessment*, 170, 545-553. https://doi.org/10.1007/s10661-009-1256-3

[4] Rani, M., Akolkar, P. & Bhamrah, H. S. (2013). "Water quality assessment of River Yamuna from origin to confluence to River Ganga, with respect to biological water quality and primary water quality criteria". *Journal of Entomology and Zoology Studies*, 1(6), 1-6.

[5] Misra, A. K. (2010). "A river about to die: Yamuna". *Journal of water resource and protection*, 2(5), 489.

[6] Ahmed, A. N., Othman, F. B., Afan, H. A., Ibrahim, R. K., Fai, C. M., Hossain, M. S., ... & Elshafie, A. (2019). "Machine learning methods for better water quality prediction". *Journal of Hydrology*, 578, 124084.

[7] Chia, S. L., Chia, M. Y., Koo, C. H. & Huang, Y. F. (2022). "Integration of advanced optimization algorithms into least-square support vector machine (LSSVM) for water quality index prediction". *Water Supply*, 22(2), 1951-1963.

[8] Hassan, M. M., Hassan, M. M., Akter, L., Rahman, M. M., Zaman, S., Hasib, K. M., ... & Mollick, S. (2021). "Efficient prediction of water quality index (WQI) using machine learning algorithms". *Human-Centric Intelligent Systems*, 1(3-4), 86-97.

[9] Wang, L., Zhu, Z., Sassoubre, L., Yu, G., Liao, C., Hu, Q. & Wang, Y. (2021). "Improving the robustness of beach water quality modeling using an ensemble machine learning approach". *Science of The Total Environment*, 765, 142760.

[10] Sillberg, C. V., Kullavanijaya, P. & Chavalparit, O. (2021). "Water quality classification by integration of attribute-realization and support vector machine for the Chao Phraya River". *Journal of Ecological Engineering*, 22(9), 70-86.

[11] Yilma, M., Kiflie, Z., Windsperger, A. & Gessese, N. (2018). "Application of artificial neural network in water quality index prediction: a case study in Little Akaki River, Addis Ababa, Ethiopia". *Modeling Earth Systems and Environment*, 4, 175-187.

[12] Bui, D. T., Khosravi, K., Tiefenbacher, J., Nguyen, H. & Kazakis, N. (2020). "Improving prediction of water quality indices using novel hybrid machine-learning algorithms". *Science of the Total Environment*, 721, 137612.

[13] Ding, Y. R., Cai, Y. J., Sun, P. D. & Chen, B. (2014). "The use of combined neural networks and genetic algorithms for prediction of river water quality". *Journal of applied research and technology*, 12(3), 493-499.

[14] Azad, A., Karami, H., Farzin, S., Saeedian, A., Kashi, H. & Sayyahi, F. (2018). "Prediction of water quality parameters using ANFIS optimized by intelligence algorithms (case study: Gorganrood River)". *KSCE Journal of Civil Engineering*, 22, 2206-2213.

[15] Zhang, Y., Gao, X., Smith, K., Inial, G., Liu, S., Conil, L. B. & Pan, B. (2019). "Integrating water quality and operation into prediction of water production in drinking water treatment plants by genetic algorithm enhanced artificial neural network". *Water research*, 164, 114888.

[16] Juna, A., Umer, M., Sadiq, S., Karamti, H., Eshmawi, A. A., Mohamed, A. & Ashraf, I (2022). " Water quality prediction using KNN imputer and multilayer perceptron". *Water*, 14(17), 2592.

[17] Ahmed, U., Mumtaz, R., Anwar, H., Shah, A. A., Irfan, R. & García-Nieto, J. (2019). "Efficient water quality prediction using supervised machine learning". *Water*, 11(11), 2210.

[18] Akhtar, N., Ishak, M. I. S., Ahmad, M. I., Umar, K., Md Yusuff, M. S., Anees, M. T., ... & Ali Almanasir, Y. K. (2021). "Modification of the water quality index (WQI) process for simple calculation using the multi-criteria decision-making (MCDM) method: a review". *Water*, 13(7), 905.

[19] Călmuc, V. A., Călmuc, M., Țopa, M. C., Timofti, M., Iticescu, C., & Georgescu, L. P. (2018). "Various methods for calculating the water quality index". *Analele Universității" Dunărea de Jos" din Galați. Fascicula II, Matematică, fizică, mecanică teoretică/Annals of the" Dunarea de Jos" University of Galati. Fascicle II, Mathematics, Physics, Theoretical Mechanics*, 41(2), 171-178.

[20] Pau, F. & Pablo, G. B. (2023). *Revisiting the Probabilistic Latent Semantic Analysis: The Method, Its Extensions and Its Algorithms*.

[21] Hutchison, P. D., George, B. & Guragai, B. (2023). "Application of Latent Semantic Analysis in Accounting Research". *Journal of Information Systems*, 37(3), 139-155.

[22] Landauer, T. (2023, January). "Latent semantic analysis: theory, method and application". In *Computer Support for Collaborative Learning* (pp. 742-743). Routledge.

[23] Yan, T., Zhou, A. & Shen, S. L. (2023). "Prediction of long-term water quality using machine learning enhanced by Bayesian optimisation". *Environmental Pollution*, 318, 120870.

[24] Dritsas, E. & Trigka, M. (2023). "Efficient Data-Driven Machine Learning Models for Water Quality Prediction". *Computation*, 11(2), 16.

[25] Koh, J. (2023). " Gradient boosting with extreme-value theory for wildfire prediction". *Extremes*, 1-27.

[26] https://www.dpcc.delhigovt.nic.in/#gsc.tab=0

[27] https://cpcb.nic.in/yamuna-monitoring-committee/

[28] Goldar, B. & Banerjee, N. (2004). "Impact of informal regulation of pollution on water quality in rivers in India". *Journal of Environmental Management*, 73(2), 117-130.

[29] Kaushik, C. P., Sharma, H. R., Jain, S., Dawra, J. & Kaushik, A. (2008). "Pesticide residues in river Yamuna and its canals in Haryana and Delhi, India". *Environmental Monitoring and Assessment*, 144(1-3), 329-340.

[30] Mamais, D., Jenkins, D. & Pitt, P. (1993). "A rapid physical-chemical method for the determination of readily biodegradable soluble COD in municipal wastewater". *Water Research*, 27(1), 195-197.

[31] Mishra, A. K. (2010). "A river about to Die: Yamuna". *Journal of Water Resource and Protection*, 2(5) 489-500.

[32] Qureshimatva, U. M., Maurya, R. R., Gamit, S. B., Patel, R. D. & Solanki, H. A. (2015). "Determination of PhysicoChemical Parameters and Water Quality Index (Wqi) of Chandlodia Lake, Ahmedabad, Gujarat, India". *Journal of Environmental and Analytical Toxicology*, 3(3), 1176-1193.

[33] Suthar, S., Sharma, J., Chabukdhara, M. & Nema, A. K. (2010). "Water quality assessment of river Hindon at Ghaziabad, India: impact of industrial and urban wastewater". *Environmental Monitoring and Assessment*, 165(1-4), 103-112.

[34] Shah, M. I., Alaloul, W. S., Alqahtani, A., Aldrees, A., Musarat, M. A. & Javed, M. F. (2021). "Predictive modeling approach for surface water quality: development and comparison of machine learning models". *Sustainability*, 13(14), 7515.

[35] Parmar, K. S. & Bhardwaj, R. (2013). "Water quality index and fractal dimension analysis of water parameters". *International journal of environmental science and technology*, 10, 151-164.

[36] Adnan, R. M., Mostafa, R. R., Elbeltagi, A., Yaseen, Z. M., Shahid, S. & Kisi, O. (2022). "Development of new machine learning model for streamflow prediction: Case studies in Pakistan". *Stochastic Environmental Research and Risk Assessment*, 1-35.

Consent to publish

The authors have read and approved the final manuscript.

Conflict of interest

The authors declare that they have no conflict of interest. This document reflects their views only and not those of the institution to which they belong.

Neetu Guptaa:

Research Fellow, Faculty of Engineering and Technology, Career Point University, Kota, India

Surendra Yadavb:

Department of Computer Science and Applications, Vivekananda Global University, Jaipur, India

Neha Chaudharyc:

Department of Computer Science and Engineering, Manipal University, Jaipur, India

Magna Scientia UCEVA
Vol. 4 N° 2 (2024) - P.P. 74 - 80
ISSN:2805-6884 e-ISSN:2805-6701
DOI:10.54502/msuceva.v4n2a7

Garantías de protección social, pensional y laboral de la gente de mar en Colombia, análisis de aplicación jurídica

Guarantees of social, pension, and labor protection for Seafarers in Colombia: Analysis Of Legal Application

Jorge Luis Restrepo Pimienta – Universidad del Atlántico
Jorge Wilmar Arias Arias - Asesor de presidencia COLPENSIONES

Open Access

Key words:

Seafarers, contract of agreement, decent work, ILO Convention on Maritime Labor 2006.

Palabras clave:

Gente de mar, contrato de enrolamiento, trabajo decente, Convenio de la OIT sobre trabajo marítimo de 2006.

Abstract

This paper analyzes the normative and jurisprudential framework, related to the protection of workers in case of work accidents, with the purpose of determining the application of the new regulations on Safety and Health at Work as the basis of sentences on the Employer's Fault , within the prevention before the responsibility of the employer, taking into account the increase of the regulations on health and safety at work (SST) and the entry into force of the Decree 1443 of 2014.

Subrogated by the Decree 1072 of 2015, which has modified and technically specializing the standards for worker protection and safety, which favor both the worker since it forces the employer to maintain a system of continuous improvement for its protection, and the employer if required by an eventual liability, what makes the validation by legal operators more complex and technical, at the moment of valuation r if it corresponds to the duty of protection and care towards the worker.

Resumen

La normatividad que regula las relaciones laborales de la gente de mar en Colombia viene establecida por los convenios internacionales de la OIT que fueron emitidos a partir del año 1921, lo que conlleva a que dicha reglamentación no esté acorde con la realidad actual de la gente de mar.

Con base en lo antes expuesto, se realizará el análisis de la implementación del Convenio de la OIT sobre trabajo marítimo de 2006 con relación a las garantías laborales de la gente de mar en Colombia, por ser este instrumento internacional el que da lugar a que la gente de mar desarrolle sus funciones bajo el principio y derecho de trabajo decente, al igual que examina y revisa los convenios ya existentes sobre la materia, aplicables a todos los trabajadores del sector.

1. Introducción

Gente de mar, cabe decir que son todas aquellas personas que prestan sus servicios personales a bordo de una embarcación cualquiera que sea su cargo y las funciones que se ejecuten en el desarrollo del mismo. La actividad de este tipo de trabajadores es regulada por la Organización Internacional del Trabajo (OIT) en el marco de los convenios, de los cuales, entre otras cosas, el más reciente no ha sido ratificado por el Estado colombiano. Ello conlleva a que, en el desarrollo de este artículo, se analice el impacto de la implementación del convenio de la OIT sobre trabajo marítimo de 2006 con relación a las garantías laborales de la gente de mar en Colombia y sus efectos jurídicos y económicos.

En esta medida, la gente de mar presta sus servicios en un ambiente y condiciones muy particulares, situación que hace necesaria la existencia de una normatividad especial que los regule, dado que el derecho laboral ordinario desconoce las particularidades sobre la navegación; en Colombia, la gente de mar no cuenta con normatividad especial actualizada, en lo relacionado con las circunstancias o condiciones laborales de este grupo de trabajadores, toda vez que la reglamentación existente hasta el momento data de 1921, producto de ratificaciones de convenios sobre trabajo marítimo de la OIT, por tanto, no está acorde con la realidad actual de las necesidades laborales que se le presentan a la gente de mar.

En este orden consecutivo de ideas, el presente estudio monográfico abarca las relaciones de trabajo en el mar, tomando de manera significativa la actividad de la gente de mar, haciendo uso de la información documental reglamentaria existente, con un método hermenéutico que permitió analizar vacíos, omisiones y faltas en estas relaciones laborales.

2. Metodología

El presente artículo científico está orientado desde el paradigma interpretativo y encasillado en un enfoque cualitativo con un tipo documental que tiene por objeto analizar la implementación del Convenio de la OIT sobre trabajo marítimo de 2006 en las garantías laborales de la gente de mar en Colombia, el cual, dentro del enfoque cualitativo propio de metodología flexible, requiere de un tipo de investigación documental hermenéutica, la cual armoniza con técnicas de investigación como la observación, análisis documental y revisión bibliográfica. En este orden sistemático de ideas y lógico-metódico, es necesario utilizar instrumentos específicos, los cuales son fichas bibliográficas, resúmenes, mapas de ideas, cuadros sinópticos y ensayos.

La metodología anteriormente descrita tiene como fin conseguir el rigor científico y el vigor acerca del tema y el título planteado, el cual está enmarcado dentro de las ciencias jurídicas, la seguridad social y el derecho del trabajo.

El presente artículo científico se desarrolla desde un enfoque interpretativo y se sitúa en un marco cualitativo, con un enfoque documental que busca examinar la implementación del Convenio sobre trabajo marítimo de la OIT de 2006 en relación con las garantías laborales de los trabajadores del mar en Colombia. Este enfoque cualitativo, característico de una metodología flexible, demanda una investigación documental de tipo hermenéutico. Este tipo de investigación se complementa con diversas técnicas, tales como la observación, el análisis de documentos y la revisión bibliográfica [1].

En este orden de ideas, es fundamental emplear herramientas específicas que faciliten la organización y el análisis de la información. Entre estas herramientas se incluyen fichas bibliográficas, resúmenes, mapas conceptuales, cuadros sinópticos y ensayos. Estas estrategias permiten estructurar el conocimiento de manera clara y lógica, lo que contribuye a una comprensión más profunda del tema.

La metodología descrita tiene como objetivo garantizar un rigor científico y un enfoque sólido sobre el tema propuesto, el cual se sitúa en el ámbito de las ciencias jurídicas, la seguridad social y el derecho laboral. Esto implica no solo un análisis detallado de la normativa y su aplicación, sino también una reflexión crítica sobre su impacto en la realidad laboral de los marinos en Colombia, considerando las complejidades sociales y económicas que rodean esta actividad. En última instancia, se busca ofrecer

una contribución significativa al campo del derecho del trabajo, destacando la importancia de una adecuada implementación de las normas internacionales en el contexto local.

3. Antecedentes normativos de las relaciones del trabajo de gente de Mar

La Organización Internacional del Trabajo (OIT) ha adoptado una serie de convenios relativos al trabajo marítimo para ser ratificados por los países miembros, como son, entre otros: C007, sobre la edad mínima (trabajo marítimo) de 1920; C008, sobre las indemnizaciones de desempleo (naufragio) de 1920; C009, sobre la colocación de la gente de mar de 1920; C022, sobre el contrato de enrolamiento de la gente de mar de 1926; C054, sobre las vacaciones pagadas de la gente de mar de 1936, C055, sobre las obligaciones del armador en caso de enfermedad o accidentes de la gente de mar de 1936 [2, 3, 4].

También se encuentran los convenios: C0056, sobre el seguro de enfermedad de la gente de mar de 1936; C057, sobre las horas de trabajo a bordo y la dotación de 1936; C070, sobre la seguridad social de la gente de mar de 1946; C0071, sobre las pensiones de la gente de mar de 1946; C072, sobre las vacaciones pagadas de la gente de mar de 1946; C076, sobre los salarios, las horas de trabajo a bordo y la dotación de 1946; C114, sobre el contrato de enrolamiento de los pescadores de 1959, y C145, sobre la continuidad del empleo (gente de mar) de 1976. Se destaca que Colombia, a pesar de ser miembro de la OIT, solo ha ratificado los convenios 8, 9, 16, 22 y 23 [5].

Así mismo, Colombia también es miembro de la Organización Marítima Internacional (OMI) (organismo especializado de la ONU), por lo que ha ratificado los convenios adoptados por este organismo que regulan el transporte marítimo internacional, a saber: Convenio internacional para la seguridad de la vida humana en el mar (SOLAS, 1974), Convenio para prevenir la contaminación por buques (MARPOL, 1978) y Convenio sobre formación, titulación y guardia de la gente de mar (STCW, 1978), los cuales, junto con el Convenio sobre trabajo marítimo (OIT, 2006), conforman los llamados cuatro pilares reguladores del transporte marítimo internacional [6].

Es de tener en cuenta que los convenios sobre trabajo marítimo de la OIT datan de los años 1920 en adelante, por tal razón, en aras de revisar tales convenios y adecuarlos a la realidad actual de los actores del sector marítimo, se concertó una resolución acogida en el año 2001 por las organizaciones internacionales de armadores y de gente mar, la cual constituye las bases para el Convenio sobre trabajo marítimo de 2006 de la OIT [7].

En la mencionada resolución, se indicaba que el transporte marítimo es la primera industria con un alcance verdaderamente mundial y, por tanto, demandaba "medidas reglamentarias internacionales adecuadas – normas globales aplicables a toda la industria" [8].

El CTM 2006 tiene total respaldo de la Federación Internacional de Armadores (ISF), de la Federación Internacional de Trabajadores del Transporte (ITF) y de la Cámara Naviera Internacional (ICS), instituciones que desempeñaron una labor fundamental en la aprobación del mismo. (Posición sobre la ratificación del Convenio Marítimo 2006 de la OIT, Central Unitaria de Trabajadores de Colombia-CUT) [9].

El CTM 2006 ha contado con el importante apoyo de la Organización Marítima Internacional, hecho relevante teniendo en cuenta que dicha organización vigila el sector mundial del transporte marítimo que mueve aproximadamente el 90 por ciento del comercio mundial; muestra de ello es que lo consideran como el cuarto pilar de las normas internacionales que rigen el transporte marítimo internacional [10].

Normas que regulan a la gente de mar en Colombia

Es de advertir que las normas jurídicas que en Colombia regulan el Código de Comercio, en el Libro V, Título V de la tripulación, artículos 1506 a 1512, no contienen una regulación laboral propiamente dicha, dado que se limita a establecer el concepto de tripulación, teniendo como tal a las personas embarcadas y dedicadas a atender los servicios de la nave y que cuenten con licencia de navegación (art. 1506 del Código de Comercio) [11].

Así también, se señalan las obligaciones de la tripulación sin perjuicio de lo establecido en las normas laborales, que van desde el estar a bordo según lo pactado, la obediencia a sus superiores jerárquicos en lo relativo al servicio prestado, la permanencia en la nave y en su puesto de trabajo, el cumplimiento temporal de funciones distintas a las asignadas, entre otras (art. 1508 del Código de Comercio).

Otros supuestos que se recogen en el Código de Comercio son: dar el alcance del contrato de enrolamiento, en el entendido de que se tendrá como celebrado por el viaje de ida y regreso, salvo pacto en contrario, y establecer que la prórroga del contrato de enrolamiento se da cuando la expiración del plazo pactado ocurre estando la nave en viaje, luego entonces el enrolamiento se prorrogará hasta la terminación del viaje (arts. 1509 y 1510 del Código de Comercio); implantar que el personal debe ser desembarcado según lo acordado en el contrato de enrolamiento (art. 1511 del Código de Comercio); designar la aplicación de la ley colombiana al contrato de enrolamiento celebrado en el exterior (art. 1512 del Código de Comercio) [6].

Luego se encuentra la Ley 35 de 1981, mediante la cual se aprobó el Convenio internacional de formación, titulación y guardia de la gente de mar STCW/78 (OMI), y su Decreto Reglamentario 1597 de 1988, mediante la cual se establecen los estándares de cualificación mínima que deben cumplir los trabajadores del mar para estar a bordo de un buque [10].

En este sentido, se tiene el Decreto 1015 de 1995, que reglamenta la Ley 129 de 1931, mediante la cual se aprobó el C022 de la OIT sobre el contrato de enrolamiento de la gente de mar; la norma en cita señala que será aplicada a todas las personas empleadas a bordo de buques de bandera colombiana de servicio internacional (art. 1 Decreto 1015 de 1995).

Así mismo, el decreto, además de definir el contrato de enrolamiento, clasifica el contrato según su duración, señala cuáles son las justas causas para dar por terminado el contrato por parte del empleador previa remisión a las consagradas en el Código Sustantivo del Trabajo y cuáles por parte de la gente de mar (arts. 2, 7, 8, 10, 11 Decreto 1015 de 1995). Este decreto fue compilado en la sección 3 del Decreto Único Reglamentario del Sector Trabajo 1072 de 2015 [13].

Por último, se encuentra la Resolución 140 de 2013, expedida por la Dirección General Marítima (DIMAR), a través de la cual se adoptan las enmiendas del convenio STCW/78 y la aplicación del CTM 2006 con respecto a la salud de la gente de mar y el fomento de la seguridad en el mar, esto es, se adoptan las directrices para la realización de los reconocimientos médicos de la gente de mar; es así como la resolución en cita fue compilada en el Reglamento Marítimo Colombiano parte 3 (REMAC 3), artículo 3.2.3.1., sobre la protección de la salud y seguridad de la gente mar (Resolución 0135 de 2018, DIMAR).

CTM (Convenio de Trabajo Marítimo) 2006

El convenio establece los estándares mínimos de trabajo y condiciones de vida aplicables a todos los marineros que trabajan en barcos que enarbolan los pabellones de los países que lo han ratificado. El convenio se aplica a todos aquellos buques, de propiedad pública o privada, que se dediquen habitualmente a actividades comerciales, con excepción de:

- Los buques dedicados a la pesca u otras actividades similares.
- Las embarcaciones de construcción tradicional, como los *dhows* y los juncos.
- Los buques de guerra y las unidades navales auxiliares.

El convenio está constituido por tres partes que, en su orden, son: los artículos, que consagran los principios y obligaciones generales; luego se encuentran las disposiciones más detalladas del reglamento y del código, que se dividen en normas denominadas parte A y en pautas designadas como la parte B. El reglamento y el código están conformados y organizados en temas de interés general consignados en cinco títulos:

- Título 1: Requisitos mínimos para trabajar a bordo de buques.
- Título 2: Condiciones de empleo.

- Título 3: Alojamiento, instalaciones de esparcimiento, alimentación y servicio de fonda.
- Título 4: Protección de la salud, atención médica, bienestar y protección social.
- Título 5: Cumplimiento y control de la aplicación.

En los cinco títulos antes anotados, no solo se recogen los mismos temas de los 68 instrumentos sobre el trabajo marítimo en vigor, sino que, de ser necesario, los actualiza e incluye como nueva temática en lo referente a la seguridad y la salud en el trabajo, a fin de dar solución a las necesidades actuales en materia de salud (Convenio sobre Trabajo Marítimo 2006, OIT) [14].

Por lo anterior, es válido afirmar que el CTM 2006 cobija la mayoría de aspectos relacionados con el trabajo y la vida a bordo de un buque acorde a la realidad actual:

- Edad mínima
- Acuerdos de trabajo
- Horas de trabajo o descanso
- Pago de salarios
- Vacaciones anuales pagadas
- Repatriación al término de contrato
- Atención médica a bordo
- Uso de servicios de contratación y colocación autorizados
- Alojamiento, alimentación y servicio de comidas
- Protección de la seguridad y la salud y prevención de accidentes
- Procedimientos de tramitación de quejas de los marineros
- Derecho a un lugar de trabajo seguro y protegido que cumpla con los estándares de seguridad
- Derecho a condiciones de empleo justas
- Derecho a condiciones decentes de trabajo y de vida a bordo
- Derecho a la protección de la salud, atención médica, bienestar social y otras formas de protección social

La importancia de este convenio radica en que agrupa los estándares internacionales mínimos para garantizar un trabajo decente a todos los marineros que hay en el mundo, cuya laboral es de vital importancia en el comercio internacional, además de contribuir con el turismo con su servicio en cruceros y una vida a bordo digna [15].

Con respecto a los convenios vigentes sobre trabajo marítimo a la entrada en vigor del CTM 2006, la OIT ha manifestado que “se irán retirando gradualmente a medida que los Estados miembros de la OIT que son parte en los mismos ratifiquen el nuevo convenio” [14].

Los estados que ratifiquen el CTM 2006, y que hayan ratificado los anteriores convenios, no tendrán que cumplir los convenios existentes al entrar en vigor el convenio para ellos. No obstante, los países que no ratifiquen el convenio deberán seguir respetando los convenios existentes que hayan ratificado [17].

Necesidad de normas internacionales efectivas en el trabajo marítimo en relación con las condiciones de trabajo de la gente de mar

La navegación de altura lleva inmerso un carácter internacional, lo que hace que los trabajadores del mar presten sus servicios en un medio y lugar muy peculiar (mar-buque), lo que conlleva a que vivan en la embarcación donde prestan sus servicios, por tanto, su vida laboral se desarrolla fuera de su país de origen.

Los anteriores argumentos son el basamento de la necesidad de contar con normas internacionales que logren conseguir un trabajo y vida decentes a bordo y para los trabajadores de este sector, sin dejar de lado que tales normas deben contar con aplicación a nivel nacional, en aras a que tales normas cumplan con su función de satisfacer la necesidades laborales y sociales de la gente de mar [18].

4. Resultados y discusión

La normatividad que regula las relaciones laborales de la gente de mar en Colombia viene establecida desde la expedición de los convenios internacionales de la OIT que fueron emitidos a partir del año 1920, lo que conlleva a que dicha reglamentación no esté acorde con la realidad actual de la gente de mar.

En esa medida, las normas que actualmente reglamentan las condiciones laborales de la gente de mar no satisfacen sus garantías mínimas, dado que tales condiciones han ido cambiando acorde a lo establecido por los conceptos de trabajo decente y trabajo digno, que tiene incidencia en temas como: requisitos que deben cumplir la gente de mar para el desempeño de su cargo, edad mínima, jornada laboral, descansos, repatriación, atención médica a bordo, alojamiento, alimentación y servicio de comidas, protección de la seguridad y la salud y prevención de accidentes, entre otros [19].

Lo antes manifestado conlleva a mayores y reales garantías laborales de la gente de mar en Colombia, por constituir este instrumento internacional un conjunto normativo que se encamina a la unificación de conceptos, aspectos y condiciones sobre el trabajo marítimo, que además examina, revisa y, si el del caso, actualiza los convenios ya existentes sobre la materia, aplicables a todos los trabajadores del sector y que en su gran mayoría no han sido ratificados por Colombia, situación que quedaría superada con dicha implementación [20].

5. Conclusiones

A través del desarrollo investigativo se evidencia que la codificación de todos los convenios sobre trabajo marítimo de la OIT a través del CTM 2006 es, desde todo punto, benéfica tanto para la gente de mar como para sus empleadores (armadores), pues para los primeros implica una serie de garantías mínimas y mejores condiciones de trabajo y de la vida a bordo y para los segundos les genera una protección contra la competencia desleal y una mejor prestación de sus servicios que impactan de manera positiva en el mercado.

Para Colombia, resulta primordial la implementación del Convenio de la OIT sobre trabajo marítimo de 2006, dado que con ello tendría las bases para garantizar unas condiciones de trabajo y vida a bordo de su gente de mar ajustadas a los derechos de trabajo decente y digno y de una vida digna a bordo, toda vez que las escasas normas vigentes a la fecha, además de estar desactualizadas, no son suficientes para garantizar las garantías y condiciones mínimas de trabajo y vida a bordo de la gente de mar colombiana, situación que no se acompasa con el hecho de ser un Estado social de derecho.

Así mismo, justifica la implementación el hecho de que tales normas resultan eficaces en la consecución de un trabajo decente y digno y una vida a bordo digna, dado que los controles por ellas implementados requieren de la participación de los Estados miembros en su calidad de Estado de abanderamiento, Estado ribereño y Estado rector del puerto y, por tanto, de las buenas prácticas y cumplimiento del convenio por parte de los armadores.

6. Referencias bibliográficas

[1] Martínez, H. E., Salcedo, J. D. & Romero, A. (2022). "Observation as a research technique: Reflections, types, recommendations, and examples". *Russian Law Journal*, 10(4). Disponible en: https://doi.org/10.52783/rlj.v10i4.4348

[2] Sánchez Calero, F. (2010). *El contrato de transporte marítimo de mercancías*. Pamplona: Aranzadi.

[3] Abello, R. "Derechos de pesca en zona económica exclusiva". Disponible en: https://www.elespectador.com/opinion/derechos-de-pesca-en-zona-economicaexclusiva-columna-415685

[4] Abello, R. "¿Le es aplicable a Colombia la Convención de Naciones Unidas sobre el Derecho del Mar de 1982?". Disponible en: https://www.ambitojuridico.com/noticias/columnista-impreso/relaciones-exteriores-e-internacional/le-es-aplicable-colombia-la Agreement

[5] Calvo Caravaca, A. L. & Carrascosa González, J. (2017). *Derecho internacional privado*, volumen II. Granada: Comares.

[6] Organización Marítima Internacional (OMI) (1971). *Special Trade Passenger Ships: la contaminación por los buques*. Disponible en: https://www.dimar.mil.co/convenioInternacional-para-prevenir-la-contaminacion-por-buques-1973-y-su-protocolo-de-1978-marpol

[7] Galbadón, J. (2012). *Curso de derecho marítimo internacional: derecho marítimo internacional público y privado y contratos marítimos*. Madrid: Marcial Pons, Ediciones Jurídicas y Sociales.

[8] Díaz, E. (1969). *Atlas de Colombia*. Bogotá: Instituto Geográfico Agustín Codazzi.

[9] Gómez, L. & Ordaz, P. "La crónica negra del «Prestige»". Disponible en: https://elpais.com/elpais/2003/06/03/actualidad/1054628225_850215.html

[10] Garrido, M. *Breve introducción al derecho marítimo: concepto y principales figuras*. Disponible en: http://www.eljurista.eu/2014/07/14/breve-introduccion-al-derecho-maritimo-concepto-y-principales-figuras/

[11] Matilla Alegre, R. (1999). *Internacionalidad del derecho marítimo y jurisdicción internacional*. Madrid: Universidad de Deusto.

[12] Recalde Castells, A. (1992). *El conocimiento de embarque y otros documentos del transporte*.

[13] Organización Marítima Internacional (OMI) (2019). *Adopción, entrada en vigor, adhesión*.

[14] Salas, S. "DIMAR anunció restricciones para navegación en el canal de acceso al puerto de Barranquilla". Disponible en: http://www.wradio.com.co/noticias/regionales/dimar-anuncio-restricciones-paranavegacion-en-canal-de-acceso-al-puerto-de-barranquilla/20180921/nota/3802204.aspx

[15] Calvo Caravaca, A. L. & Blanco-Morales Limones, P. (1998). "Capítulo XXII, Sucesión hereditaria". En: Calvo Caravaca, A. L. & Carrascosa González, J. (editores). *Derecho internacional privado*, Vol. II. Granada: Comares, 1998.

[16] López, F. "Concepto y características del derecho marítimo". (2003). *Universitas*, 52(106). Disponible en: https://www.imo.org/es/About/Conventions/Paginas/Home.aspx

[17] Pérez, J. "Delincuentes provocan derrame de 70 galones de hidrocarburo al río". Disponible en:https://www.elheraldo.co/barranquilla/delincuentes-provocan-derrame-de-70-galones-de-hidrocarburo-al-rio-490010

[18] Serna Vallejo, M. "Cuestiones varias sobre la costumbre Special Trade Passenger Ships". Disponible en: https://cil.nus.edu.sg/wp-content/uploads/formidable/14/1973-Prot-Space-Requirements-for-Special-Trade-Passenger-Ships.pdf

[19] Organización Marítima Internacional (OMI) (1973a). *Protocol on the Space requirements for Special Trade Passenger Ships*.

[20] Organización Marítima Internacional (OMI) (1973b). *Convenio internacional para prevenir la contaminación por buques*.

Consentimiento de publicación

El autor leyó y aprobó el manuscrito final.

Conflicto de interés

El autor declara no tener conflicto de interés. Este documento solo refleja sus puntos de vista y no el de la institución a la que pertenece.

Jorge Luis Restrepo Pimienta

PhD. en Derecho. PhD. en Seguridad Social. PhD. en Epistemología. Magíster en Derecho. Magíster en Salud Pública. Abogado. Docente de Carrera en la Universidad del Atlántico, Colombia. E-mail: jorluisrestrepo@yahoo.com ORCID: https://orcid.org/0000-0002-6285-7793

Jorge Wilmar Arias Arias

Especialista en Seguridad Social, Derecho Administrativo y Abogado, Asesor de Presidencia COLPENSIONES. E-mail: jwariasa@colpensiones.gov.co ORCID: https://orcid.org/0009-0007-0611-2010

Magna Scientia UCEVA

Volumen 4 - Nº 2 - 2024 http://revistas.uceva.edu.co/index.php/magnascientia/issue/archive e-ISSN:2805-6701 ISSN:2805-6884

Carrera 27 A No. 48 – 144 Kilómetro 1 Salida Sur
Tuluá – Valle del Cauca – Colombia,
Sur América. Código postal: 763022
Tel. 57 602 2242202. Ext. 122 – 139

Institución de Educación Superior
UCEVA
Unidad Central del Valle del Cauca