

**AN INTERNATIONAL FORUM FOR THE RAPID PUBLICATION OF
ORIGINAL SCIENTIFIC ARTICLES DEALING WITH SCIENCES AND
RELATED INTERDISCIPLINARY AREAS**

**SOUTHERN JOURNAL
OF SCIENCES**

VOLUME THIRTY-THREE, NUMBER FORTY-ONE

ISSN: 2764-5967 - E-ISSN: 2764-5959

SEPTEMBER– 2026

SOUTHERN JOURNAL OF SCIENCES

ISSN: 2764-5967

E-ISSN: 2764-5959

Volume 34

Number 41

2026

Dados Internacionais de Catalogação na Publicação (CIP)

S727 Southerm Journal of Sciences [recurso eletrônico] :
interdisciplinary path for scientific divulgation / Araucária
Associação Científica – (Fev. 2022). – Dados eletrônicos. –
Nova Prata. : Araucária Associação Científica, 2024-.

Semestral

Recurso on-line

Descrição baseada em: Vol. 30, n. 33 (JUN. 2022)

Formerly known as: Southern Brazilian Journal of
Chemistry

Modo de acesso: < <https://sjofsciences.com> >.

E-ISSN: 2764-5959

ISSN: 2764-5967

1. Química. 2. Física. 3. Biologia. 4. Ciências Naturais. 5.
Farmacologia. 6. Ciências exatas. 7. Ciências aplicadas. 8.
Ciências. I. Dr. D. Scientific Consulting.

UDC 001

SOUTHERN JOURNAL OF SCIENCES

ISSN: 2764-5967

E-ISSN: 2764-5959

Volume 34

Number 41

2026

Editorial Board

Editor-in-Chief

- Cristián Andrés Quintero, Ph.D., cristian.quintero@um.edu.ar, Argentina, Universidad de Mendoza

Deputy Editor

- María Virgina Avena, Ph.D., Argentina, maria.avena@um.edu.ar Universidad de Mendoza

Assistant Editors

- Ketevan Kupatadze, Ph.D., ketevan_kupatadze@iliauni.edu, Georgia, ISU.
- Shaima R. Banoon, MsC., shimarb@uomisan.edu.iq, Iraq, University of Misan.
- Walter José Peláez, Ph.D., walter.pelaez@unc.edu.ar, Argentina, UNC.
- Aline Maria dos Santos, PhD., aline.santos@ifrrj.edu.br Brazil, IFRJ.
- Cristiane de Souza Siqueira Pereira, PhD., cristiane.pereira@universidadedevassouras.edu.br Brazil, Universidade de Vassouras.

Scientific Council

- Teresa M. Roseiro Maria Estronca, Ph.D., troseiro@ci.uc.pt, UC, Portugal.
- Rafael Rodrigues de Oliveira, Ph.D., rafa_rdo@yahoo.com.br, Neoprospecta, Brazil.
- Marcos Antônio Klunk, Ph.D., marcosak@edu.unisinos.br, UNISINOS, Brazil.
- Francisco José Santos Lima, Ph.D., limafjs@yahoo.com, UFRN, Brazil.
- Monica Regina da Costa Marques, Ph.D., mmarquesrj@gmail.com, UERJ, Brazil.
- Rodrigo Brambilla, Ph.D., kigobrambilla@gmail.com, UFRGS, Brazil.
- Gabriel Rubensam, Me., rubensam_quimico@hotmail.com, PUCRS, Brazil.
- Andrian Saputra, Ph.D., andriansaputra@fkip.unila.ac.id, University of Lampung, Indonesia.
- Zhanar Zhumadilova, Ph.D., zhanar_85@mail.ru, Satbayev University, Kazakhstan.
- Roberto Fernandez, Ph.D., rfernandezm@unicartagena.edu.co, Universidad de Cartagena, Colombia.
- Andrey Vladimirovich Sevbitov, Ph.D., avsevbitov@mail.ru, I. M. Sechenov First Moscow State Medical University, Russian Federation.
- Jorge Fernando Silva de Menezes, Ph.D., jorge_fernando@ufrb.edu.br, UFRB, Brazil.

- Paulo Sergio Souza, Ph.D., Brazil, paulosergio@fosorio.g12.br, Brazil, Fundação Osorio.
- Alessandra Deise Sebben, PhD., adsebben@gmail.com, Brazil
- Fredy Hernán Martínez Sarmiento, PhD., fhmartinezs@udistrital.edu.co, UD-FJC, Colombia.
- Fabiana de Carvalho Fim, PhD., fabianafim@ct.ufpb.br, UFPB, Brazil.
- Gustavo Guthmann Pesenatto, MD., gustavoggp@gmail.com, Primary Health Care, Brazil.
- Fábio Herrmann, MD., fabioherrmannfh@gmail.com, Santa Casa de Misericórdia de Porto Alegre Hospital, Brazil.
- Marco Antonio Smiderle Gelain, MD., marco_gelain@hotmail.com, Dante Pazzanese Cardiology Institute, São Paulo - Brazil.
- Rene Francisco Boschi Gonçalves, Ph.D., renefbg@gmail.com, Technological Institute of Aeronautics - ITA, Brazil.
- Élcio J. de Oliveira, Ph.D., Kvantum Technology & Innovation, São Paulo, Brazil.
- Ademir Oliveira da Silva, Ph.D., aosquimica@gmail.com, Federal University of Rio Grande do Norte - UFRN, Brazil.
- Francisco José Santos Lima, Ph.D., limafjs@yahoo.com, Federal University of Rio Grande do Norte - UFRN, Brazil.
- Anton Timoshin, Ph.D., anton-timoshin007@yandex.ru, I. M. Sechenov First Moscow State Medical University, Russian Federation.
- Intisar Razzaq Sharba, Ph.D., intisar.sharba@uokufa.edu.iq, University of Kufa, Iraq.
- Paulo Roberto Barros Gomes, Ph.D., prbgomes@yahoo.com.br, Federal Institute of Technical Education of Pará - IFPA, Brazil.
- Dra. Elizabeth Laura Moyano, Ph.D., e.laura.moyano@unc.edu.ar, INFIQC-CONICET-Universidad Nacional de Córdoba, Argentina.
- Dra. Ana Graciela Iriarte, Ph.D., airiarte@unc.edu.ar, INFIQC-CONICET-Universidad Nacional de Córdoba, Argentina.
- Husam Al-hraishawi, Ph.D., husam.mcm@uomisan.edu.iq, University of Misan,

Managing Editor

- Luis Alcides Brandini De Boni, Ph.D., labdeboni@gmail.com, Araucária - Scientific Association, Brazil;

SOUTHERN JOURNAL OF SCIENCES

ISSN: 2764-5959 (Online)

ISSN: 2764-5967 (Print)

DOI: 10.48141/2764-5959

Digital preservation: Portico

Former Southern Brazilian Journal of Chemistry

Former E-ISSN 2674-6891

Former ISSN 0104-5431

Available at

<https://sjofsciences.com>

Mission

The **SOUTHERN JOURNAL OF SCIENCES** is a double-blind peer review, open access, **multidisciplinary** Journal dedicated to publishing high-quality content and is intended to fill a gap in terms of scientific information for Southern Brazil. We have set high standards for the articles to be published by ensuring strong but fair refereeing by at least two reviewers. The Journal publishes original research articles in all the fields of Engineering, Mathematics, physics, Chemistry, Biology, Agriculture, Natural resource management, Pharmacy, Medicine, and others.

Occasionally the Journal will include review papers, interviews, and other types of communications. It will be published mainly in English, and at present, there are no page charges.

We hope this Journal will provide a forum for disseminating high-quality research in Science and are open to any questions and suggestions.

The responsibility for the articles is exclusive to the authors.

Subjects List

UDC 001

Correspondências

Boulogne Sur Mer 683.

Ciudad - Mendoza - Argentina

CP 5500

www.sjofsciences.com

southbchem@gmail.com

INDEX OF THE ISSUE NUMBER 41

ISSN: 2764-5967

E-ISSN: 2764-5959

Volume 34

2026

<u>1. Editorial</u> QUINTERO, Cristián Andrés; AVENA, María Virginia Argentina A NEW CHAPTER IN THE EVOLUTION OF SOUTHERN JOURNAL OF SCIENCES Pg. 01	<u>2. Letter to the editor</u> GIAI, Constanza Argentina BEYOND THE HOSPITAL: A ONE HEALTH REFLECTION ON ANTIMICROBIAL RESISTANCE Pg. 07
<u>3. Original research paper</u> GIAI, Marcos; FRANCO, Estela Dolores Argentina PHYSICOCHEMICAL AND PHYTOTOXIC QUALITY OF IRRIGATION WATER FOR THE TREES OF GENERAL SAN MARTÍN PARK, MENDOZA, ARGENTINA. Pg. 17	<u>4. Original research paper</u> CORVALAN, Lucia; MESSINA, Diego Nicolás; AVENA ÁLVAREZ, María Virginia Argentina CARDIOVASCULAR RISK AND DIETARY HABITS IN TRANSGENDER ADULTS RECEIVING HORMONE THERAPY Pg. 34
<u>5. Commemorative note</u> BRANDINI DE BONI, Luis Alcides; BARROS GOMES, Paulo Roberto Brazil SEVENTY YEARS OF THE BRAZILIAN FEDERAL COUNCIL OF CHEMISTRY (1956– 2026): INSTITUTIONAL TRAJECTORY, PRESIDENCIES, AND PERSPECTIVES FOR THE CHEMISTRY PROFESSION Pg. 52	<u>6. Original research paper</u> YAMÍN, Paula; DI CATALDO, Sophia; VASCONCELOS, Daniela; QUINTERO, Cristián Andrés Argentina CHARACTERIZATION OF TICKS IN THE GRAN MENDOZA AREA, MENDOZA, ARGENTINA Pg. 65

A NEW CHAPTER IN THE EVOLUTION OF SOUTHERN JOURNAL OF SCIENCES

Cristián Andrés Quintero^{1,3} & María Virginia Avena^{2,3}

¹ Universidad de Mendoza, Facultad de Ciencias Médicas. Argentina: ORCID: 0000-0003-4365-4189

² Universidad de Mendoza, Facultad de Ciencias de la Salud. Argentina: ORCID: 0000-0003-0752-7713

³ Southern Journal of Sciences, Brazil.

* Correspondence author

email: sjofsciences@sjofsciences.com

Dear authors, reviewers, readers, and collaborators,

In nature, one thing is unstoppable: **evolution**. It can be fast or incredibly slow, but it never stops. From bacteria to humans, all living organisms evolve. **Southern Journal of Sciences is no exception.**

The journal was born in Brazil in 1993, founded by Dr. Lavinel Ionescu under the name *Southern Brazilian Journal of Chemistry*. Since then, science has witnessed extraordinary discoveries and achievements: the Human Genome Project, the discovery of the Higgs boson, the development of super-resolution microscopy, and many others. Today, we can edit genomes, develop vaccines based on RNA, carry powerful computers in our pockets, store vast amounts of information in the cloud, and—perhaps most remarkably—witness the birth and rapid growth of Artificial Intelligence.

Against this backdrop, **Southern Journal of Sciences is entering a new stage in its own evolution.**

For the first time, the journal will be edited from Argentina. For the first time, it will also be managed by a university. The Faculties of Medical Sciences and Health Sciences of the **Universidad de Mendoza** will join forces to continue and expand the legacy established by Dr. Ionescu.

Since its creation, the journal has been guided by a succession of editors who have contributed to its development and continuity: Dr. Lavinel Ionescu, followed by Dr. Luis Alcides Brandini De Boni (2017–2021), Dr. Walter José Peláez, and Dr. Cristián Andrés Quintero (2022–2025).

Now, a new editorial team takes on this responsibility. **Cristián Andrés Quintero and María Virginia Avena**, with the support of the Knowledge Management Unit of the Universidad de Mendoza, will lead the journal into this new chapter.

Changes are coming. We will introduce new sections, thematic collections, and special issues, while seeking new ways to connect scientific knowledge with researchers, professionals, students, and society.

This new phase will also strengthen the journal's interdisciplinary and international character. From its origins in Brazil to its new leadership in Argentina, the Southern Journal of Sciences aspires to consolidate its position as a space for Latin American scientific cooperation, open to dialogue with the international academic community. We also reaffirm our commitment to scientific integrity, good editorial practices, transparency, and the responsible communication of knowledge.

But while the journal evolves, **its fundamental principles will remain unchanged.**

Southern Journal of Sciences will continue to be accessible to all readers, free of charge, and firmly committed to **open science**. We will continue to promote high-quality research, a transparent and rigorous peer-review process, and, above all, respect and gratitude toward the authors, reviewers, readers, and collaborators who make this journal possible.

Evolution does not mean forgetting where we came from. **It means building on what we have inherited to reach somewhere new.**

We invite you to join us in this new challenge. Keep trusting us, publishing with us, reviewing for us, and sharing your science with us.

Together, let us continue the evolution of Southern Journal of Sciences—and share our science with the world.

With our best regards,

Cristián Andrés Quintero & María Virginia Avena

Editors

Southern Journal of Sciences

UN NUEVO CAPÍTULO EN LA EVOLUCIÓN DE SOUTHERN JOURNAL OF SCIENCES

Estimados autores, revisores, lectores y colaboradores,

En la naturaleza hay una cosa que es imparable: **la evolución**. Puede ser rápida o increíblemente lenta, pero nunca se detiene. Desde las bacterias hasta los humanos, todos los organismos vivos evolucionan. **Southern Journal of Sciences** no es una excepción.

La revista nació en Brasil en 1993, fundada por el Dr. Lavinel Ionescu con el nombre de *Southern Brazilian Journal of Chemistry*. Desde entonces, la ciencia ha sido testigo de descubrimientos y logros extraordinarios: el Proyecto Genoma Humano, el descubrimiento del bosón de Higgs, el desarrollo de la microscopía de superresolución y muchos otros. Hoy en día podemos editar genomas, desarrollar vacunas basadas en ARN, llevar potentes computadoras en el bolsillo, almacenar grandes cantidades de información en la nube y, quizás lo más sorprendente, presenciar el nacimiento y el rápido crecimiento de la Inteligencia Artificial.

En este contexto, **Southern Journal of Sciences está entrando en una nueva etapa de su propia evolución.**

Por primera vez la revista será editada desde Argentina. Por primera vez también estará gestionada por una universidad. Las Facultades de Ciencias Médicas y Ciencias de la Salud de la **Universidad de Mendoza** unirán esfuerzos para continuar y ampliar el legado establecido por el Dr. Ionescu.

Desde su creación, la revista ha estado guiada por una sucesión de editores que han contribuido a su desarrollo y continuidad: el Dr. Lavinel Ionescu, seguido por el Dr. Luis Alcides Brandini De Boni (2017–2021), el Dr. Walter José Peláez y el Dr. Cristián Andrés Quintero (2022–2025). Ahora, un nuevo equipo editorial asume esta responsabilidad. **Cristián Andrés Quintero y María Virginia Avena**, con el apoyo de la Unidad de Gestión del Conocimiento de la Universidad de Mendoza, liderarán la revista en este nuevo capítulo.

Se avecinan cambios. Introduciremos nuevas secciones, colecciones temáticas y números especiales, mientras buscamos nuevas formas de conectar el conocimiento científico con investigadores, profesionales, estudiantes y la sociedad.

Esta nueva etapa también fortalecerá el carácter interdisciplinario e internacional de la revista. Desde sus orígenes en Brasil hasta su nueva conducción desde Argentina, *Southern Journal of Sciences* aspira a consolidarse como un espacio de cooperación científica latinoamericana, abierto al diálogo con la comunidad académica internacional. Reafirmamos, asimismo, nuestro compromiso con la integridad científica, las buenas prácticas editoriales, la transparencia y la comunicación responsable del conocimiento.

Pero mientras la revista evoluciona, **sus principios fundamentales permanecerán sin cambios.**

Southern Journal of Sciences seguirá siendo accesible para todos los lectores, de forma gratuita y firmemente comprometida con la **ciencia abierta**. Continuaremos promoviendo investigaciones de alta calidad, un proceso de revisión por pares transparente y riguroso y, sobre todo, respeto y gratitud hacia los autores, revisores, lectores y colaboradores que hacen posible esta revista.

La evolución no significa olvidar de dónde venimos. **Significa aprovechar lo que hemos heredado para llegar a algún lugar nuevo.**

Los invitamos a acompañarnos en este nuevo desafío y a continuar confiando en la revista,

publicando, colaborando como revisores y compartiendo con nosotros el compromiso de hacer avanzar la ciencia.

Juntos, continuemos la evolución de Southern Journal of Sciences y compartiendo nuestra ciencia con el mundo.

Agregar un agradecimiento?

Expresamos nuestro sincero agradecimiento a todas las personas que, a lo largo de su historia, han sostenido la revista y han hecho posible este nuevo capítulo.

Un cordial saludo

Cristián Andrés Quintero & María Virginia Avena

Editores

Southern Journal of Sciences

UM NOVO CAPÍTULO NA EVOLUÇÃO DO SOUTHERN JOURNAL OF SCIENCES

Prezados autores, revisores, leitores e colaboradores,

Na natureza, uma coisa é imparável: a **evolução**. Ela pode ser rápida ou incrivelmente lenta, mas nunca para. De bactérias a humanos, todos os organismos vivos evoluem. O **Southern Journal of Sciences** não é exceção.

O periódico nasceu no Brasil em 1993, fundado pelo Dr. Lavinel Ionescu com o nome de *Southern Brazilian Journal of Chemistry*. Desde então, a ciência testemunhou descobertas e conquistas extraordinárias: o Projeto Genoma Humano, a descoberta do bóson de Higgs, o desenvolvimento da microscopia de super-resolução e muitas outras. Hoje, podemos editar genomas, desenvolver vacinas baseadas em RNA, carregar computadores poderosos em nossos bolsos, armazenar vastas quantidades de informações na nuvem e — talvez o mais notável — testemunhar o nascimento e o rápido crescimento da Inteligência Artificial.

Nesse contexto, o **Southern Journal of Sciences** está entrando em uma nova etapa em sua própria evolução.

Pela primeira vez, o periódico será editado na Argentina. Pela primeira vez, também será gerido por uma universidade. As Faculdades de Ciências Médicas e Ciências da Saúde da **Universidade de Mendoza** unirão forças para dar continuidade e expandir o legado estabelecido pelo Dr. Ionescu.

Desde a sua criação, a revista tem sido orientada por uma sucessão de editores que contribuíram para o seu desenvolvimento e continuidade: Dr. Lavinel Ionescu, seguido pelo Dr. Luis Alcides Brandini De Boni (2017–2021), Dr. Walter José Peláez e Dr. Cristián Andrés Quintero (2022–2025).

Agora, uma nova equipe editorial assume essa responsabilidade. **Cristián Andrés Quintero e María Virginia Avena**, com o apoio da Unidade de Gestão do Conhecimento da Universidade de Mendoza, conduzirão a revista neste novo capítulo.

Mudanças estão a caminho. Introduziremos novas seções, coleções temáticas e edições especiais, buscando novas maneiras de conectar o conhecimento científico com pesquisadores, profissionais, estudantes e a sociedade.

Esta nova fase também fortalecerá o caráter interdisciplinar e internacional da revista. Desde suas origens no Brasil até sua nova direção na Argentina, a Southern Journal of Sciences aspira consolidar sua posição como um espaço de cooperação científica latino-americana, aberto ao diálogo com a comunidade acadêmica internacional. Reafirmamos, ainda, nosso compromisso com a integridade científica, as boas práticas editoriais, a transparência e a comunicação responsável do conhecimento.

Mas, embora o periódico evolua, **seus princípios fundamentais permanecerão inalterados**.

O Southern Journal of Sciences continuará acessível a todos os leitores, gratuitamente, e firmemente comprometido com a **ciência aberta**. Continuaremos a promover pesquisas de alta qualidade, um processo de revisão por pares transparente e rigoroso e, acima de tudo, respeito e gratidão aos autores, revisores, leitores e colaboradores que tornam este periódico possível.

Evoluir não significa esquecer de onde viemos. **Significa construir sobre o que herdamos para alcançar um novo patamar.**

Convidamos você a se juntar a nós neste novo desafio. Continue confiando em nós, publicando

conosco, revisando para nós e compartilhando sua ciência conosco.

Juntos, vamos continuar a evolução do Southern Journal of Sciences — e compartilhar nossa ciência com o mundo.

Atenciosamente,

Cristián Andrés Quintero & María Virginia Avena

Editores

Southern Journal of Sciences

BEYOND THE HOSPITAL: A ONE HEALTH REFLECTION ON ANTIMICROBIAL RESISTANCE

Constanza Gai^{1,2,*}

¹ Laboratorio BioCyM, Facultad de Farmacia y Bioquímica, Universidad Juan Agustín Maza. ORCID: 0009-0009-9568-8912

² Área de Microbiología, Facultad de Ciencias Médicas, Universidad Nacional de Cuyo

* Correspondence author
email: consgai@gmail.com

Dear Editor:

In May 2024, the World Health Organization (WHO) published an update to its Bacterial Priority Pathogens List (BPPL), an instrument that identifies 24 pathogens grouped into 15 antibiotic-resistant families, classified into critical, high, and medium categories, with the aim of guiding research, the development of new treatments, and antimicrobial resistance control strategies (1).

When presenting the list, the WHO itself insisted that addressing resistance requires a comprehensive approach that combines infection prevention, access to essential services, timely diagnosis, and appropriate treatment (1). This update offers an opportunity to ask whether the most influential prioritization instrument in the field actually reflects that comprehensiveness, or whether it remains anchored, in its underlying logic, to a predominantly hospital-based and clinical perspective.

Antimicrobial resistance constitutes one of the most serious threats to global public health. Its impact is no longer limited to the therapeutic failure of individual infections, but rather involves complex medical procedures, prolongs hospital stays, raises healthcare costs, and increases mortality. However, despite the magnitude of the problem, much of the institutional response and clinical mindset continues to focus on the hospital as the main setting for emergency care and control. This view is necessary, but it is incomplete (2, 3).

The accumulated evidence indicates that antimicrobial resistance cannot be properly understood or addressed from an exclusively hospital-based perspective. It is an ecological, evolutionary, and social phenomenon, sustained by the interaction between human health, animal health, and the environment. From a One Health perspective, resistant microorganisms and their genes circulate among people, animals, food, wastewater, soils, and aquatic ecosystems, such that the boundaries between the clinical, veterinary, and environmental domains are far more porous than is often assumed (4, 5).

Hospitals remain critical settings because they concentrate vulnerable patients, intensive antimicrobial use, and conditions favorable to the selection and transmission of multidrug-resistant bacteria. However, reducing the problem to intrahospital epidemiology leaves out important sources of selective pressure and reservoirs of resistance. A substantial portion of antimicrobial consumption in humans occurs in the community, and this use is also associated with the emergence of resistance in clinically important pathogens (6). In other words, the response cannot be limited to hospital stewardship programs if outpatient prescribing, self-medication, or inadequate access to antibiotics continue to fuel the problem outside the clinic.

To this is added the role of the animal sector. The use of antimicrobials in food-producing animals contributes to the selection of resistant bacteria with potential relevance to human health (2, 3). The integrated analysis of consumption and resistance in Europe showed associations between the use of certain antimicrobial classes in animals and the resistance observed in zoonotic bacteria isolated from humans (6). Even more convincingly, a systematic review with meta-analysis found that interventions aimed at restricting antibiotic use in food-producing animals are associated with a decrease in the prevalence of resistance in those animals, as well as a reduction among directly exposed human populations (7). These findings undermine any reading that positions the hospital as a sufficient space for cutting the chain of selection and dissemination.

The environmental component further reinforces this need to broaden the perspective. The environment does not function merely as a passive receptor of human and animal waste, but rather as a reservoir, a mixing point, and, in certain contexts, a site of resistance selection (8, 9). Urban and hospital wastewater, pharmaceutical industry effluents, agricultural runoff, manure, and sediments can contain antibiotics, resistant bacteria, and resistance genes that interact under conditions favorable to persistence and genetic transfer (8, 9). This dimension is especially relevant because it reminds us that resistance depends not only on the contact between physician, patient, and drug, but also on sanitation infrastructure, waste management, water quality, and pollution control.

The wastewater literature illustrates this complexity well. Hospitals can locally enrich the resistance burden in their effluents and act as an important source of multidrug-resistant gram-negative bacteria (10). However, studies conducted along complete treatment pathways show that the hospital contribution does not always account for the largest share of the total burden that ultimately reaches the environment, compared with broader community and urban sources (11). This point has both conceptual and practical implications. Conceptually, because it shows that the hospital is a relevant node within a larger network. Practically, because it suggests that

a policy focused solely on hospital effluents would be insufficient unless accompanied by broader improvements in sanitation, water treatment, and environmental surveillance.

From this perspective, the One Health approach is not a rhetorical device, but an analytical and operational necessity. Its main contribution lies in shifting the discussion from isolated sectors toward connected systems. This implies accepting that resistance can emerge in one reservoir, amplify in another, and become clinically visible in a third (4-8). It also implies recognizing that the most effective measures will not always come from the same place where the problem becomes most apparent. In some cases, an improvement in the prudent use of antimicrobials in animal production, in food biosecurity, in waste treatment, or in basic sanitation can have effects on human health that are just as relevant as a well-designed intrahospital intervention (2, 3).

This tension becomes visible when examining the criteria used to construct the BPPL itself. Although the discourse accompanying the list explicitly invokes the need for sanitation, safe drinking water, and hygiene to curb community-acquired pathogens (1), the prioritization of the included pathogens is based primarily on the disease burden in human clinical isolates, treatability with antibiotics used in humans, and gaps in the development of new drugs for that same population (1). In other words, the flagship instrument that globally guides investment in R&D against antimicrobial resistance illustrates, in its very architecture, the hospital-centric bias this letter highlights: it names the problem in One Health terms, yet continues to measure it almost exclusively from the standpoint of human clinical medicine. The recent reclassification of carbapenem-resistant *Pseudomonas aeruginosa*, which moved from the critical category to the high-priority category based on new surveillance data, further confirms how much this prioritization depends on monitoring systems that, as discussed below, remain predominantly clinical and hospital-based.

Surveillance constitutes another point where the hospital-centric bias becomes evident. The most historically developed monitoring systems have been built primarily from human clinical isolates, particularly hospital-based ones. Although this component remains indispensable, isolated sectoral surveillance does not allow for a clear reconstruction of transmission pathways among humans, animals, and the environment, nor for the robust integration of consumption and resistance data across sectors (12, 13). Recent reviews show that truly integrated surveillance systems remain scarce, are concentrated in high-income countries, and still face challenges related to methodological harmonization, governance, and data comparability (13, 14). Even so, the direction of the field appears unequivocal: without integrated surveillance, a significant part of the real ecology of resistance remains hidden.

In this context, adopting a One Health perspective requires avoiding two

oversimplifications. The first would be to minimize the role of the hospital. The evidence does not support this position. Hospitals continue to be key settings for the selection of resistance, the use of broad-spectrum antibiotics, and the transmission of high-priority pathogens. The second oversimplification, perhaps more common, would be to assume that acting well within the hospital is enough to contain the problem as a whole. This conclusion is likewise not supported by the available literature (2, 5). Antimicrobial resistance reflects a continuity among the community, animal production, the environment, and healthcare, and that continuity demands coordinated responses.

For this reason, the current debate should not focus on choosing between hospital-based control and a One Health approach, but rather on overcoming the false opposition between the two. Hospital-based action must be integrated into a broader strategy that includes the prudent use of antimicrobials in humans and animals, strengthening of primary care, improved sanitation, wastewater surveillance, control of polluting effluents, and intersectoral surveillance systems capable of translating data into action (9-13, 15). Only in this way will it be possible to move from a reactive response, focused on the places where resistance already causes visible harm, to a preventive strategy that also addresses the conditions that generate, sustain, and spread it.

An agenda consistent with this diagnosis should also be reflected in how we build our own prioritization instruments. If the WHO's BPPL is to fully deliver on its One Health promise, future updates should explicitly incorporate environmental and veterinary burden criteria—not only human clinical burden—when weighting each pathogen (1). Otherwise, the list risks remaining, in practice, a catalog of priorities for human medicine dressed in intersectoral language.

In summary, antimicrobial resistance does not stop at the hospital door, because it does not originate there exclusively either. Thinking about it through a One Health lens does not abstractly broaden the problem; rather, it places it at its true biological, ecological, and public health scale. If an effective and sustainable response is to be achieved, the hospital must remain part of the solution, but it can no longer remain the sole center of the conversation (3, 4-8).

Sincerely,

Dr. Constanza Gai

Laboratorio BioCyM, Facultad de Farmacia y Bioquímica, Universidad Juan Agustín Maza

Área de Microbiología, Facultad de Ciencias Médicas, Universidad Nacional de Cuyo

MÁS ALLÁ DEL HOSPITAL: UNA REFLEXIÓN ONE HEALTH SOBRE LA RESISTENCIA A LOS ANTIMICROBIANOS

Estimado Editor:

En mayo de 2024, la Organización Mundial de la Salud (OMS) publicó una actualización de su Lista de Patógenos Bacterianos Prioritarios (BPPL, por su sigla en inglés), un instrumento que identifica 24 patógenos agrupados en 15 familias resistentes a los antibióticos, clasificados en las categorías crítica, alta y media, con el objetivo de orientar la investigación, el desarrollo de nuevos tratamientos y las estrategias de control de la resistencia a los antimicrobianos (1).

Al presentar la lista, la propia OMS insistió en que abordar la resistencia requiere un enfoque integral que combine la prevención de infecciones, el acceso a servicios esenciales, el diagnóstico oportuno y el tratamiento adecuado (1). Esta actualización ofrece una oportunidad para preguntarnos si el instrumento de priorización más influyente en el campo refleja realmente esa integralidad, o si continúa anclado, en su lógica de construcción, a una perspectiva predominantemente hospitalaria y clínica.

La resistencia a los antimicrobianos constituye una de las amenazas más serias para la salud pública global. Su impacto ya no se limita al fracaso terapéutico de infecciones individuales, sino que compromete procedimientos médicos complejos, prolonga estancias hospitalarias, eleva los costos sanitarios y aumenta la mortalidad. Sin embargo, pese a la magnitud del problema, gran parte de la respuesta institucional y del imaginario clínico sigue concentrándose en el hospital como escenario principal de atención de emergencias y control. Esta perspectiva es necesaria, pero resulta incompleta (2, 3).

La evidencia acumulada indica que la resistencia a los antimicrobianos no puede comprenderse ni abordarse adecuadamente desde una perspectiva exclusivamente hospitalaria. Se trata de un fenómeno ecológico, evolutivo y social, sostenido por la interacción entre la salud humana, la salud animal y el medioambiente. Desde una perspectiva One Health, los microorganismos resistentes y sus genes circulan entre personas, animales, alimentos, aguas residuales, suelos y ecosistemas acuáticos, de modo que los límites entre los ámbitos clínico, veterinario y ambiental son mucho más permeables de lo que suele asumirse (4, 5).

Los hospitales siguen siendo entornos críticos porque concentran pacientes vulnerables, un uso intensivo de antimicrobianos y condiciones favorables para la selección y

transmisión de bacterias multirresistentes. Sin embargo, reducir el problema a la epidemiología intrahospitalaria deja fuera fuentes importantes de presión selectiva y reservorios de resistencia. Una proporción sustancial del consumo de antimicrobianos en seres humanos ocurre en la comunidad, y ese uso también está asociado con la emergencia de resistencia en patógenos de relevancia clínica (6). En otras palabras, la respuesta no puede limitarse a los programas de control hospitalario si la prescripción ambulatoria, la automedicación o el acceso inadecuado a los antibióticos continúan alimentando el problema fuera de la clínica.

A esto se suma el papel del sector animal. El uso de antimicrobianos en animales destinados a la producción de alimentos contribuye a la selección de bacterias resistentes con potencial relevancia para la salud humana (2, 3). El análisis integrado del consumo y la resistencia en Europa mostró asociaciones entre el uso de ciertas clases de antimicrobianos en animales y la resistencia observada en bacterias zoonóticas aisladas en seres humanos (6). De manera aún más contundente, una revisión sistemática con metaanálisis encontró que las intervenciones destinadas a restringir el uso de antibióticos en animales de producción se asocian con una disminución de la prevalencia de resistencia en esos animales, así como con una reducción entre las poblaciones humanas directamente expuestas (7). Estos hallazgos debilitan cualquier lectura que posicione al hospital como un espacio suficiente para cortar la cadena de selección y diseminación.

El componente ambiental refuerza aún más la necesidad de ampliar la perspectiva. El medio ambiente no funciona únicamente como receptor pasivo de residuos humanos y animales, sino también como reservorio, punto de mezcla y, en ciertos contextos, sitio de selección de resistencia (8, 9). Las aguas residuales urbanas y hospitalarias, los efluentes de la industria farmacéutica, el escurrimiento agrícola, el estiércol y los sedimentos pueden contener antibióticos, bacterias resistentes y genes de resistencia que interactúan en condiciones favorables para su persistencia y transferencia genética (8, 9). Esta dimensión es especialmente relevante porque nos recuerda que la resistencia no depende únicamente del contacto entre médico, paciente y fármaco, sino también de la infraestructura sanitaria, la gestión de residuos, la calidad del agua y el control de la contaminación.

La literatura sobre aguas residuales ilustra bien esta complejidad. Los hospitales pueden enriquecer localmente la carga de resistencia en sus efluentes y actuar como una fuente importante de bacterias gramnegativas multirresistentes (10). Sin embargo, los estudios realizados a lo largo de vías de tratamiento completas muestran que la contribución hospitalaria no siempre representa la mayor proporción de la carga total que finalmente llega al medioambiente, en comparación con las fuentes comunitarias y urbanas más amplias (11).

Este punto tiene implicaciones tanto conceptuales como prácticas. Conceptual, porque demuestra que el hospital es un nodo relevante dentro de una red más amplia. Prácticamente, porque sugiere que una política centrada exclusivamente en los efluentes hospitalarios resultaría insuficiente si no va acompañada de mejoras más amplias en saneamiento, tratamiento de aguas y vigilancia ambiental.

Desde esta perspectiva, el enfoque One Health no es un recurso retórico, sino una necesidad analítica y operativa. Su principal aporte reside en desplazar la discusión de sectores aislados hacia sistemas conectados. Esto implica aceptar que la resistencia puede emerger en un reservorio, amplificarse en otro y volverse clínicamente visible en un tercero (4-8). Implica también reconocer que las medidas más eficaces no siempre provendrán del mismo lugar donde el problema se manifiesta con mayor evidencia. En algunos casos, una mejora en el uso prudente de antimicrobianos en la producción animal, en la bioseguridad alimentaria, en el tratamiento de residuos o en el saneamiento básico puede tener efectos sobre la salud humana tan relevantes como una intervención intrahospitalaria bien diseñada (2, 3).

Esta tensión se hace visible al examinar los criterios utilizados para construir la propia BPPL. Aunque el discurso que acompaña a la lista invoca explícitamente la necesidad del saneamiento, el agua potable segura y la higiene para frenar los patógenos de adquisición comunitaria (1), la priorización de los patógenos incluidos se basa principalmente en la carga de enfermedad en aislamientos clínicos humanos, la tratabilidad con antibióticos de uso humano y las brechas en el desarrollo de nuevos fármacos para esa misma población (1). En otras palabras, el instrumento emblemático que orienta globalmente la inversión en I+D contra la resistencia a los antimicrobianos ilustra, en su propia arquitectura, el sesgo hospitalocéntrico que esta carta señala: nombra el problema en términos One Health, pero continúa midiéndolo casi exclusivamente desde la perspectiva de la medicina clínica humana. La reciente reclasificación de *Pseudomonas aeruginosa* resistente a carbapenémicos, que pasó de la categoría crítica a la de alta prioridad con base en nuevos datos de vigilancia, confirma además cuánto depende esta priorización de sistemas de monitoreo que, como se discute a continuación, siguen siendo predominantemente clínicos y hospitalarios.

La vigilancia constituye otro punto donde el sesgo hospitalocéntrico se hace evidente. Los sistemas de monitoreo con mayor desarrollo histórico se han construido principalmente a partir de aislamientos clínicos humanos, en particular los de origen hospitalario. Aunque este componente sigue siendo indispensable, la vigilancia sectorial aislada no permite reconstruir con claridad las vías de transmisión entre seres humanos, animales y el medioambiente, ni integrar de manera robusta los datos de consumo y resistencia entre sectores (12, 13).

Revisiones recientes muestran que los sistemas de vigilancia verdaderamente integrados siguen siendo escasos, están concentrados en países de altos ingresos y aún enfrentan desafíos relacionados con la armonización metodológica, la gobernanza y la comparabilidad de los datos (13, 14). Aun así, la dirección del campo parece inequívoca: sin vigilancia integrada, una parte significativa de la ecología real de la resistencia permanece oculta.

En este contexto, adoptar una perspectiva One Health requiere evitar dos simplificaciones excesivas. La primera sería minimizar el papel del hospital. La evidencia no respalda esta posición. Los hospitales continúan siendo entornos clave para la selección de resistencia, el uso de antibióticos de amplio espectro y la transmisión de patógenos de alta prioridad. La segunda simplificación, quizás más frecuente, sería asumir que actuar bien dentro del hospital es suficiente para contener el problema en su conjunto. Esta conclusión tampoco está respaldada por la literatura disponible (2, 5). La resistencia a los antimicrobianos refleja una continuidad entre la comunidad, la producción animal, el medioambiente y la atención sanitaria, y esa continuidad exige respuestas coordinadas.

Por esta razón, el debate actual no debería centrarse en elegir entre el control hospitalario y el enfoque One Health, sino en superar la falsa oposición entre ambos. La acción hospitalaria debe integrarse en una estrategia más amplia que incluya el uso prudente de antimicrobianos en seres humanos y animales, el fortalecimiento de la atención primaria, la mejora del saneamiento, la vigilancia de aguas residuales, el control de efluentes contaminantes y sistemas de vigilancia intersectorial capaces de traducir los datos en acción (9-13, 15). Solo así será posible pasar de una respuesta reactiva, centrada en los lugares donde la resistencia ya causa daño visible, a una estrategia preventiva que también aborde las condiciones que la generan, sostienen y propagan.

Una agenda coherente con este diagnóstico debe reflejarse también en la forma en que construimos nuestros propios instrumentos de priorización. Si la BPPL de la OMS ha de cumplir plenamente su promesa One Health, las actualizaciones futuras deberían incorporar explícitamente criterios de carga ambiental y veterinaria —no solo la carga clínica humana— al ponderar cada patógeno (1). De lo contrario, la lista corre el riesgo de seguir siendo, en la práctica, un catálogo de prioridades para la medicina humana vestido con lenguaje intersectorial.

En síntesis, la resistencia a los antimicrobianos no se detiene en la puerta del hospital, porque tampoco se origina allí de manera exclusiva. Pensarla a través de una mirada One Health no amplía el problema de forma abstracta; más bien, lo sitúa en su verdadera escala biológica, ecológica y de salud pública. Si se quiere alcanzar una respuesta eficaz y sostenible, el hospital debe seguir siendo parte de la solución, pero ya no puede ser el único centro de la

conversación (3, 4-8).

Atentamente,

Dra. Constanza Gai

Laboratorio BioCyM, Facultad de Farmacia y Bioquímica, Universidad Juan Agustín Maza

Área de Microbiología, Facultad de Ciencias Médicas, Universidad Nacional de Cuyo

Referencias

1. World Health Organization, "WHO updates list of drug-resistant bacteria most threatening to human health," News release, May 17, 2024. Available: <https://www.who.int/news/item/17-05-2024-who-updates-list-of-drug-resistant-bacteria-most-threatening-to-human-health>
2. P. Collignon and S. McEwen, "One Health—Its Importance in Helping to Better Control Antimicrobial Resistance," *Tropical Medicine and Infectious Disease*, vol. 4, Jan. 2019, doi: [10.3390/tropicalmed4010022](https://doi.org/10.3390/tropicalmed4010022)
3. S. McEwen and P. Collignon, "Antimicrobial Resistance: a One Health Perspective." *Microbiology spectrum*, vol. 6 2, Mar. 2018, doi: [10.1128/microbiolspec.ARBA-0009-2017](https://doi.org/10.1128/microbiolspec.ARBA-0009-2017)
4. M. Woolhouse, M. Ward, B. van Bunnik, and J. Farrar, "Antimicrobial resistance in humans, livestock and the wider environment," *Philosophical Transactions of the Royal Society B: Biological Sciences*, vol. 370, Jun. 2015, doi: [10.1098/rstb.2014.0083](https://doi.org/10.1098/rstb.2014.0083)
5. T. Robinson et al., "Antibiotic resistance is the quintessential One Health issue," *Transactions of the Royal Society of Tropical Medicine and Hygiene*, vol. 110, pp. 377–380, Jul. 2016, doi: [10.1093/trstmh/trw048](https://doi.org/10.1093/trstmh/trw048)
6. O. Heuer, E. Iosifidis, C. Quinten, and K. Weist, "ECDC/EFSA/EMA second joint report on the integrated analysis of the consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from humans and food-producing animals," *EFSA Journal*, vol. 15, Jul. 2017, doi: [10.2903/j.efsa.2017.4872](https://doi.org/10.2903/j.efsa.2017.4872)
7. K. Tang et al., "Restricting the use of antibiotics in food-producing animals and its associations with antibiotic resistance in food-producing animals and human beings: a systematic review and meta-analysis," *The Lancet. Planetary Health*, vol. 1, pp. e316–e327, Nov. 2017, doi: [10.1016/S2542-5196\(17\)30141-9](https://doi.org/10.1016/S2542-5196(17)30141-9)
8. D. Larsson and C.-F. Flach, "Antibiotic resistance in the environment," *Nature Reviews. Microbiology*, vol. 20, pp. 257–269, Nov. 2021, doi: [10.1038/s41579-021-00649-x](https://doi.org/10.1038/s41579-021-00649-x)
9. T. Berendonk et al., "Tackling antibiotic resistance: the environmental framework," *Nature Reviews Microbiology*, vol. 13, pp. 310–317, Mar. 2015, doi: [10.1038/nrmicro3439](https://doi.org/10.1038/nrmicro3439)
10. N. Hassoun-Kheir et al., "Comparison of antibiotic-resistant bacteria and antibiotic resistance genes abundance in hospital and community wastewater: A systematic review." *The Science of the total environment*, vol. 743, pp. 140804, Jul. 2020, doi: [10.1016/j.scitotenv.2020.140804](https://doi.org/10.1016/j.scitotenv.2020.140804)
11. I. Verburg, S. García-Cobos, L. H. Leal, K. Waar, A. Friedrich, and H. Schmitt, "Abundance and Antimicrobial Resistance of Three Bacterial Species along a Complete Wastewater Pathway," *Microorganisms*, vol. 7, Sep. 2019, doi: [10.3390/microorganisms7090312](https://doi.org/10.3390/microorganisms7090312)
12. K. Queenan, B. Häsler, and J. Rushton, "A One Health approach to antimicrobial resistance surveillance: is there a business case for it?" *International journal of antimicrobial agents*, vol. 48 4, pp. 422–7, Oct. 2016, doi: [10.1016/j.ijantimicag.2016.06.014](https://doi.org/10.1016/j.ijantimicag.2016.06.014)

13. L. Delpy et al., "Integrated surveillance systems for antibiotic resistance in a One Health context: a scoping review," BMC Public Health, vol. 24, Jun. 2024, doi: [10.1186/s12889-024-19158-6](https://doi.org/10.1186/s12889-024-19158-6)
14. R. Lappan et al., "Towards integrated cross-sectoral surveillance of pathogens and antimicrobial resistance: Needs, approaches, and considerations for linking surveillance to action." Environment international, vol. 192, pp. 109046, Oct. 2024, doi: [10.1016/j.envint.2024.109046](https://doi.org/10.1016/j.envint.2024.109046)
15. A. Pruden, P. Vikesland, B. C. Davis, and A. M. de R. Husman, "Seizing the moment: now is the time for integrated global surveillance of antimicrobial resistance in wastewater environments." Current opinion in microbiology, vol. 64, pp. 91–99, Oct. 2021, doi: [10.1016/j.mib.2021.09.013](https://doi.org/10.1016/j.mib.2021.09.013)



PHYSICOCHEMICAL AND PHYTOTOXIC QUALITY OF IRRIGATION WATER FOR THE TREES OF GENERAL SAN MARTÍN PARK, MENDOZA, ARGENTINA.

QUALIDADE FÍSICO-QUÍMICA E FITOTÓXICA DA ÁGUA DE IRRIGAÇÃO PARA AS ÁRVORES DO PARQUE GENERAL SAN MARTÍN, MENDOZA, ARGENTINA

GIAI, Marcos^{1,*}; FRANCO, Estela Dolores²

¹ Universidad Juan Agustín Maza. Facultad de Farmacia y Bioquímica. Mendoza. Argentina. ORCID: 0000-0003-3687-5645

² Universidad Juan Agustín Maza. Facultad de Farmacia y Bioquímica. Mendoza. Argentina. ORCID: 0000-0001-7397-4744

*Corresponding author: mgiai@umaza.edu.ar

Received 14th April 2026; received in revised form 11st May 2026; accepted 12nd May 2026

ABSTRACT

Background: General San Martín Park, located in Mendoza, Argentina, is the city's most emblematic green infrastructure, designed in 1896 by architect Carlos Thays. The park plays a critical role in microclimate regulation, water conservation, and public health resilience. **Aim:** The purpose of this study was to assess the quality of the water used for irrigation in the most important park of the city of Mendoza, the General San Martín Park, through a comprehensive series of analyses. **Methods:** This study assessed the physicochemical and biological quality of irrigation water in the park, focusing on parameters such as temperature, pH, turbidity, electrical conductivity, hardness, alkalinity, nitrates, sulfates, and anthropogenic contaminants. Samples were collected at 20 points across the irrigation network during three periods (October 2024, April 2025, October 2025). **Results:** Indicate that irrigation water is generally of good quality, suitable for sustaining the park's forest mass. pH values remained within the optimal irrigation range (6.5–8.4), while nitrate levels were consistently below the 30 ppm threshold, with no nitrites detected. Hardness and alkalinity varied spatially, particularly near the Alto Godoy Water Treatment Plant, suggesting localized inputs of dissolved solids. Turbidity and conductivity strongly correlated with hardness, reflecting the influence of suspended and dissolved mineral content from runoff and seasonal hydrological dynamics of the Mendoza River. Importantly, we found no evidence of toxic anthropogenic contaminants such as heavy metals, cyanides, or petroleum derivatives. **Discussion:** Overall, the findings emphasize the need for continuous monitoring. From a management perspective. These results establish a baseline of water quality indicators for the park. They provide essential input for long-term strategies in conservation, recreation, and environmental education, ensuring resilience against water scarcity and urban expansion. The study underscores the park's role as both a cultural heritage site and a living laboratory for sustainable urban ecology.

Keywords: Quality, Irrigation, Trees, San Martín Park, Mendoza

RESUMO

Introdução: O Parque General San Martín, localizado em Mendoza, Argentina, é a infraestrutura verde mais emblemática da cidade, criado em 1896 sob o projeto do arquiteto Carlos Thays. O parque desempenha um papel crítico na regulação do microclima, na conservação da água e na resiliência da saúde pública. **Objetivo:** Avaliar a qualidade da água utilizada para irrigação no principal parque da cidade de Mendoza, o Parque General San Martín, por meio de uma série abrangente de análises. **Métodos:** Foram avaliados parâmetros físico-químicos e biológicos da água de irrigação do parque, incluindo temperatura, pH, turbidez, condutividade elétrica, dureza, alcalinidade, nitratos, sulfatos e contaminantes antropogênicos. As amostras foram coletadas em 20 pontos da rede de irrigação durante três períodos (outubro de 2024, abril de 2025, outubro de 2025). **Resultados:** Indicam que a água de irrigação apresenta, em geral, boa qualidade, adequada para sustentar a massa florestal do parque. Os valores de pH permaneceram dentro da faixa ótima para irrigação (6,5–8,4), enquanto os níveis de nitrato estiveram consistentemente abaixo do limite de 30 ppm, sem detecção de nitritos. A dureza e a alcalinidade mostraram variabilidade espacial, particularmente em pontos próximos à Estação de Tratamento de Água Alto Godoy, sugerindo aportes localizados de sólidos dissolvidos. A turbidez e a condutividade apresentaram forte correlação com a dureza, refletindo a influência do conteúdo mineral suspenso e dissolvido proveniente do escoamento e da dinâmica hidrológica sazonal do Rio Mendoza. Importante destacar que não foram encontradas evidências de contaminantes antropogênicos tóxicos, como metais pesados, cianetos ou derivados de petróleo. **Discussão:** Os achados enfatizam a necessidade de monitoramento contínuo. Do ponto de vista da gestão, os resultados estabelecem uma linha de base de indicadores de qualidade da água para o parque, fornecendo insumos essenciais para estratégias de longo prazo em conservação, recreação e educação ambiental, garantindo resiliência frente à escassez hídrica e à expansão urbana. O estudo reforça o papel do parque como patrimônio cultural e como laboratório vivo para a ecologia urbana sustentável.

Palavras-chave: Qualidade, Irrigação, Árvores, Parque San Martín, Mendoza

1. INTRODUCTION

Urban parks, as public green spaces, are multifunctional. Their functions include leisure and recreation, environmental regulation, aesthetics, education, and social interaction all of which contribute to improving the population's quality of life (Segovia & Neira, 2009).

The General San Martín Park is located in the district of Ciudad de Mendoza, the provincial capital. Established in 1896, it is the oldest and most significant park in the city of

Mendoza, serving as a local emblem. The park encompasses 307 cultivated hectares and 86 hectares under expansion, with 17 km of pathways. At the time of its creation, public health policies were being developed, so the park was designed around environmental principles (oxygen provision, climate regulation) as well as social purposes.

It was conceived as a cultural product that reflected domesticated, culturalized nature while also fulfilling important landscape functions. Its design followed the European

style, particularly French, and the project incorporated a wide range of attractions, services, and activities integrating social, recreational, cultural, and sports uses. These included a botanical garden, zoo, regatta lake (shown in Figure 1), restaurant, music kiosk, bathhouses, and facilities for cricket, lawn tennis, soccer, and cycling, along with avenues, gardens, waterfalls, grottos, and islands (Suden, 2024).



Figure 1. View of the artificial lake of General San Martín Park, Mendoza, Argentina

Mendoza’s General San Martín Park originated with the proposal of hygienist physician Emilio Coni, who believed it was necessary to establish a health-promoting space, including a provincial hospital, in an elevated area of the city protected by green barriers.

To make this possible, they had to build infrastructure such as irrigation canals and flood defenses. Architect Carlos Thays was entrusted with the design, and in 1897 the layout of streets, canalization, and the planting of the first tree species began. Today, the park represents Mendoza’s “great garden,” where streets, lush groves, and irrigation ditches coexist as shown in Figure 2.

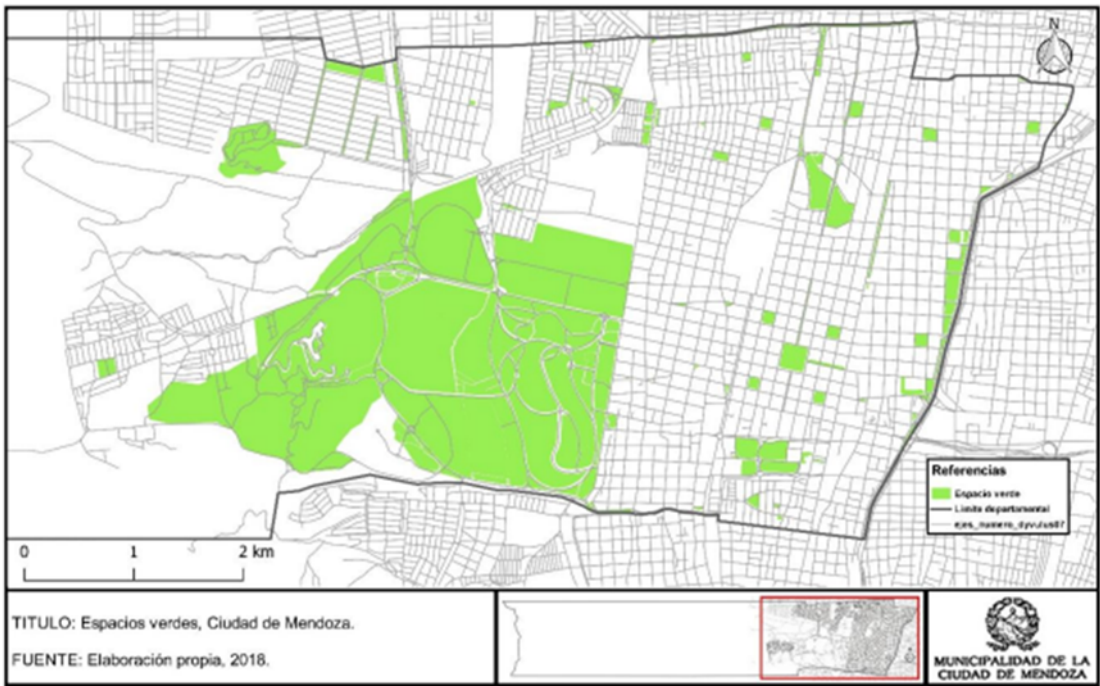


Figure 2. Green Spaces of the city of Mendoza, Argentina (Source: Municipality of Mendoza, 2018)

The park constitutes an example of green infrastructure in semi-arid regions, where the artificial lake and forested areas fulfill strategic functions for urban resilience, including microclimate regulation, water storage, and environmental education. Its study is relevant to disciplines such as urban planning, urban ecology, water resource management, and public health.

The city of Mendoza lies on a neotectonically active piedmont,

characterized by alluvial fans, river terraces, and colluvial deposits that create a complex and dynamic geomorphological profile. The Mendoza piedmont functions as a transitional zone between the Andes Mountains and the plain, strongly influenced by tectonic activity, erosion, and sedimentation processes that condition both urban development and water resource availability, as can be observed in the geomorphological profile of the city of Mendoza shown in Figure 3

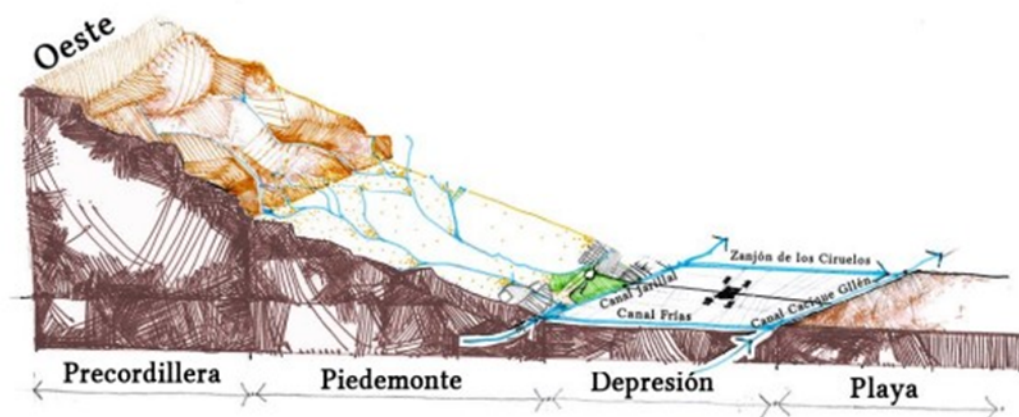


Figure 3.

Geomorphological profile of the city of Mendoza.

The piedmont is the area that topographically connects the mountainous zone with the plain; elevations range between 1,300 and 1,600 m a.s.l., descending to 800 m a.s.l. in the urbanized area (Vich & Pedriani, 1993). General San Martín Park is located in the transitional zone between the piedmont and the depression where Mendoza's urban core lies. This configuration facilitates the irrigation of the park through a complex system of canals and ditches.

Since 1996, General San Martín Park has been designated a protected environmental area, to be preserved for its

qualified representativeness as natural and cultural heritage—both present and future—aimed at its integral development through conservation, education, recreation, production, and research, with multiple ecological, social, and economic purposes (Law 6394, 1996). The law establishes specific uses for General San Martín Park, including the conservation of diverse species of flora and fauna, its landscape and cultural resources, environmental education and training, research to generate scientific knowledge of the urban environmental unit, the training of scientists, technicians, administrators, and managers in

environmental management, as well as the use of the area as an open laboratory for environmental research.

Human activity and peripheral urbanization may affect the quality of the water resources used for irrigating the park's trees. Anthropogenic activities and the growing vehicle fleet cause direct air pollution and indirectly affect irrigation water, a phenomenon more pronounced in the downtown area than in San Martín Park (Puliafito et al., 1997). Consequently, human activity and urbanization may influence the water resources intended for irrigation.

This project aims to conduct a comprehensive assessment of the physicochemical and phytotoxic quality of the water used to irrigate tree species in General San Martín Park. This evaluation seeks not only to determine the suitability of the water for sustaining urban vegetation, but also to identify potential risks associated with anthropogenic pressures and peripheral urbanization. By analyzing key physicochemical parameters (such as pH, electrical conductivity, dissolved solids, and nutrient concentrations) together with phytotoxic indicators, the study aims to provide a reproducible diagnostic framework for understanding how water quality influences tree health and long-term ecosystem resilience. The results are expected to inform evidence-based management strategies that integrate conservation, public health, and urban

ecological planning in semi-arid environments.

2. MATERIALS AND METHODS

2.1. Study Area

General San Martín Park is located in the city of Mendoza, Argentina (32°53'25"S, 68°52'16"W) and covers 394 hectares of forested and urbanized land. It contains more than 300,000 planted tree specimens adapted to stony soils and an arid climate, sustained by an irrigation system composed of a network of ditches and canals that maintain the forested mass within a desert environment.

The main irrigation canals of General San Martín Park are the Canal del Oeste and the Canal Civit, shown in Figure 4, which are derivations of the Mendoza River originating from the Cipolletti Dam and crossing the department of Godoy Cruz. The General Department of Irrigation – First Zone Canal Inspection (Canal del Oeste–Canal Civit) of Mendoza Province manages irrigation. The Canal Civit primarily supplies raw water to the Alto Godoy Water Treatment Plant, with its effluents subsequently integrated into the irrigation system of General San Martín Park. In contrast, the Canal del Oeste mainly irrigates forested and ornamental areas within the park.

Samples were collected at 20 sampling points, beginning at the main irrigation inflow (control #1, Canal del Oeste), with the remaining 19 samples distributed along the

layout of the gravity-fed irrigation system, as shown in Figure 4 and the geospatial information in Table 1.

Sampling point (control #1) corresponds to the inflow of the water resource into the irrigation system, representing the control point with no

anthropogenic contamination. At each sampling point, samples were collected in quintuplicate, and the mean value of each assay was calculated for statistical comparisons across the different sampling periods.

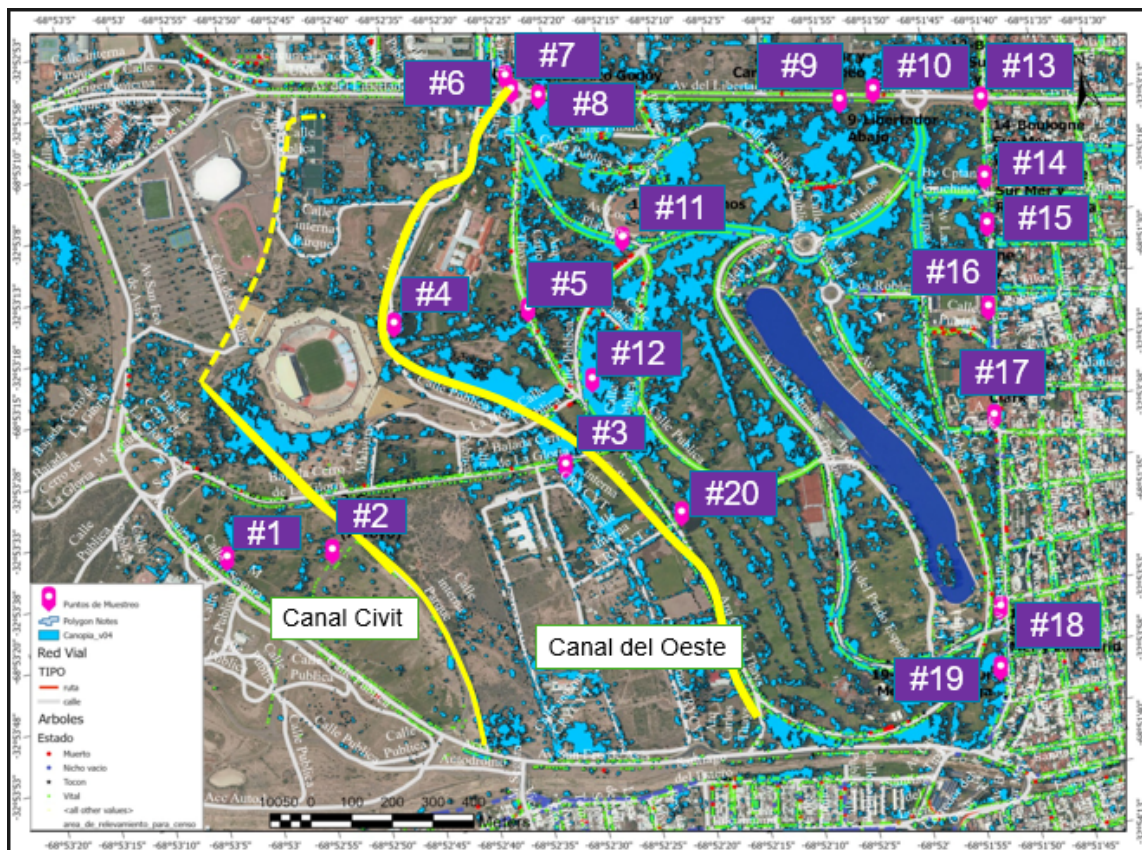


Figure 4. General San Martín Park. Irrigation canals (highlighted in yellow), sampling points (highlighted in magenta), and canopy (highlighted in light blue).

The processed samples correspond to the periods of October 2024, April 2025, and October 2025.

2.2. Design:

This study was descriptive and prospective in nature. Determinations were performed for physicochemical indicators of water quality, phytotoxicity, and anthropogenic contaminants in the irrigation

water of the tree population in General San Martín Park, Mendoza City.

Table 2 shows the parameters tested in the irrigation water.

2.3. Statistical Analysis

Variability among sampling points was evaluated using repeated-measures ANOVA followed by Dunnett’s multiple comparison test (significance threshold: $p < 0.05$). All statistical analyses were performed with

GraphPad® Prism software.

3. RESULTS AND DISCUSSION

3.1. Results

3.1. Results

Sample temperatures were consistently maintained within normal irrigation limits. Mean values recorded in October 2024 and 2025 remained stable at 13.5 ± 0.1 °C across all initial samples, whereas lower temperatures were observed in April 2025, averaging 9.6 ± 0.1 °C (range: 9.4–10.0 °C). No significant variations were detected among the sampling points in each seasonal measurement when compared to the water inflow (ANOVA, $p = 0.1836$).

Sample pH levels remained within acceptable limits for irrigation. Mean pH values ranged between 7.25 and 7.88 across all samples. Temporal measurements showed slight variation: October 2024, mean 7.66 ± 0.14 (range: 7.25–7.88); April 2025, mean 7.60 ± 0.15 (range: 7.21–7.80); and October 2025, mean 7.64 ± 0.12 (range: 7.20–7.78). In all sampling periods, pH remained within the suitable range for irrigation (6.5–8.4), as shown in Figure 5. Significant variation compared to the inflow was observed at sampling point #3 (Canal del Oeste/CONICET) (ANOVA, $p < 0.05$), #9 (Libertador Street) (ANOVA, $p < 0.01$), and #13 (Boulogne Sur Mer & Civit) (ANOVA, $p < 0.05$).

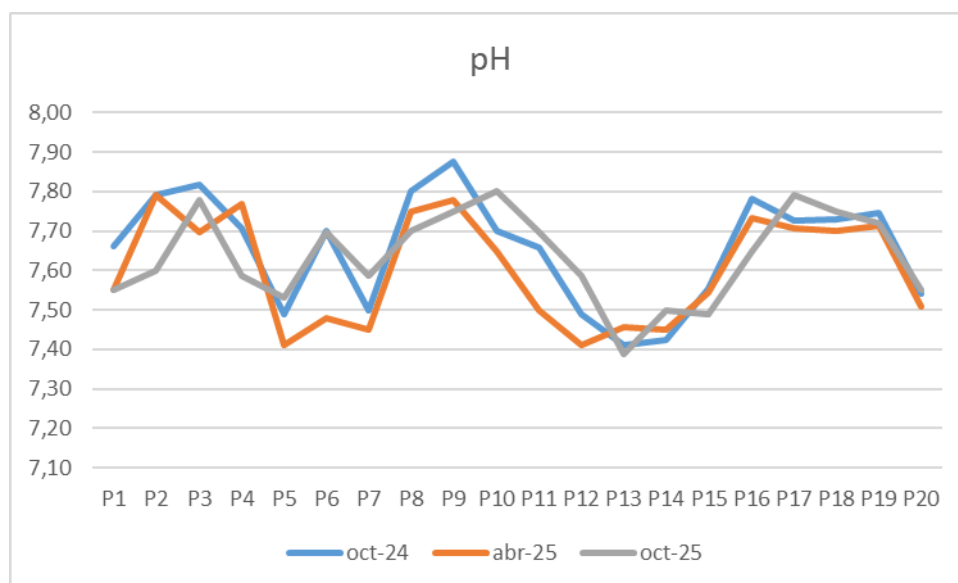


Figure 5. pH variability in the irrigation water of sampling points in General San Martín Park, Mendoza sampling periods were October 2024,

Turbidity levels were slightly elevated at sampling points #6 (Canal del Oeste – National University of Cuyo) and #7 (Alto Godoy Water Treatment Plant outlet), with values ranging from 8 to 12 NTU, as shown in Figure 6. Average turbidity values across

2.75 $\pm$ 3.13 NTU; April 2025, 2.84 $\pm$ 3.15 NTU; and October 2025, 3.13 $\pm$ 3.91 NTU. Turbidity increased overall in October 2025. Highly significant variation compared to the inflow was detected at sampling points #6 (ANOVA,

$p < 0.001$) and #7 (ANOVA, $p < 0.001$).

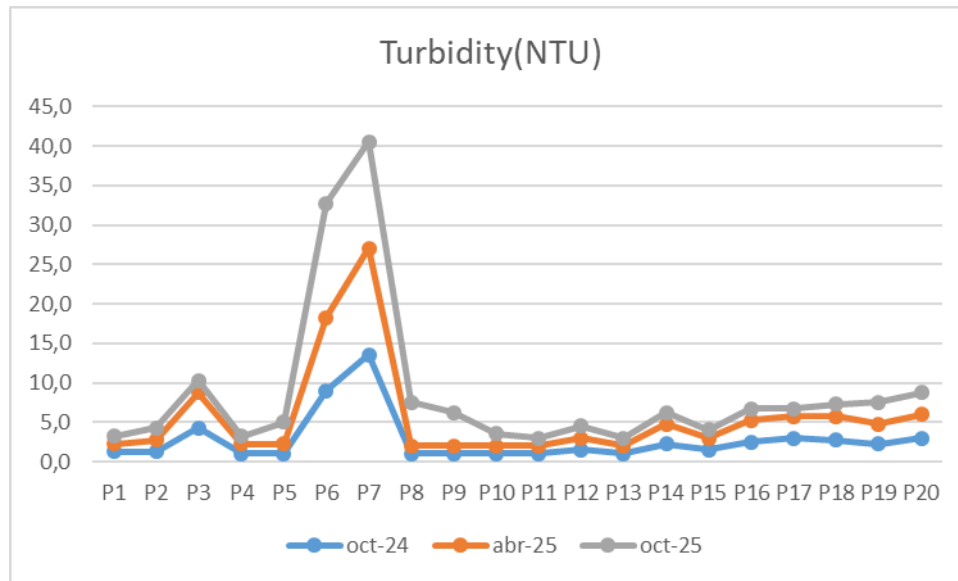


Figure 6. Turbidity variability in the irrigation water of sampling points in General San Martín Park, Mendoza

Alterations in electrical conductivity (0–3 dS/m). Average conductivity values were levels were detected at sampling points #6 2.05 ± 0.63 dS/m in October 2024, 1.85 ± 0.78 dS/m in April 2025, and 1.93 ± 0.83 dS/m in and #7 (Alto Godoy outlet) (ANOVA, $p < 0.001$) dS/m in October 2025, as shown in Figure 7. 0.001). All other measurements remained within the normal values for irrigation water

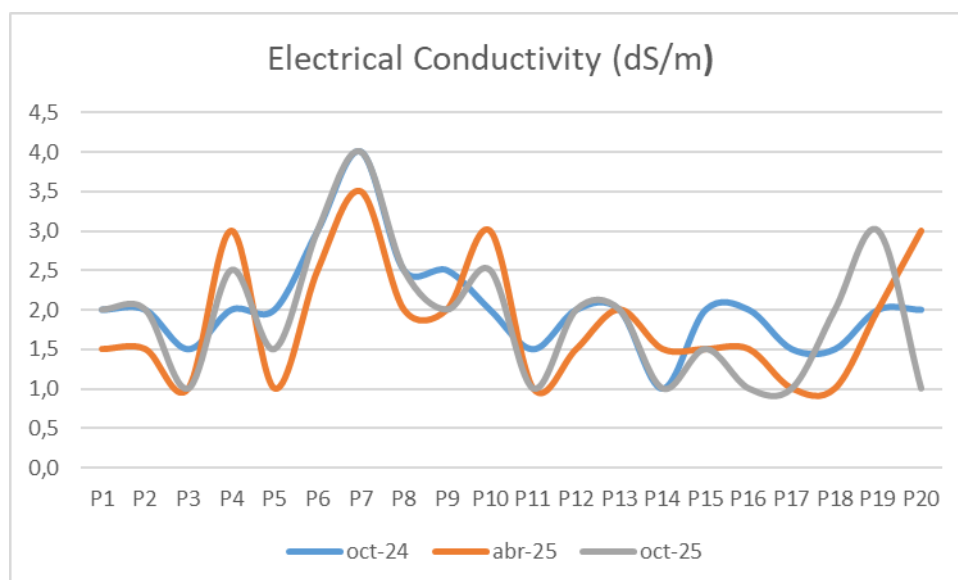


Figure 7. Electrical Conductivity variability in the irrigation water of sampling points in General San Martín Park, Mendoza

Most samples showed phosphate concentrations below 0.25 ppm, remaining under the irrigation water limits (0–2 ppm). The mean phosphate concentration was 0.22 ± 0.02 ppm. Higher values (0.25–0.35 ppm) were observed at sampling point #4 (Canal Civit – Stadium) in October 2025 and at sampling point #6 (Canal del Oeste – UNC) in October 2024 and April 2025, as shown in Figure 8. No significant differences compared to the inflow were detected (ANOVA, $p = 0.1346$).

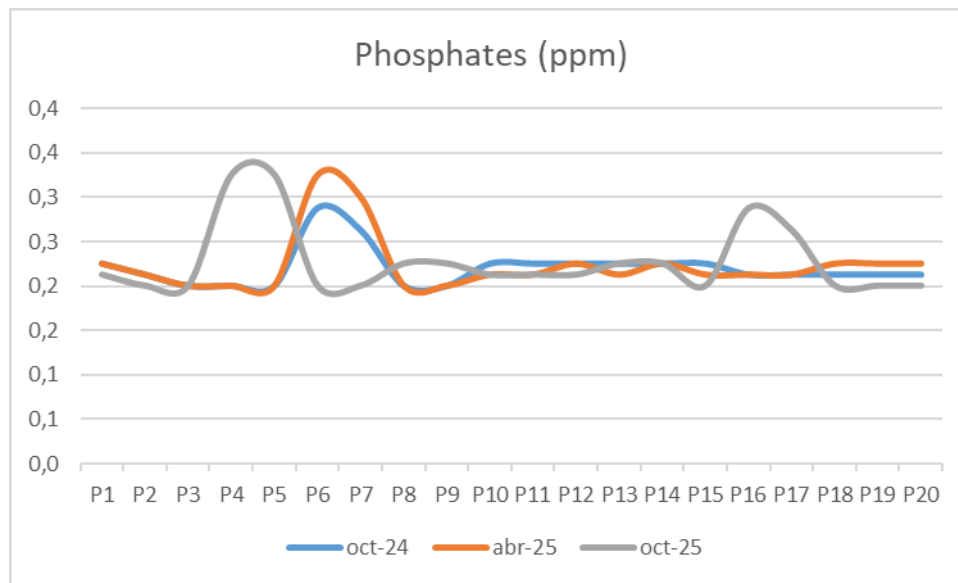


Figure 8. Phosphates variability in the irrigation water of sampling points in General San Martín Park, Mendoza

Nitrate concentrations were generally low and within the reference values for irrigation (<10 ppm). Mean values were 0.79 $\pm$ 0.62 ppm; April 2025, 0.64 $\pm$ 0.47 ppm; and October 2025, 0.80 $\pm$ 0.71 ppm. Elevated values were noted at sampling point #7 (Alto Godoy outlet), #8 (Libertador Street – Upper), and #9 (Libertador Street – Lower), as shown in Figure 9. Significant differences compared to the inflow were detected at sampling point #7 (ANOVA, $p < 0.01$), #8 (ANOVA, $p < 0.001$), and #9 (ANOVA, $p < 0.01$).

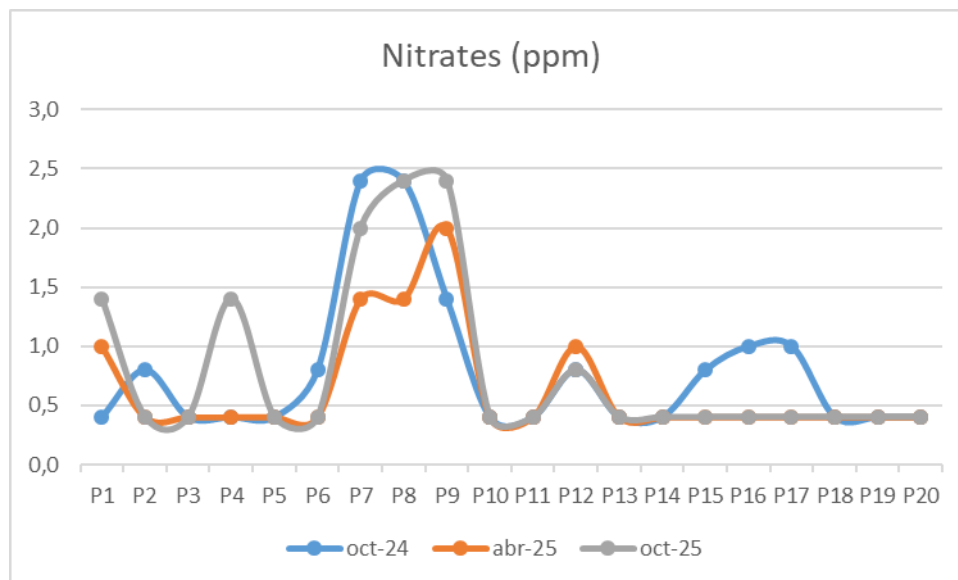


Figure 9. Nitrates variability in the irrigation water of sampling points in General San Martín Park, Mendoza

Total hardness consistently exhibited values (220–420 ppm) classify the water as the highest values. The measurements were hard. Sampling point #7 (Alto Godoy outlet) as follows: October 2024, 285.80 ± 34.25 consistently showed the highest hardness ppm; April 2025, 283.00 ± 32.90 ppm; and levels, as illustrated in Figure 10. October 2025, 291.20 ± 49.77 ppm. These

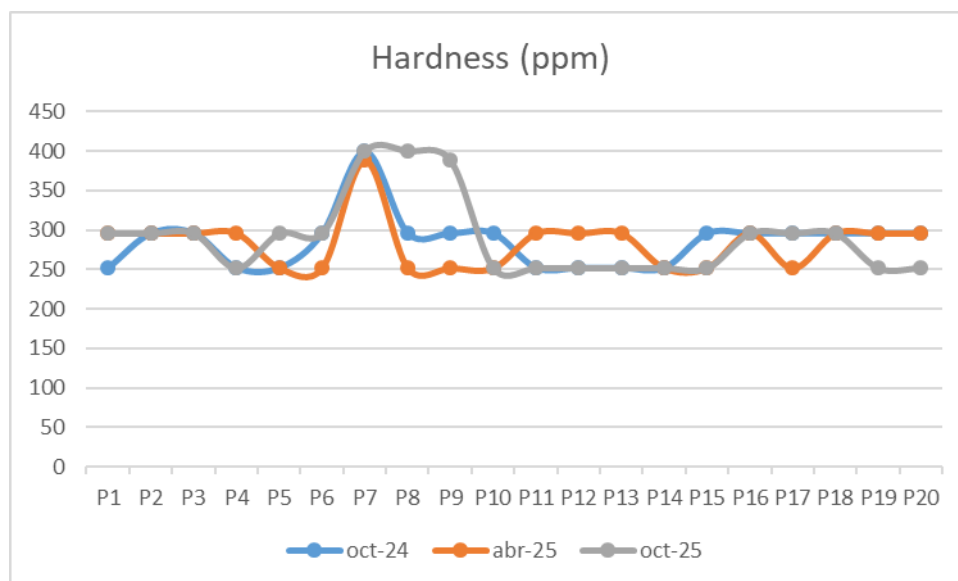


Figure 10. Hardness variability in the irrigation water of sampling points in General San Martín Park, Mendoz

Sulfate concentrations remained within 238.00 $\pm$ 18.15 ppm; and October 2025, the acceptable limits for irrigation (<250 ppm). 238.00 $\pm$ 16.90 ppm. Higher but still tolerable Mean sulfate values were October 2024, values (250–350 ppm) were observed at 238.40 $\pm$ 12.94 ppm; April 2025, sampling point #7 (Alto Godoy outlet), as

shown in Figure 11. Significant differences sampling points #7 and #8 (ANOVA, $p < 0.001$) compared to the inflow were detected at 0.001).

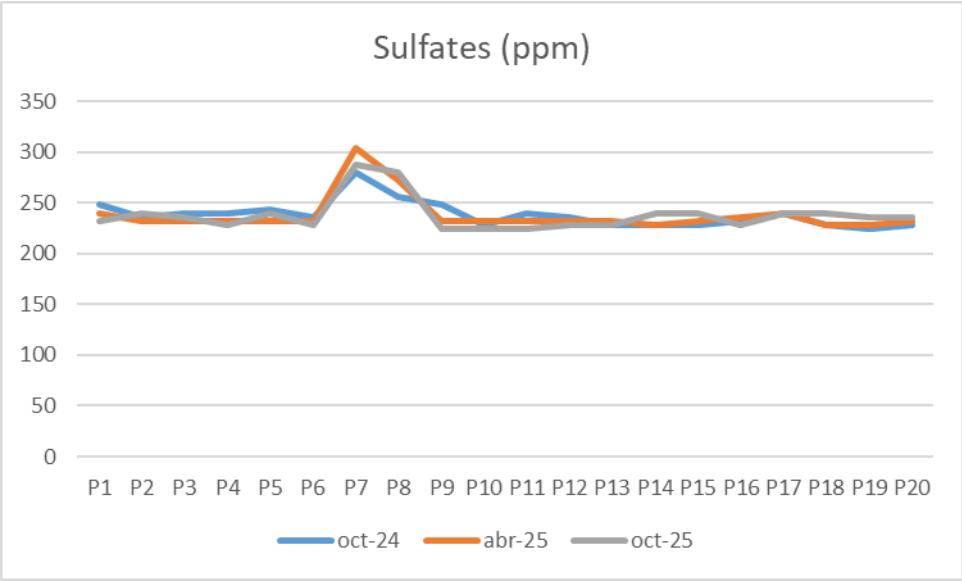


Figure 11. Sulfates variability in the irrigation water of sampling points in General San Martín Park, Mendoza

ppm; and October 2025, 130.20 ± 4.72 ppm, Alkalinity values remained within the as shown in Figure 12. A significant difference moderate ranges for irrigation (50–150 ppm). compared to the inflow was detected at Mean alkalinity values were: October 2024, sampling point #8 (ANOVA, $p < 0.001$). 133.20 ± 7.35 ppm; April 2025, 127.40 ± 9.82

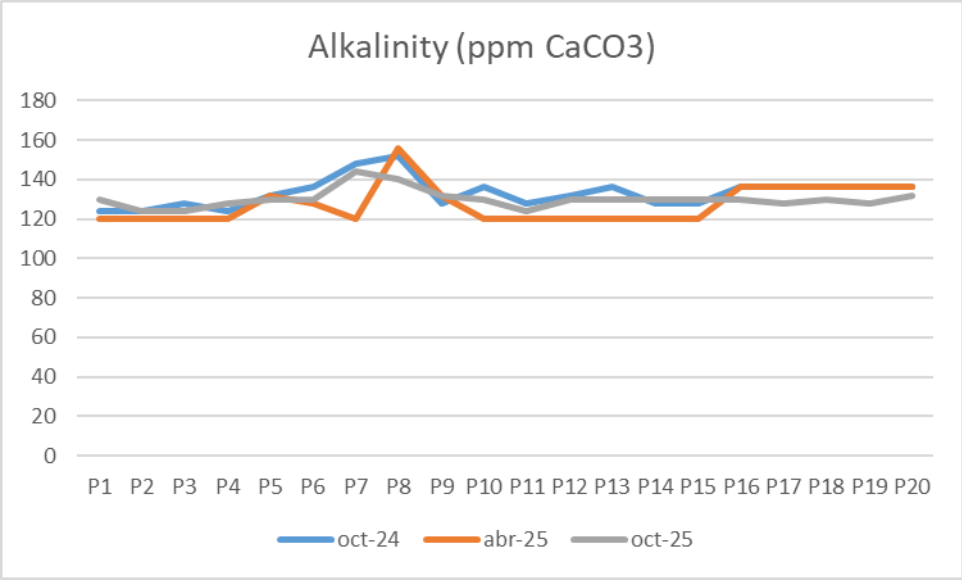


Figure 12. Alkalinity variability in the irrigation water of sampling points in General San Martín Park, Mendoza

irrigation. ($<10,000$ CFU/ml), with no Total mesophilic aerobic counts significant differences compared to the inflow. remained within the acceptable ranges for Mean values were: October 2024,

12.85 ± 4.68 CFU/ml; April 2025, 8.35 ± 5.55 CFU/ml; and October 2025, 19.00 ± 6.61 CFU/ml.

Root germination index values were mostly optimal (80–90%). Only sampling points #6 (UNC outlet) and #7 (Alto Godoy outlet) exhibited reduced but still acceptable values (70–75%), as shown in Figure 13. Mean root growth values of *Lactuca sativa*

were: October 2024, 86.75 ± 3.91%; April 2025, 87.95 ± 3.12%; and October 2025, 84.80 ± 4.23%. Significant differences compared to the inflow were detected at sampling points #6 and #7 (ANOVA, $p < 0.001$), while a slight difference was observed at sampling point #11 (Los Plátanos Street) (ANOVA, $p < 0.05$).

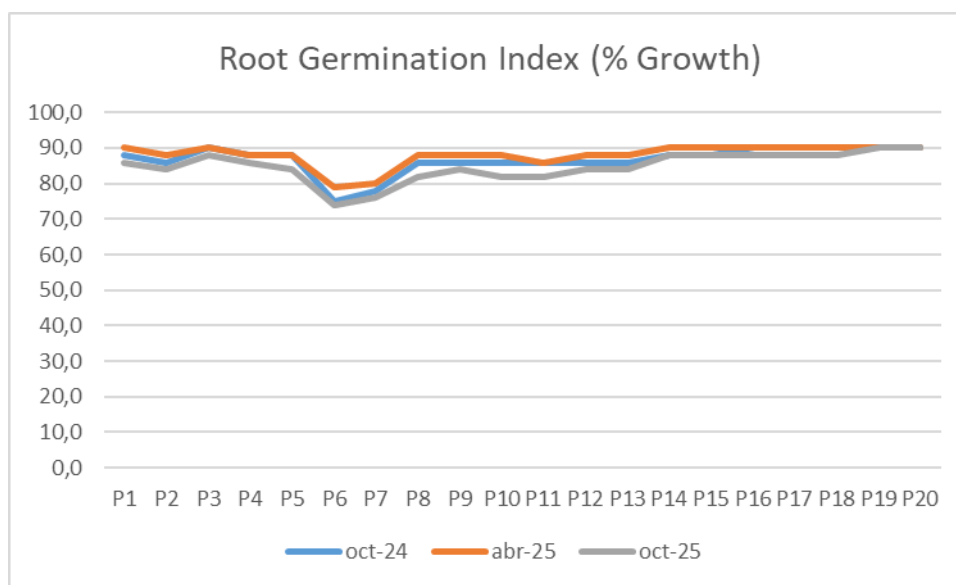


Figure 13. Root Germination Index variability in the irrigation water of sampling points in General San Martín Park, Mendoza

No evidence of anthropogenic contaminants such as bromine, copper, total chlorine, free chlorine, iron, potassium bisulfate, cyanides, lead, nickel, or petroleum derivatives was detected in the analyzed samples.

The comprehensive analysis of water quality parameters for irrigating tree species in General San Martín Park, Mendoza, Argentina, indicates that the analyzed water is of good quality for irrigation, with no significant problems related to salinity or anthropogenic

toxic elements. The greatest variability was identified at sampling points #6 (Canal del Oeste/National University of Cuyo) and #7 (Alto Godoy Water Treatment Plant outlet), which consistently showed higher values, suggesting local input of solids through runoff. This variability showed seasonal patterns associated with periods of increased flow or watershed activity of the Mendoza River during spring months (October) compared to autumn months (April). Nitrate levels were consistently well below the irrigation limit (30 ppm NO_3^-), and no nitrites were detected.

3.2. Discussions

Turbidity is directly associated with the concentration of total dissolved and suspended solids, and a correlational model can be established to estimate the concentration of dissolved solids in water samples intended for forest irrigation. This finding is consistent with data reported for domestic wastewater (Bolívar-Cuartas et al., 2021) and can be linked to various environmental variables such as flow rate, discharge, and the deposition velocity of dissolved sediments (Vidart et al., 2022).

Total hardness, salinity, and alkalinity in irrigation water are associated with calcium carbonate inputs carried by runoff from the melting Mendoza River and the limestone formations of the Andes Mountains (Morábito et al., 2005). These authors also note that these mineral contributions shape salinity, which affects the suitability of water for agricultural irrigation. Seasonal variations may relate to dilution from autumn rains compared with spring, as rainfall changes the proportion of surface and groundwater flow (Lauro et al., 2022).

The observed nitrate levels may be associated with decomposing organic matter and diffuse inputs from urban anthropogenic activities (Salatino et al., 2017). However, these concentrations do not pose a risk to the park's plant species. The sulfates detected in the irrigation water of General San Martín Park may result from the dissolution of gypsum

($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) in geological substrates transported from the Andes Mountains (Rosselot, 2017). No evidence of contamination from urban discharges or other anthropogenic sources affected the quality of the irrigation water system in the park under study, in contrast to reports from irrigation canals in Greater Mendoza (Morábito et al., 2012).

4. CONCLUSIONS

Total hardness and alkalinity in irrigation water in General San Martín Park show clear spatial patterns and strong relationships with pH and carbonate concentrations, requiring sector-specific monitoring. Current values are suitable for irrigation; however, the observed variability justifies continuous monitoring. The very low chlorine levels do not pose a risk to the trees, although points with detections (#6 and #8) require monitoring. The observed variability suggests specific sources associated with processes at the nearby water treatment plant. Low sulfate levels do not affect the quality of irrigation water for the park's trees. However, potential increases should be monitored, as they could affect more sensitive species such as ash. Seed germination indices of *Lactuca sativa* affected by elevated turbidity levels and the presence of nitrates serve as a sensitive bioindicator. Although they do not indicate acute toxicity, adult woody species may be more tolerant than lettuce

seedlings, while chronic exposure to contaminants could compromise their long-term health. General San Martín Park hosts a diversity of tree species, many of which are tolerant to semi-arid conditions but sensitive to contaminants in water and soil. Periodic monitoring is therefore necessary to prevent progressive degradation of more sensitive tree species, particularly in a context of water scarcity and increasing urban pressure.

5. DECLARATIONS

5.1. Management Implications

These initial results on irrigation water quality in General San Martín Park constitute a baseline of contamination risk indicators and provide the foundation for periodic monitoring over time. Such monitoring will optimize resource management and enhance its potential uses, ensuring a supply of safe water for both forestry and recreational activities.

5.2. Disclosure Statement

The authors declare no conflicts of interest.

5.5. Open Access

This article is licensed under a Creative Commons Attribution 4.0 (CC BY 4.0) International License, which permits use, sharing, adaptation, distribution, and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license unless indicated otherwise in a credit line to the material. Suppose material is not included in the article's Creative Commons license, and your intended use is not permitted by statutory regulation or exceeds

the permitted use. In that case, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

6. REFERENCES:

- 1) Bolívar-Cuartas, S. M., Castaño-Muñoz, D. L., & Gutiérrez-Flórez, O. D. (2021). *Correlational Model of Total Suspended Solids Present in Domestic Wastewater through Turbidity Analysis*. Producción + Limpia, 16(1), 186–197. Electronic publication April 26, 2022. <https://doi.org/10.22507/pml.v16n1a10>
- 2) Lauro, C., Vich, A. I. J., Vaccarino Pasquali, E. L. B., Otta, S. A., & Bastidas Mejía, L. B. (2022). *Analysis of the Base Flow Index of the Mendoza River, Argentina*. Available at: https://ri.conicet.gov.ar/bitstream/handle/11336/275175/CONICET_Digital_Nr_o.21b48bf1-c3ba-4bd6-a75b-80bf264f3eec_B.pdf?sequence=2&isAllowed=y
- 3) Morábito, J., Salatino, S., Medina, R., Zimmermann, M., Filippini, M. F., Bermejillo, A., ... & Mastrantonio, L. (2005). *Water Quality in the Irrigation Area of the Mendoza River (Argentina)*. Revista de la Facultad de Ciencias Agrarias, 37(1), 1–23. Available at: <https://www.ina.gov.ar/archivos/pdf/CRA-IIIIFERTI/CRA-RYD-11-Mor%C3%A1bito%201.pdf>

- 4) Morábito, J. A., Mirábile, C. M., Salatino, S. E., Mastrantonio, L., Barone, R. R., & Comellas, E. A. (2012). *Impact of Solid Urban Waste (SUW) Pollution on the Distribution of Irrigation Water from the Mendoza River (Argentina)*. Doctoral dissertation, Centro Regional Andino-INA, Belgrano 210 Oeste, Universidad Nacional de Cuyo.
- 5) Puliafito, C. M., Puliafito, S. E., & Quero, J. L. (1997). *Air Pollution in Mendoza*. Revista de la Universidad de Mendoza. Available at: <https://www.um.edu.ar/ojs2019/index.php/RUM/article/view/77>
- 6) Rosselot, E. A. (2017). *Geology between the Mendoza and Blanco Rivers, Principal Cordillera, Mendoza*. Doctoral dissertation, Universidad de Buenos Aires, Facultad de Ciencias Exactas y Naturales. Available at: https://bibliotecadigital.exactas.uba.ar/download/seminario/seminario_nGEO_001077_Rosselot.pdf
- 7) Salatino, S. E., Morábito, J. A., Bermejillo, A. I., Dediol, C., Miralles, S. A. N., Stocco, A. N., ... & Hernández, R. (2017). *Mendoza River: 12 Years of Water Quality Records. Evolutionary Analysis of Pollution*. Available at: <https://ri.conicet.gov.ar/handle/11336/160373>
- 8) Segovia, O., & Neira, H. (2009). *Urban Public Spaces: A Contribution to Identity and Social and Private Trust*. Revista INVI, North America, 20. Available at: <https://repositorio.uchile.cl/handle/2250/117985>
- 9) Suden, C. (2024). *Urban Parks as Cultural Heritage Landscapes*. Realidad, Tendencias y Desafíos en Turismo, 22(2), 115–125.
- 10) Vidart, G., Cechich, A., Buccella, A., & Montenegro, A. (2022). *Turbidity Analysis Based on Context Characterization*. JAIIO, Argentine Conference on Informatics, 8(4), 170–183. Available at: <https://sedici.unlp.edu.ar/bitstream/handle/10915/151915/Resumen.pdf-PDFA.pdf?sequence=1>
- 11) Vich, A. I., & Pedriani, A. (1993). *Research and Development Program: Ecological Management of the Piedmont*. Mendoza: Ministry of Environment, Urbanism and Housing, Regional Center for Scientific and Technological Research (CRICYT), Ecological Watershed Management Unit, Phase I: 154 p. Mendoza.

Table 1. . Geospatial Info of sampling points in General San Martín Park, Mendoza

ID	Location	Coordinates
#1	Canal del Oeste Entrance	-32.893852, -68.883338
#2	Canal Civit (Stream)	-32.894167, -68.880597
#3	Canal del Oeste (CONICET)	-32.893300, -68.874119
#4	Canal Civit (Malvinas Argentinas Stadium)	-32.889326, -68.877727
#5	Canal del Oeste (Escuela Hogar)	-32.889597, -68.874202
#6	Canal del Oeste (National University of Cuyo)	-32.884225, -68.873473
#7	Canal del Oeste (Alto Godoy Water Treatment Plant Outlet)	-32.884568, -68.873398
#8	Canal del Oeste (Libertador Street – Upper)	-32.884820, -68.872733
#9	Canal del Oeste (Libertador Street – Lower)	-32.886289, -68.865019
#10	Libertador Street and underground canal	-32.886217, -68.864102
#11	Los Plátanos Street and underground canal	-32.888424, -68.871381
#12	Thays Street and Del Grifo	-32.891484, -68.872948
#13	Boulogne Sur Mer Street and Civit	-32.886889, -68.861382
#14	Boulogne Sur Mer Street and Zapata	-32.888682, -68.861725
#15	Boulogne Sur Mer Street and Rufino Ortega	-32.889763, -68.861929
#16	Boulogne Sur Mer Street and Arístides Villanueva	-32.891655, -68.862369
#17	Boulogne Sur Mer Street and Clark	-32.894141, -68.862830
#18	Boulogne Sur Mer Street and Lamadrid	-32.898502, -68.863753
#19	Boulogne Sur Mer Street and Luzuriaga	-32.899871, -68.864096
#20	Thays Street (Golf Course Entrance)	-32.894916, -68.871413

Table 2. Parameters tested in the irrigation water of sampling points in General San Martín Park, Mendoza

Parameter	Method	Limit of detection
Temperature	Thermometer, pH meter(Milwaukee® PH55)	-5.0 – 60 °C
pH	Thermometer, pH meter(Milwaukee® PH55)	-2.0 – 16.0
Electrical Conductivity	Conductivity-meter/TDS (Milwaukee® T75)	0-2000 ppm
Turbidity	Turbidimeter (Arcano® TB100)	0 - 1100 NTU
Phosphates	Colorimetry (API®)	0 – 100 ppm
Carbonates	Semi-quantitative colorimetric (Tespert®).	0 - 400 ppm
Nitrates	Semi-quantitative colorimetric (Tespert®).	0 – 250 ppm
Nitrites	Colorimetry (Tetra®)	0 – 40 ppm
Total Hardness	Semi-quantitative colorimetric (Tespert®).	0 – 425 ppm
Total Alkalinity	Semi-quantitative colorimetric (Tespert®).	0 – 240 ppm
Calcium	Colorimetry (API®)	
Bromine	Semi-quantitative colorimetric (Tespert®).	0 – 20 ppm
Copper	Semi-quantitative colorimetric (Tespert®).	0 – 10 ppm
Total Chlorine	Semi-quantitative colorimetric (Tespert®).	0 – 10 ppm
Free Chlorine	Semi-quantitative colorimetric (Tespert®).	0 – 10 ppm
Sulfates	Semi-quantitative colorimetric (Tespert®).	0 – 250 ppm
Iron	Semi-quantitative colorimetric (Tespert®).	0 – 10 ppm
Potassium Bisulfate	Semi-quantitative colorimetric (Tespert®).	0 -20 ppm
Cyanides	Semi-quantitative colorimetric (Tespert®).	0 – 240 ppm
Lead	Semi-quantitative colorimetric (Tespert®).	0 – 500 ppm
Nickel	Semi-quantitative colorimetric (Tespert®).	0 – 250 ppm
Petroleum Derivatives	Semi-quantitative colorimetric (Macherey-Nagel® 90760).	0 -10 ppm
Mesophilic Aerobic	Culture Media. (Britania® Nutrient Agar)	CFU/mL
Total & Fecal Coliform	Culture Media (Chromocult®)	CFU/mL
Root Germination Index	(Bioassay with <i>Lactuca sativa</i>)	0 – 100 %

**CARDIOVASCULAR RISK AND DIETARY HABITS IN TRANSGENDER ADULTS RECEIVING HORMONE THERAPY****RISCO CARDIOVASCULAR E HÁBITOS ALIMENTARES EM ADULTOS TRANSGÊNEROS EM TERAPIA HORMONAL**CORVALAN, Lucia¹; MESSINA, Diego Nicolás; AVENA ÁLVAREZ, María Virginia^{3*}¹ Universidad de Mendoza, Facultad de Ciencias de la Salud. Argentina. ORCID: 0009-0002-4532-9152² Universidad Juan Agustín Maza, Facultad de Ciencias de la Nutrición. Argentina. ORCID: 0000-0002-4240-2505³ Universidad de Mendoza, Facultad de Ciencias de la Salud. Argentina. ORCID: 0000-0003-0752-7713

*Corresponding author: maria.avena@um.edu.ar

Received 24th June 2026; received in revised form 31st July 2026; accepted 1st August 2026

ABSTRACT

Background: Transgender and gender-diverse individuals experience health inequities that may increase cardiometabolic risk. Gender-affirming hormone therapy has been associated with changes in body composition, lipid metabolism, and cardiovascular risk markers. However, limited evidence is available regarding dietary habits and cardiovascular risk profiles in transgender populations in Latin America. **Objective:** To evaluate cardiovascular risk factors and cardioprotective food consumption among transgender adults receiving gender-affirming hormone therapy. **Methods:** A quantitative, observational, descriptive, and cross-sectional study was conducted in transgender adults undergoing gender-affirming hormone therapy in Mendoza, Argentina. Eighty-seven participants completed surveys regarding sociodemographic characteristics, lifestyle habits, nutritional counseling, and consumption of cardioprotective foods. We assessed anthropometric indicators and biochemical parameters related to cardiovascular risk. Statistical analyses were performed using GraphPad Prism 8. Data were analyzed using Spearman correlation, the chi-square test, and the Mann-Whitney U test. **Results:** A high prevalence of modifiable cardiovascular risk factors was identified, including overweight, sedentary behavior, smoking, and low intake of cardioprotective foods. More than half of the participants had never received nutritional counseling. No statistically significant differences were observed between transgender women and transgender men in the evaluated anthropometric and biochemical variables. Nevertheless, significant correlations were identified between body mass index, waist circumference, waist-to-height ratio, and atherogenic lipid markers. Dietary quality showed limited associations with cardiovascular risk indicators, although higher dietary quality was positively associated with HDL cholesterol levels in transgender men. **Conclusion:** The study highlights the presence of multiple cardiovascular risk factors in transgender individuals receiving gender-affirming hormone therapy and emphasizes the importance of integrating nutritional assessment and cardiometabolic monitoring into comprehensive transgender healthcare. These findings support the need for inclusive nutritional interventions and longitudinal studies addressing cardiovascular health in transgender populations.

Keywords: *transgender health; nutrition; gender-affirming hormone therapy; cardiometabolic health.*

RESUMO

Introdução: Pessoas transgênero e com diversidade de gênero enfrentam desigualdades em saúde que podem aumentar o risco cardiometabólico. A terapia hormonal de afirmação de gênero tem sido associada a alterações na composição corporal, no metabolismo lipídico e em marcadores de risco cardiovascular. No entanto, existem evidências limitadas sobre hábitos alimentares e perfis de risco cardiovascular em populações transgênero na América Latina. **Objetivo:** Avaliar fatores de risco cardiovascular e o consumo de alimentos cardioprotetores entre adultos transgênero em terapia hormonal de afirmação de gênero. **Métodos:** Foi realizado um estudo quantitativo, observacional, descritivo e transversal com adultos transgênero em terapia hormonal de afirmação de gênero na província de Mendoza, Argentina. Oitenta e sete participantes responderam a questionários sobre características sociodemográficas, hábitos de vida, aconselhamento nutricional e consumo de alimentos cardioprotetores. Foram avaliados indicadores antropométricos e parâmetros bioquímicos relacionados ao risco cardiovascular. As análises estatísticas foram realizadas no GraphPad Prism 8. Os dados foram analisados por meio da correlação de Spearman, teste do qui-quadrado e teste U de Mann-Whitney. **Resultados:** Foi identificada uma alta prevalência de fatores de risco cardiovascular modificáveis, incluindo excesso de peso, sedentarismo, tabagismo e baixo consumo de alimentos cardioprotetores. Mais da metade dos participantes nunca havia recebido aconselhamento nutricional. Não foram observadas diferenças estatisticamente significativas entre mulheres trans e homens trans nas variáveis antropométricas e bioquímicas avaliadas. Entretanto, foram identificadas correlações significativas entre índice de massa corporal, circunferência da cintura, razão cintura-estatura e marcadores lipídicos aterogênicos. A qualidade da alimentação apresentou associações limitadas com os indicadores de risco cardiovascular, embora uma melhor qualidade da dieta tenha sido positivamente associada aos níveis de colesterol HDL em homens trans. **Conclusão:** O estudo destaca a presença de múltiplos fatores de risco cardiovascular em indivíduos transgênero em terapia hormonal de afirmação de gênero e enfatiza a importância da integração da avaliação nutricional e do monitoramento cardiometabólico ao cuidado integral da população trans. Esses achados reforçam a necessidade de intervenções nutricionais inclusivas e de estudos longitudinais voltados à saúde cardiovascular em populações transgênero.

1. INTRODUCTION

Cardiovascular diseases remain the leading cause of morbidity and mortality worldwide and are strongly associated with modifiable lifestyle-related factors, including dietary habits, obesity, physical inactivity, and smoking. In recent years, growing attention has been directed toward the cardiovascular health of transgender and gender-diverse populations, particularly in relation to the metabolic effects associated with gender-affirming hormone therapy (GAHT) (Streed *et al.*, 2021).

Gender-affirming hormone therapy constitutes a fundamental component of healthcare for many transgender individuals and contributes positively to psychological well-being and quality of life (Coleman *et al.*, 2022). Nevertheless, hormonal treatment may induce changes in lipid metabolism, body composition, insulin sensitivity, and vascular function, potentially influencing long-term cardiovascular risk profiles. Previous studies have reported alterations in total cholesterol, triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and fat distribution patterns among transgender individuals receiving GAHT, although findings remain heterogeneous and influenced by

treatment duration, hormonal regimens, lifestyle factors, and baseline metabolic status (Waters & Linsenmeyer, 2024; Rahman *et al.*, 2024).

Recent evidence suggests that transgender populations may experience disproportionate exposure to cardiovascular risk factors due not only to biological and hormonal influences but also to social determinants of health, including barriers to healthcare access, discrimination, food insecurity, and reduced access to preventive nutritional counseling or mental health services (del Río Martín *et al.*, 2024; Sánchez-Reyes *et al.*, 2024; Mattacotta *et al.*, 2026). The American Heart Association has emphasized the importance of comprehensive cardiovascular assessment in transgender individuals, including evaluation of dietary patterns, anthropometric indicators, smoking habits, and physical activity levels (Streed *et al.*, 2021).

Dietary quality plays a critical role in cardiovascular prevention. Increased consumption of fruits, vegetables, legumes, whole grains, fiber-rich foods, and unsaturated fats has consistently been associated with lower cardiovascular morbidity and mortality. Conversely, excessive intake of saturated fats, ultra-processed foods, sodium, and refined carbohydrates contributes to dyslipidemia, obesity, insulin resistance, and systemic inflammation (Diab *et al.*, 2023). Despite the

recognized role of nutrition in cardiometabolic health, evidence regarding dietary habits and cardioprotective food consumption in transgender populations remains scarce, particularly in Latin American settings.

Current evidence regarding cardiovascular risk in transgender populations remains inconclusive. While some studies have reported an increased incidence of thromboembolic events, stroke, and cardiovascular mortality, particularly among transgender women, others have demonstrated variable effects depending on the type, duration, and route of hormone administration (Rahman *et al.*, 2024; Van Zijverden *et al.*, 2024). This heterogeneity underscores the importance of evaluating cardiovascular risk factors within specific populations and healthcare settings.

In Argentina, despite advances in gender identity legislation and improved access to gender-affirming healthcare, transgender individuals continue to encounter barriers to healthcare access and disparities in health outcomes (Cordero & Saletti-Cuesta, 2025). Moreover, local evidence regarding nutritional status, dietary habits, and cardiovascular risk in this population remains limited. Therefore, understanding the relationship between cardiometabolic risk factors and cardioprotective food consumption among transgender adults receiving GAHT may contribute to the development of preventive strategies and more inclusive healthcare interventions.

The present study aimed to assess cardiovascular risk factors and cardioprotective food consumption among transgender individuals receiving GAHT in Mendoza, Argentina. By providing local evidence, this study seeks to contribute to the development of tailored nutritional interventions and cardiovascular prevention strategies for this population.

2. MATERIALS AND METHODS

2.1. Materials

Anthropometric measurements were performed using a portable stadiometer (MEDNIB®, measurement range: 1–210 cm; accuracy: 0.5 cm) for height and a bioelectrical impedance scale (OMRON BF-511, capacity: 150 kg; accuracy: 100 g) for body weight. Waist and hip circumferences were measured using a flexible anthropometric tape measure (Calibres Argentinos®, Rosario, Argentina; scale: 10 mm; measurement error: 1 mm) (Capone *et al.*, 2025; Mussi

et al., 2026).

2.2. Study design

A quantitative, observational, descriptive, and cross-sectional study was conducted in transgender adults receiving GAHT at Hospital Central in Mendoza, Argentina.

2.3. Participants and Sampling

Participants were recruited through convenience sampling. Inclusion criteria consisted of transgender adults aged 18 years or older who were undergoing GAHT (> 3 months) and voluntarily agreed to participate in the study. Individuals who did not complete the survey or lacked essential anthropometric or biochemical data were excluded. The final sample consisted of 87 participants, including transgender women (TW, *n* = 34) and transgender men (TM, *n* = 53).

2.4. Data Collection

Data collection was performed through structured questionnaires and clinical assessments. Sociodemographic variables included age, gender identity, smoking habits, physical activity, family history of cardiovascular and metabolic diseases, and history of nutritional counseling. We assessed dietary habits through questions about consumption of cardioprotective and non-cardioprotective foods and dietary practices, including the type of fat used, added sugar, beverage choices, dairy products, and habitual intake of major food groups (Table 2). To summarize these heterogeneous dietary data into a single indicator, we developed a study-specific dietary quality score inspired by the conceptual framework of the PREDIMED dietary score (Downer *et al.*, 2016), but not corresponding to the validated PREDIMED questionnaire. We assigned each dietary component a positive, neutral, or negative weight based on current evidence and dietary recommendations for cardiovascular health. Beneficial dietary practices and food groups received positive scores, neutral practices received 0 points, and less favorable foods or practices received negative scores. Dichotomous variables (e.g., olive oil use) were scored according to the predefined

weights shown in Table 2, whereas food groups assessed by intake frequency were assigned scores by multiplying the corresponding weight by the reported number of daily or weekly servings, categorized as 0, 1, 2, 3, 4, or ≥ 5 servings (with values ≥ 5 capped at 5). The overall dietary quality score was calculated as the sum of all component scores, with theoretical values ranging from -12 to +19. Higher scores reflected greater adherence to a cardioprotective dietary pattern, whereas lower scores indicated poorer dietary quality. We developed this score specifically for this study as an exploratory measure of overall dietary quality, and it has not been previously validated.

Anthropometric variables included height, weight, body mass index (BMI), waist and hip circumferences, waist-to-height and waist-to-hip ratios. A single evaluator trained in anthropometry obtained all measurements, following the standardized protocols established by the International Society for the Advancement of Kinanthropometry (ISAK), as previously described (Capone *et al.*, 2025; Mussi *et al.*, 2026).

Biochemical parameters related to cardiovascular risk included total cholesterol, HDL-C, and TG. Participants were asked to provide the results of their most recent clinical laboratory tests, performed within the previous three months. Additionally, we calculated lipid-derived cardiovascular risk indicators, including the triglyceride-to-HDL cholesterol ratio (TG/HDL-C), Non-high-density lipoprotein cholesterol (Non-HDL-C; total cholesterol minus HDL-C), and the Castelli I Atherogenic Index (total cholesterol divided by HDL-C). These indicators were used as complementary markers of cardiometabolic and atherogenic risk. A TG/HDL-C ratio ≥ 3.5 was considered indicative of increased insulin resistance and cardiovascular risk, as previously reported in the literature (Baez-Duarte 2022). Likewise, a Castelli I Atherogenic Index > 4 was considered suggestive of elevated cardiovascular risk and has been associated with the presence of coronary atherosclerotic plaques (Raaj *et al.*, 2024). Non-HDL-C was included as an additional marker of atherogenic

lipoprotein burden and cardiovascular risk (Katsi *et al.*, 2025).

2.5. Statistical Analysis

Descriptive analyses were performed for all variables included in the study. Statistical analyses were conducted using GraphPad Prism 8 software. Quantitative variables were expressed as mean $\pm$ standard deviation (SD) or median $\pm$ interquartile range (IQR), while qualitative variables were described using absolute and relative frequencies. The normality of quantitative variables was evaluated using the Shapiro–Wilk test. Since several variables did not present normal distribution, non-parametric tests were applied for inferential analyses. Analyses were stratified by gender identity, treating TW and TM as independent groups. Comparisons between groups were performed using the Mann–Whitney U test for continuous variables. Correlation analyses between anthropometric or dietary and biochemical variables were performed using Spearman's correlation coefficient. Associations between qualitative variables were evaluated with the Chi-square test or Fisher's exact test. Statistical significance was established at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Results

Sociodemographic Characteristics and Lifestyle Habits

Most participants were young adults, with the highest proportion aged 18 to 34 years (median: 30 years). Table 1 details sociodemographic variables, including health history. Regarding hormone therapy, most participants reported receiving treatment for more than two years, indicating prolonged exposure to hormonal interventions. Family history of cardiovascular disease was reported by 47.1% ($n = 41$) of participants, whereas 49.4% ($n = 43$) reported no family history and 3.4% ($n = 3$) were unaware of their family medical history. Metabolic diseases were also frequently reported among first-degree relatives. Diabetes mellitus was the most prevalent condition (50.6%, $n = 44$), followed by hypertension (37.9%, $n = 33$), dyslipidemia (20.7%, $n = 18$), and overweight or obesity (17.2%, $n = 15$). Physical activity patterns varied among participants. Although more than half of the sample reported engaging in regular exercise, sedentary behavior remained common. Participants reported different types of physical

activity, including walking, gym-based exercise, recreational sports, and structured training programs. Smoking was identified as a frequent lifestyle risk factor. The prevalence and intensity of tobacco consumption varied between TW and TM, with daily cigarette use reported in both groups.

Nutritional Counseling and Dietary Habits

When asked whether they had ever attended a consultation with a nutrition professional during the transition process, 51.7% (n = 45) reported never having received nutritional counseling, whereas 48.3% (n = 42) had attended at least one consultation. Among those who had received nutritional care, weight management was the most frequently reported reason for consultation.

Analysis of dietary habits revealed heterogeneous patterns of cardioprotective food consumption, as described in **Table 2**. Most participants reported regular consumption of vegetable oils as their primary source of dietary fat, although they also used other fat sources, including animal fats. Milk consumption was reported by 69.0% (n = 60) of participants. Whole milk represented the most frequently consumed option, while low-fat milk and plant-based alternatives were reported less frequently. Other dairy products, including yogurt, cheese, and ricotta cheese, were consumed by 82.8% (n = 72) of participants. Among dairy consumers, most reported choosing full-fat products, while nearly 20% reported consuming reduced-fat or plant-based alternatives.

Fruit consumption was generally below current dietary recommendations. A substantial proportion of participants reported consuming fewer than the recommended daily servings. Similar findings were observed for vegetable intake, with most participants failing to achieve recommended consumption levels. Regarding protein-rich foods, egg consumption was common throughout the sample. Participants frequently consumed red meat and pork weekly, while poultry was consumed more regularly. Fish consumption was notably low, with many participants reporting infrequent intake or complete absence of fish in their habitual diet. The intake of foods traditionally associated with cardioprotective dietary patterns was also limited. Participants reported low consumption of nuts, seeds, legumes, and soy-based products. In particular, participants rarely consumed legumes and nuts regularly. Overall

dietary quality did not differ significantly between TW and TM.

Hydration habits were also evaluated. Water was the most frequently consumed beverage; however, a considerable proportion of participants also reported consuming sugar-sweetened beverages and other caloric drinks.

Anthropometric and Biochemical Indicators

These variables were analyzed in the whole sample as well as its two groups: TW and TM (**Table 3**), since hormonal factors can promote differences between sexes regarding anthropometry (Fragala *et al.*, 2012, Rezende *et al.*, 2015, Stein *et al.*, 2024) and serum lipids (Gupta *et al.*, 2016, Holven & Roeters van Lennep, 2023). Anthropometric assessment demonstrated the presence of overweight and obesity in both groups. Although no statistically significant differences were observed between TW and TM in mean BMI, TM showed a higher prevalence of overweight and obesity.

Central adiposity indicators were also evaluated through waist circumference and waist-to-height ratio measurements. Strong positive correlations were identified between BMI and waist circumference, as well as between BMI and waist-to-height ratio, indicating a close relationship between general and abdominal adiposity.

No statistically significant differences were observed between TW and TM for the primary lipid parameters evaluated. Correlation analyses revealed several significant associations between anthropometric and biochemical variables. In TW, BMI showed a negative correlation with HDL-C concentrations and positive correlations with atherogenic markers, including TG/HDL-C ratio, Non-HDL-C, and atherogenic index values. In TM, the relationship between anthropometric indicators and lipid parameters was less pronounced. However, we observed a positive correlation between dietary quality score and HDL-C concentrations. Comparisons of atherogenic index values between groups showed no statistically significant differences. Likewise, dietary quality scores did not differ significantly by gender identity. Finally, analyses of adherence to fruit and vegetable recommendations showed no significant differences in atherogenic index values by compliance status.

Although BMI categories were similarly distributed between groups, indicators of central

adiposity differed significantly, with TW showing higher waist circumference categories and TM showing a higher prevalence of elevated waist-to-height ratio categories (**Figure 1**).

Regarding biochemical risk classification, TW showed a higher prevalence of low HDL-C values, whereas TM more frequently exhibited elevated atherogenic index categories. No significant between-group differences were observed for the remaining lipid markers (**Figure 2**).

Associations Between Nutritional Status, Diet Quality and Cardiometabolic Risk

The relationship between nutritional status and cardiometabolic risk markers was evaluated through correlation analyses between BMI and lipid parameters (Figure 3). Significant associations were observed in both TW and TM, although the correlations were generally stronger among TW. In this group, BMI was moderately and negatively correlated with HDL-C concentrations ($r = -0.5147$, $p = 0.0022$), indicating that higher BMI values were associated with lower levels of this cardioprotective lipoprotein. Additionally, moderate positive correlations were identified between BMI and the TG/HDL-C ratio ($r = 0.5864$, $p = 0.0003$), as well as between BMI and the atherogenic index ($r = 0.5868$, $p = 0.0003$). These markers have been widely recognized as indirect indicators of insulin resistance and cardiovascular risk, suggesting that excess body weight may contribute to a more unfavorable cardiometabolic profile among TW receiving GAHT.

Diet quality was further examined in relation to cardiovascular risk indicators (Figure 4). No significant association was observed between diet quality score and HDL-C concentrations among TW. In contrast, a positive correlation was identified among TM ($r = 0.2873$, $p = 0.0410$), indicating that higher diet quality scores were associated with higher HDL-C levels. No additional significant associations were identified between diet quality and the remaining cardiometabolic markers evaluated.

3.2. Discussions

To our knowledge, this is the first study conducted in Argentina to assess cardiovascular risk factors and cardioprotective dietary habits among transgender individuals receiving GAHT. Overall, the findings suggest that cardiovascular risk in this population is associated with nutritional status, central adiposity, lifestyle-related factors and hormone therapy. These associations highlight the multifactorial nature of cardiometabolic health among transgender individuals receiving GAHT. Although mean BMI did not differ significantly between TW and TM, BMI category distribution showed a higher prevalence of overweight and obesity among TM, whereas normal weight predominated among TW. These findings are consistent with previous reports indicating that testosterone therapy may contribute to increases in body weight and BMI (Waters, 2022). However, the prevalence of obesity in the present sample was comparable to, or even lower than, that reported for the Argentine population as a whole, which has been estimated at approximately 30% in recent national surveys (Pou *et al.*, 2021; Pou *et al.*, 2023). Given the well-established association between excess body weight, insulin resistance, and dyslipidemia, these findings support the incorporation of nutritional assessment and counseling into comprehensive transgender healthcare, particularly for individuals with overweight or obesity.

A strong positive association was observed between BMI and indicators of central adiposity, including waist circumference and waist-to-height ratio. Since central adiposity is more closely linked to cardiometabolic risk factor than BMI alone, this finding reinforces the relevance of assessing body fat distribution in addition to overall body weight. Hormone therapy has been shown to influence body composition, particularly in individuals receiving testosterone (Kolla & Kalra, 2025), which may partially contribute to the observed associations.

The relationship between nutritional status and lipid profile was particularly evident among TW. Higher BMI was associated with lower HDL-C levels and higher TG/HDL-C ratio and atherogenic index values, markers commonly associated with insulin resistance and cardiovascular risk. Although these correlations were of moderate magnitude, they are clinically relevant because they suggest that routine assessment of body weight and central adiposity may help identify transgender women who could benefit from early nutritional and lifestyle interventions aimed at

reducing cardiometabolic risk. Overall, these findings support the inclusion of nutritional status and central adiposity as relevant components of cardiovascular risk assessment in transgender populations. While GAHT may influence metabolic outcomes, the observed associations suggest that excess body weight and fat distribution patterns should also be considered when evaluating cardiometabolic risk in this population.

Additionally, lifestyle-related factors such as smoking, which was more prevalent than in the general Argentine population (Franzoy *et al.*, 2023), and physical inactivity may have contributed to the observed lipid alterations. Obesity, smoking, hypertension, dyslipidemia, and diabetes remain well-established cardiovascular risk factors among transgender individuals (Irwig, 2018). Therefore, these findings reinforce the importance of comprehensive cardiovascular risk assessment and multidisciplinary follow-up that includes nutritional counseling, smoking cessation, and promotion of regular physical activity, in addition to hormone therapy. Recent longitudinal and population-based studies have reported heterogeneous cardiometabolic effects of GAHT. While some investigations have described unfavorable changes in lipid profile and increased prevalence of metabolic syndrome, others have found more modest effects after adjusting for baseline cardiovascular risk factors (Hashemi *et al.*, 2024; Glintborg *et al.*, 2024). In this context, the present findings suggest that nutritional status and body fat distribution are important factors associated with cardiometabolic risk.

No significant differences in overall diet quality were observed between TW and TM, suggesting that dietary patterns may be influenced more strongly by socioeconomic and environmental factors than by gender identity. Similarly, adherence to fruit and vegetable intake recommendations was not associated with differences in atherogenic index. While higher consumption of these foods has been associated with lower cardiovascular risk in the general population (Wang *et al.*, 2023), their isolated effect may be insufficient to explain variations in lipid profile within this population. Interestingly, higher diet quality was associated with higher HDL-C concentrations among TM, in agreement with previous studies linking healthy dietary patterns to improved lipid profiles (Peñalvo *et al.*, 2015; Avena Álvarez *et al.*, 2019; Schwingshackl *et al.*, 2021; Lopes *et al.*, 2023; Flatscher *et al.*, 2023). Although this association was modest in magnitude, it may still be clinically relevant because even small improvements in HDL-C have

been associated with better cardiometabolic health. These findings support the promotion of healthy dietary patterns as part of comprehensive cardiovascular care in transgender men.

Overall, these findings suggest that cardiometabolic health among transgender individuals receiving GAHT is associated with a complex interplay between nutritional status, body fat distribution, lifestyle behaviors and hormone therapy. Although the observed associations do not imply causality, they highlight the importance of integrating nutritional assessment and counseling into gender-affirming healthcare as part of a comprehensive strategy to support cardiovascular health and identify individuals who may benefit from early preventive interventions.

Several observed correlations were of moderate magnitude, but they are consistent with the multifactorial nature of cardiovascular risk, where individual lifestyle-related factors are not expected to explain a large proportion of overall variability. Therefore, even modest associations may be biologically meaningful, particularly when they involve modifiable behaviors such as dietary quality, and could contribute to cardiovascular risk reduction when considered with other lifestyle and clinical factors. Consequently, interpret these findings in terms of potential clinical relevance rather than solely on the basis of statistical significance.

4. CONCLUSIONS

This study identified a high prevalence of modifiable cardiovascular risk factors among transgender adults receiving gender-affirming hormone therapy, including excess body weight, sedentary behavior, smoking, and low consumption of cardioprotective foods. These findings highlight the importance of integrating nutritional assessment, dietary counseling, and cardiometabolic monitoring into comprehensive transgender healthcare. Further longitudinal studies are needed to clarify the long-term relationship between nutrition, hormone therapy, and cardiovascular risk in this population.

5. DECLARATIONS

5.1. Study Limitations

This study has some limitations that should be considered when interpreting the findings. First, its cross-sectional design does not allow causal relationships to be established between the variables analyzed. In addition, the use of a non-probabilistic convenience sample recruited from a single healthcare center may have introduced selection bias and limits the generalizability of the results to the broader transgender population. The relatively small sample size may have reduced the statistical power to detect differences between transgender women and transgender men.

Although all participants had been receiving GAHT for at least three months, detailed information on hormone formulation, route of administration, dosage, treatment adherence, antiandrogen use, previous hormonal regimens, and cumulative treatment exposure was not systematically collected. Consequently, the specific contribution of different GAHT regimens to the observed cardiometabolic profiles could not be assessed.

Dietary information was obtained through self-reported food frequency questionnaires, making the results susceptible to recall bias. Biochemical parameters were obtained from participants' recent laboratory reports rather than being analyzed under standardized study conditions. As these tests may have been performed in different laboratories across the province and at different time points, inter-laboratory variability and differences in analytical procedures could have influenced the comparability of the biochemical measurements.

Although the observed effect sizes were modest, they provide evidence of meaningful associations that warrant confirmation in prospective and interventional studies. Finally, the absence of cardiovascular risk assessment tools and nutritional guidelines specifically validated for transgender populations required the use of criteria developed for cisgender individuals, which may not fully capture the particularities of cardiovascular risk in this population.

5.2. Acknowledgments

The authors thank all participants for their collaboration and willingness to contribute to this research.

5.3. Funding source

This research received no funding.

5.4. Competing Interests

The authors declare no conflicts of interest.

5.5. Open Access

This article is licensed under a Creative Commons Attribution 4.0 (CC BY 4.0) International License, which permits use, sharing, adaptation, distribution, and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license unless indicated otherwise in a credit line to the material. Suppose material is not included in the article's Creative Commons license, and your intended use is not permitted by statutory regulation or exceeds the permitted use. In that case, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

6. HUMAN AND ANIMAL-RELATED STUDIES

6.1. Ethical Approval

This study was approved by the Research Ethics Committee of Hospital Central, Mendoza, Argentina (Ethical Approval No. 03/2025).

The study was conducted in accordance with the ethical principles established in the Declaration of Helsinki.

6.2. Informed Consent

Written informed consent was obtained from all participants before participation in the study. Participants received detailed information regarding the study objectives and procedures and were informed that participation was voluntary and that all collected information would remain confidential and be analyzed anonymously.

7. REFERENCES:

1. Avena Álvarez, M. V., Messina, D. N., Corte, C., Mussi Stoizik, J. A., Saez, A., Boarelli, P., & Pérez Elizalde, R. (2019). Asociación entre el consumo de yerba mate y el perfil lipídico en mujeres con sobrepeso. *Nutricion hospitalaria*, 36(6), 1300–1306.
<https://doi.org/10.20960/nh.02599>
2. Baez-Duarte, B. G., Zamora-Ginez, I., Rodríguez-Ramírez, S. O., Pesqueda-Cendejas, K., & García-Aragón, K. H. (2022). Índice TG/HDL para identificar a sujetos con síndrome metabólico en población mexicana. *Gaceta Médica de México*, 158(5).
<https://doi.org/10.24875/gmm.22000079>
3. Canaan Rezende, F. A., Queiroz Ribeiro, A., Priore, S. E., & Castro Franceschini, S. do C. (2015). Anthropometric differences related to genders and age in the elderly. *Nutricion hospitalaria*, 32(2), 757–764.
<https://doi.org/10.3305/nh.2015.32.2.8641>
4. Capone, L. A., Muscia, M. V., & Messina, D. N. (2025). Agreement between Body Fat Estimation Methods: From Durnin and Womersley Equation to Bioimpedance. *International Journal of Kinanthropometry*, 5(1), 121–131.
<https://doi.org/10.34256/ijk25112>
5. Coleman, E., Radix, A. E., Bouman, W. P., Brown, G. R., de Vries, A. L. C., Deutsch, M. B., Ettner, R., Fraser, L., Goodman, M., Green, J., Hancock, A. B., Johnson, T. W., Karasic, D. H., Knudson, G. A., Leibowitz, S. F., Meyer-Bahlburg, H. F. L., Monstrey, S. J., Motmans, J., Nahata, L., ... Arcelus, J. (2022). Standards of Care for the Health of Transgender and Gender Diverse People, Version 8. *International Journal of Transgender Health*, 23(sup1), S1–S259.
<https://doi.org/10.1080/26895269.2022.2100644>
6. Cordero, M. L., & Saletti-Cuesta, L. (2025). Barreras y estrategias para la accesibilidad a la salud de las personas trans en Córdoba, Argentina. *Salud Colectiva*, 21, e5200.
<https://doi.org/10.18294/sc.2025.5200>
7. del Río Martín, M., Martín, S. P., & Barrientos Delgado, J. (2024). Efectos de la transición de género en la percepción de salud mental de personas transgénero en Chile. *Revista Médica de Chile*, 152(12), 1219–1229.
<https://doi.org/10.4067/s0034-98872024001201219>
8. Diab, A., Dastmalchi, L. N., Gulati, M., & Michos, E. D. (2023). A Heart-Healthy Diet for Cardiovascular Disease Prevention: Where Are We Now? *Vascular Health and Risk Management*, Volume 19, 237–253.
<https://doi.org/10.2147/vhrm.s379874>
9. Downer, M. K., Gea, A., Stampfer, M., Sánchez-Tainta, A., Corella, D., Salas-Salvadó, J., Ros, E., Estruch, R., Fitó, M., Gómez-Gracia, E., Arós, F., Fiol, M., De-la-Corte, F. J. G., Serra-Majem, L., Pinto, X., Basora, J., Sorlí, J. V., Vinyoles, E., Zazpe, I., & Martínez-González, M.-Á. (2016). Predictors of short- and long-term adherence with a Mediterranean-type diet intervention: the PREDIMED randomized trial. *International Journal of Behavioral Nutrition and Physical Activity*, 13(1).
<https://doi.org/10.1186/s12966-016-0394-6>
10. Flatscher, M., Garnier, A., Marques-Vidal, P., & Kraege, V. (2023). Impact of Mediterranean Diet on Lipid Composition in the ColaUS-PsyColaUS Study. *Nutrients*, 15(21), 4659.
<https://doi.org/10.3390/nu15214659>
11. Fragala, M. S., Clark, M. H., Walsh, S. J., Kleppinger, A., Judge, J. O., Kuchel, G. A., & Kenny, A. M. (2012). Gender Differences in Anthropometric Predictors of Physical Performance in Older Adults. *Gender Medicine*, 9(6), 445–456.
<https://doi.org/10.1016/j.genm.2012.10.004>
12. Franzoy, J., Ginetti, B., Perri, M., Zelaya, N., Salvado, A., & Ernst, G. (2023). Análisis exhaustivo de las encuestas sobre el tabaco en Argentina: evaluación del aumento de la prevalencia del tabaquismo entre las mujeres. *Fronteras En Medicina*, 18(04), 0246–0249.
<https://doi.org/10.31954/rfem/202304/0246-0249>
13. Glintborg, D., Christensen, L. L., & Andersen, M. S. (2024). Transgender healthcare: metabolic outcomes and cardiovascular risk. *Diabetologia*, 67(11), 2393–2403.
<https://doi.org/10.1007/s00125-024-06212-6>
14. Gupta, R., Sharma, M., Goyal, N., Bansal, P., Lodha, S., & Sharma, K. (2016). Gender differences in 7 years trends in cholesterol lipoproteins and lipids in India:

- Insights from a hospital database. *Indian Journal of Endocrinology and Metabolism*, 20(2), 211. <https://doi.org/10.4103/2230-8210.176362>
15. Hashemi, L., Marijic Buljubasic, A., Budoff, M. J., Copeland, L. A., Jackson, N. J., Jasuja, G. K., Gornbein, J., & Reue, K. (2024). Gender-Affirming Hormone Treatment and Metabolic Syndrome Among Transgender Veterans. *JAMA network open*, 7(7), e2419696. <https://doi.org/10.1001/jamanetworkopen.2024.19696>
 16. Holven, K. B., & Roeters van Lennep, J. (2023). Sex differences in lipids: A life course approach. *Atherosclerosis*, 384, 117270. <https://doi.org/10.1016/j.atherosclerosis.2023.117270>
 17. Irwig M. S. (2018). Cardiovascular health in transgender people. *Reviews in endocrine & metabolic disorders*, 19(3), 243–251. <https://doi.org/10.1007/s11154-018-9454-3>
 18. Katsi, V., Argyriou, N., Fragoulis, C., & Tsioufis, K. (2025). The Role of Non-HDL Cholesterol and Apolipoprotein B in Cardiovascular Disease: A Comprehensive Review. *Journal of Cardiovascular Development and Disease*, 12(7), 256. <https://doi.org/10.3390/jcdd12070256>
 19. Kolla, B., & Kalra, P. (2025). Body composition following gender affirming hormone therapy in transgender individuals. *The Indian Journal of Medical Research*, 162, 513–519. https://doi.org/10.25259/ijmr_560_2025
 20. Lopes, S., Fontes, T., Menezes, R., Rodrigues, L., & Ferreira-Pêgo, C. (2023). Mediterranean Diet Adherence and Its Relationship to Metabolic Markers and Body Composition in Portuguese University Students. *Nutrients*, 15(10), 2330. <https://doi.org/10.3390/nu15102330>
 21. Mattacotta, G., Aguilera, P., Yomaha, S., Carmona, N., Gervasoni, A., Bustos, J. P., & Ribeiro, R. (2026). Memoria e Historia Trans en San Rafael: Trans Memory and History in San Rafael. *Investigación Ciencia Y Universidad*, 10(16), 21. <https://doi.org/10.59872/icu.v10i16.644>
 22. Mussi Stoizik, J. A., Pérez Roper, F., Sosa, M. V., Carranza Amoedo, J., Avena, M. V., Mezzatesta, P., & Boarelli, P. V. (2026). Anthropometry and Body Composition in University Students: Implications for the Prevention of Chronic Non-Communicable Diseases. *Investigación Ciencia Y Universidad*, 10(15), 16–21. <https://doi.org/10.59872/icu.v10i15.599>
 23. Peñalvo, J. L., Oliva, B., Sotos-Prieto, M., Uzhova, I., Moreno-Franco, B., León-Latre, M., & Ordovás, J. M. (2015). Greater Adherence to a Mediterranean Dietary Pattern Is Associated With Improved Plasma Lipid Profile: the Aragon Health Workers Study Cohort. *Revista Española de Cardiología (English Edition)*, 68(4), 290–297. <https://doi.org/10.1016/j.rec.2014.09.019>
 24. Pou, S. A., Diaz, M. D. P., Velázquez, G. A., & Aballay, L. R. (2021). Sociodemographic disparities and contextual factors in obesity: updated evidence from a National Survey of Risk Factors for Chronic Diseases. *Public Health Nutrition*, 25(12), 3377–3389. <https://doi.org/10.1017/s1368980021004924>
 25. Pou, Sonia A., Wirtz Baker, Julia M, & Aballay, Laura R. (2023). Epidemia de obesidad: evidencia actual, desafíos y direcciones futuras. *Medicina (Buenos Aires)*, 83(2), 283-289. Recuperado en 14 de junio de 2026, de https://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S0025-76802023000400283&lng=es&tlng=es.
 26. Raaj, I., Thalamati, M., Gowda M N, V., & Rao, A. (2024). The Role of the Atherogenic Index of Plasma and the Castellí Risk Index I and II in Cardiovascular Disease. *Cureus*. <https://doi.org/10.7759/cureus.74644>
 27. Rahman, S. U., Manasrah, N., Kumar, N., Hamza, M., Sharma, A., Patel, N., Patel, B., Naseem, M., Razzaq, S., Gill, S. I., Naveed, H., Harmouch, K. M., Bahar, Y., Aamir, M., Sattar, Y., & Alraies, M. C. (2024). Impact of Gender-Affirming Hormonal Therapy on Cardiovascular Risk Factors in Transgender Health: An Updated Meta-Analysis. *JACC. Advances*, 3(10), 101265. <https://doi.org/10.1016/j.jacadv.2024.101265>
 28. Sánchez-Reyes, L., Anguita-Martínez, R., & Castro-Alija, M. J. (2024). Mental Health and Health Care for Transgender and Gender Nonconforming Adolescents: A Systematic Review. *Papeles Del Psicólogo - Psychologist Papers*, 45(3), 136–145.

- <https://doi.org/10.23923/pap.psicol.3042>
29. Stein, M. J., Fischer, B., Bohmann, P., Ahrens, W., Berger, K., Brenner, H., Günther, K., Harth, V., Heise, J.-K., Karch, A., Klett-Tammen, C. J., Koch-Gallenkamp, L., Krist, L., Lieb, W., Meinke-Franze, C., Michels, K. B., Mikolajczyk, R., Nimptsch, K., Obi, N., ... Sedlmeier, A. M. (2024). Differences in anthropometric measures based on sex, age, and health status: Findings from the German National Cohort (NAKO). *Deutsches Ärzteblatt International*.
<https://doi.org/10.3238/arztebl.m2024.0016>
 30. Streed, C. G., Jr, Beach, L. B., Caceres, B. A., Dowshen, N. L., Moreau, K. L., Mukherjee, M., Poteat, T., Radix, A., Reisner, S. L., & Singh, V. (2021). Assessing and Addressing Cardiovascular Health in People Who Are Transgender and Gender Diverse: A Scientific Statement From the American Heart Association. *Circulation*, 144(6).
<https://doi.org/10.1161/cir.0000000000000000>
 31. Valenzuela-Gallego, A. L., Becerra-Granados, L. M., Castillo-Albarracin, A. N., & Fernández-González, A. (2026). Body Composition by Bioimpedance in Transgender Women, Cali, Colombia. *BioMed research international*, 2026(1), e8869056.
<https://doi.org/10.1155/bmri/8869056>
 32. van Zijverden, L. M., Wiepjes, C. M., van Diemen, J. J. K., Thijs, A., & den Heijer, M. (2024). Cardiovascular disease in transgender people: a systematic review and meta-analysis. *European Journal of Endocrinology*, 190(2), S13–S24.
<https://doi.org/10.1093/ejendo/lvad170>
 33. Waters, J., & Linsenmeyer, W. (2024). The impact of gender-affirming hormone therapy on nutrition-relevant biochemical measures. *Frontiers in Nutrition*, 11.
<https://doi.org/10.3389/fnut.2024.1339311>

Table 1. Sociodemographic variables. Source: the authors

	n	%
Time of treatment		
3 - 12 months	15	17.24%
12 - 24 months	9	10.34%
> 24 months	63	72.41%
Family history		
CVD	41	47.13%
HBP	33	37.93%
DM	44	50.57%
Obesity	15	17.24%
Dyslipidemia	18	20.69%
No history	43	49.43%
Doesn't know	3	3.45%
Diagnosed		
DM	1	1.15%
HBP	1	1.15%
Dyslipidemia	11	12.64%
No diagnosis	74	85.06%
Physical activity	49	56.32%
Smoking	34	39.08%

CVD: cardiovascular disease; HBP: high blood pressure; DM: diabetes mellitus

Table 2. Dietary habits and quality score. Source: the authors

Food groups	n	%	Quality Score	
			Yes	No
Oils and fats				
Olive	16	18.39%	1	0
Seeds	78	89.66%	-1	0
Butter	44	50.57%	-1	0
Margarine	7	8.05%	-1	0
Fats	5	5.75%	-1	0
Coconut	1	1.15%	0.5	0
Carbohydrates				
Adds sugar	65	74.71%	-1	0
Doesn't add sugar	22	25.29%	0.5	0
Hydration				
Only water	47	54.02%	0.5	0
Adds sweet and caloric beverages	40	45.98%	-0.5	0
Dairy products				
Full- fat	70	80.46	-1	0
Reduced fat	10	11.49	0	0
No intake (only vegetal)	7	8.05	0	0
Weekly frequency	Median	IQR	Per portion	
Fruits	1	0 - 2	1	
Nuts	0	0 - 1	1	
Vegetables	1	1 - 2	1	
Seeds	0	0 - 1	0.5	
Legumes	1	1 - 2	1	
Soy	0	0 - 1	1	
Egg	1	0 - 2	0.5	
Red meat	1	1 - 2	-1	
Poultry	2	1 - 2	0.5	
Fish	0	0 - 1	1	

Table 3. Comparison of Anthropometric and Biochemical Variables Between Transgender Women and Transgender Men Receiving Gender-Affirming Hormone Therapy. Source: the authors

Variable	Total	Transgender Women	Transgender Men	p-value
Age (years)	29.78 ± 8.55	31.97 ± 9.65	28.38 ± 7.52	0.1252
Weight (kg)	73.26 ± 18.46	76.22 ± 17.53	71.37 ± 18.95	0.1500
Height (m)	1.651 ± 0.08	1.70 ± 0.08	1.62 ± 0.06	<0.001
BMI (kg/m ²)	26.80 ± 6.26	26.37 ± 5.77	27.08 ± 6.59	0.6418
Waist Circumference (cm)	82.19 ± 13.09	82.54 ± 13.82	81.95 ± 12.71	0.7562
Hip Circumference (cm)	100.60 ± 10.90	101.10 ± 11.64	100.20 ± 10.47	0.7595
Waist-to-Hip Ratio	0.81 ± 0.07	0.81 ± 0.07	0.81 ± 0.06	0.9693
Waist-to-Height Ratio	0.50 ± 0.08	0.50 ± 0.08	0.49 ± 0.08	0.1321
Total Cholesterol (mg/dL)	177.5 ± 34.51	176.40 ± 38.16	178.20 ± 32.27	0.7870
HDL Cholesterol (mg/dL)	52.17 ± 15.21	55.70 ± 18.49	49.88 ± 12.31	0.2287
Triglycerides (mg/dL)	125.50 ± 69.64	123.00 ± 59.05	127.20 ± 76.29	0.9213
TG/HDL-C Ratio	2.66 ± 1.82	2.39 ± 1.34	2.83 ± 2.07	0.4561
Non-HDL Cholesterol (mg/dL)	126.50 ± 37.69	122.30 ± 37.20	129.30 ± 38.11	0.3636
Atherogenic Index	2.63 ± 1.22	2.36 ± 1.06	2.81 ± 1.29	0.0943

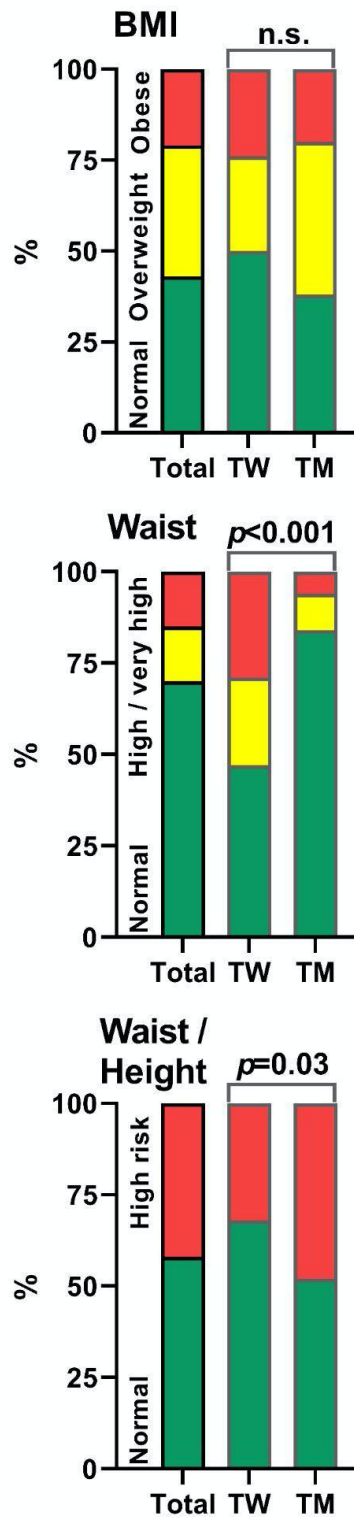


Figure 1. Distribution of BMI, waist circumference, and waist-to-height ratio categories among transgender women (TW) and transgender men (TM). No significant differences were observed in BMI categories between groups. TW showed a higher prevalence of elevated waist circumference categories ($p < 0.001$), whereas TM showed a higher prevalence of high-risk waist-to-height ratio ($p = 0.03$). P values were obtained using the chi-square test.

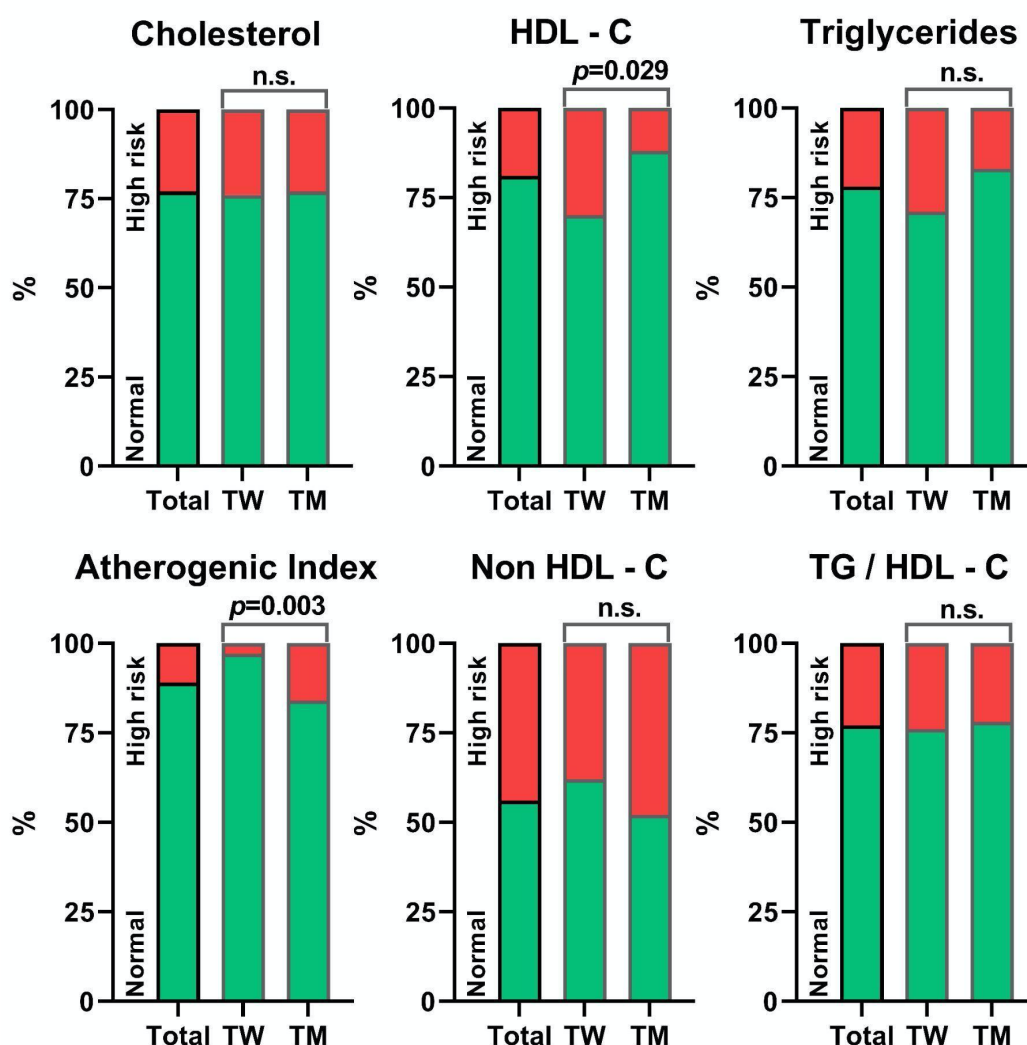


Figure 2. Distribution of normal- and high-risk categories for biochemical cardiovascular risk markers among transgender women (TW) and transgender men (TM). TW showed a higher prevalence of high-risk HDL-C values ($p = 0.029$), whereas TM exhibited a higher prevalence of elevated atherogenic index values ($p = 0.003$). No significant differences were observed between groups for total cholesterol, triglycerides, non-HDL cholesterol, or triglyceride-to-HDL ratio categories. *P* values were obtained using the chi-square test.

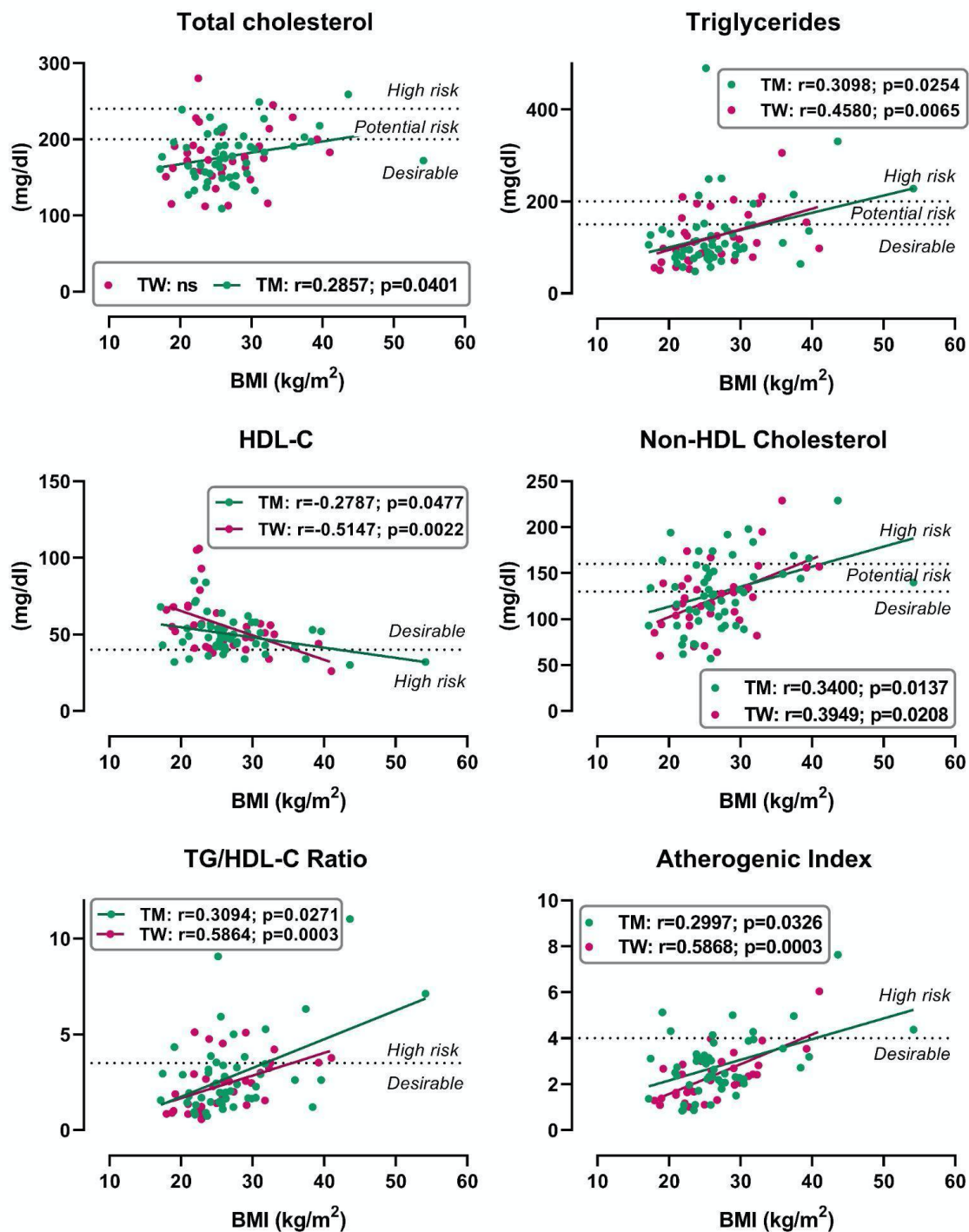


Figure 3. BMI positively correlated with biochemical determinations. Spearman correlation.

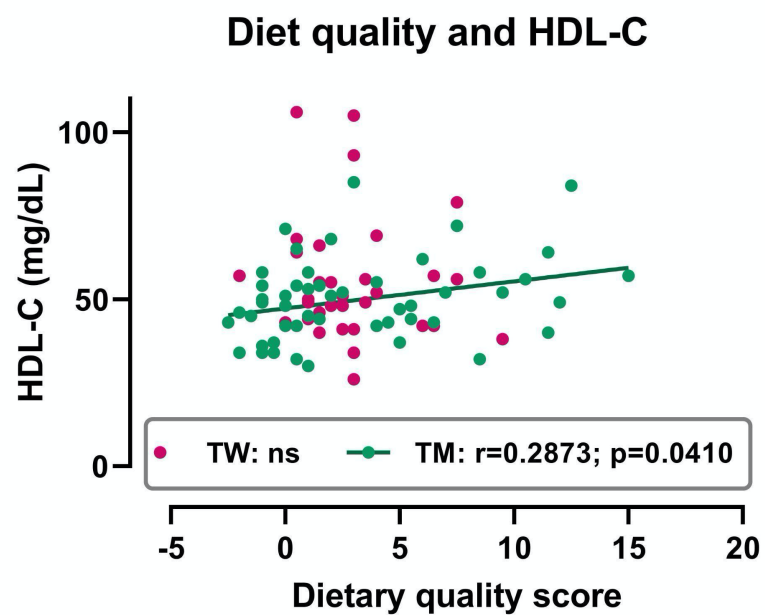


Figure 4. Dietary quality score positively correlated with HDL-C in TM. Spearman correlation.



SEVENTY YEARS OF THE BRAZILIAN FEDERAL COUNCIL OF CHEMISTRY (1956–2026): INSTITUTIONAL TRAJECTORY, PRESIDENCIES, AND PERSPECTIVES FOR THE CHEMISTRY PROFESSION - EN

SETENTA ANOS DO CONSELHO FEDERAL DE QUÍMICA (1956–2026): TRAJETÓRIA INSTITUCIONAL, PRESIDÊNCIAS E PERSPECTIVAS PARA A PROFISSÃO QUÍMICA - EN

Luis Alcides Brandini De Boni *

Periódico Tchê Química. Brazil. ORCID: <https://orcid.org/0009-0000-8102-6197>

Paulo Roberto Barros Gomes

Federal Institute of Technical Education of Pará, Department of Teaching, Extension, Graduate Studies, and Innovation, Paragominas Campus, Brazil. ORCID: <https://orcid.org/0000-0002-4221-6577>

* Corresponding author

e-mail: labdeboni@gmail.com

Received 16 May 2026; received in revised form 28 June 2026; accepted 20 July 2026

RESUMO

Introdução: Em 2026, o Sistema CFQ/CRQs completa 70 anos (Lei nº 2.800/1956), fiscalizando um setor responsável por cerca de 11% do PIB industrial, mas carecia de reconstrução cronológica baseada em seus registros primários oficiais. **Objetivo:** Reconstruir a gênese jurídica do Sistema, estabelecer a cronologia oficial documentada das presidências e discutir os desafios regulatórios atuais. **Métodos:** Pesquisa documental historiográfico-descritiva apoiada em fontes normativas e no acesso inédito ao registro interno "Galeria de Presidentes", fornecido pelo Gabinete da Presidência do CFQ em 2026. **Resultados:** Detalhou-se oito presidências efetivas e interinatos (1957–2026), fundamentando o exercício interino de Oscar Bergstron Lourenço (1963–1964) e a posse de Juvenal Dória em 1964. O Sistema hoje reúne 21 CRQs e mais de 230 mil registrados. Identificou-se subdocumentação da trajetória de Hebe Martelli (única mulher na presidência) e divergência em aberto sobre o número de CRQs criados em 1957. **Discussão:** A Resolução Normativa nº 36/1974 permanece como marco das atribuições. As normativas recentes retomam desafios históricos, como a atribuição a currículos híbridos e a segurança química como bem público, exigindo antecipação frente às transições energética, de materiais e digital. **Limitações:** A cronologia depende de registros institucionais não auditados independentemente em arquivo primário pelos autores. **Conclusões:** O acesso aos registros primários consolidou a memória documental dos setenta anos do Sistema, cujo legado reside na adaptação do arcabouço regulatório às transformações tecnológicas.

Palavras-chave: *Regulamentação profissional; Pesquisa documental; Resoluções Normativas; Governança de conselhos profissionais; Lei 2.800/1956.*

ABSTRACT

Background: In 2026, the CFQ/CRQ System turns 70 (Law No. 2,800/1956), overseeing a sector responsible for ~11% of industrial GDP, but it lacked a chronological reconstruction based on its own official primary records. **Aim:** To reconstruct the System's legal genesis, establish a documented official chronology of its presidencies, and discuss current regulatory challenges. **Methods:** Historiographical-descriptive documentary research based on normative sources and unprecedented access to the internal record "Galeria de Presidentes," provided by the CFQ Presidency Office in 2026. **Results:** Eight substantive presidencies and interim periods (1957–2026) were detailed, substantiating the interim exercise by Oscar Bergstron Lourenço (1963–1964) and Juvenal Dória's inauguration in 1964. The System now comprises 21 regional councils and over 230,000 registrants. The study identified under-documentation of Hebe Martelli's trajectory (the only female president) and an open divergence regarding the number of regional councils created in 1957. **Discussion:** Normative Resolution No. 36/1974 remains the milestone for professional attributions. Recent regulations revisit historical challenges, such as

attributing competencies to hybrid curricula and establishing chemical safety as a public good, requiring anticipation of energy, materials, and digital transitions. **Limitations:** The chronology relies on institutional records that the authors did not independently audit against primary archives. **Conclusions:** Access to primary records consolidated the documentary memory of the System's seventy years, whose legacy lies in adapting the regulatory framework to technological transformations.

Keywords: *Professional regulation; Documentary research; Normative resolutions; Council governance; Law 2,800/1956.*

1. INTRODUCTION

Professions are not born regulated: they become regulated. The Brazilian case of Chemistry exemplifies this distinction. Between the creation of the first higher education courses in industrial chemistry in the 1910s and 1920s and the effective establishment of a dedicated registration and oversight body, about four decades of institutional dispute elapsed (Santos, Pinto, & Alencastro, 2006; Silva, Santos, & Afonso, 2006). The dispute ended on 18 June 1956, when Law No. 2,800 created the Federal Council of Chemistry (CFQ) and the Regional Councils of Chemistry (CRQs) (Brasil, 1956). That date is now celebrated as the National Day of the Chemistry Professional.

In 2026, the CFQ/CRQ System completes seventy years. The anniversary was marked by a special session of the Federal Senate, by a solemn session in the Chamber of Deputies, by the release of a commemorative stamp and postmark by the Brazilian Post Office (Correios), and by the minting of a medal by the Brazilian Mint (Casa da Moeda do Brasil), in addition to institutional actions regulated by the autarchy itself (Correios, 2026; CFQ, 2026b; Senado Federal, 2026).

Until this update, reconstructing the chronology of CFQ presidencies depended entirely on searches across several secondary sources (RQI, 2020, 2023), which hindered historical research by requiring consultation of multiple scattered records. The CFQ Presidency Office, in response to a formal request by the authors, provided the official list of presidents and an internal record of the minutes of Ordinary Meetings ("Galeria de Presidentes"), making it possible to complete the timeline of the Council of Chemistry (CFQ, Gabinete da Presidência, 2026).

1.1. Objectives

This communication aims to reconstruct, from verifiable primary sources:

- (i) the legal genesis of the System;
- (ii) a documented chronology of the CFQ presidencies, based on the signatures affixed to the Normative Resolutions and on the records of Ordinary Meetings provided by the CFQ itself;
- (iii) the evolution of the framework that defines professional attributions; and
- (iv) a frank discussion of the challenges the System faces in its eighth decade. Where evidence is still lacking, this is stated. Where sources diverge, the divergence is recorded.

2. SOURCES AND METHOD

2.1. Documentary sources

This is documentary research of a historiographical-descriptive nature, supported by four classes of sources:

- Normative primary sources: Law No. 2,800/1956; Decree-Law No. 5,452/1943 (CLT, the Brazilian Consolidation of Labor Laws); Decree No. 24,693/1934; Decrees No. 85,877/1981 and 86,593/1981; and the Normative Resolutions of the CFQ, with particular attention to the signatures of president and secretary affixed to them, which function as dated testimony of the officeholder.
- Biographical primary sources: the "Pioneiros da Química" (Pioneers of Chemistry) series of the Revista de Química Industrial (RQI), published by the Brazilian Chemistry Association, and the obituaries and institutional profiles published by the CFQ itself.
- Contemporary sources: releases from Agência Senado, Correios, and the CFQ concerning the seventieth anniversary (2026), in addition to sector data on the chemical industry.
- Official institutional source (new in this update): the official list of presidents and the internal record "Galeria de

Presidentes”, provided by the CFQ Presidency Office to the authors on 25 June 2026, in response to the request filed on 22 June 2026. The record compiles the dates of Ordinary Meetings (O.M.) of the CFQ Plenary, identifying who held the Presidency at each session—incumbent, vice-president, or acting secretary—since 08 July 1957 (CFQ, Gabinete da Presidência, 2026).

2.2. Evidence criteria and limitations

The evidence criterion adopted was conservative: the date of an Ordinary Meeting (O.M.) or a dated signature on a normative act was preferred over any secondary mention. Where the internal record of the “Galeria de Presidentes” showed probable internal inconsistencies — for example, numerical jumps between sessions incompatible with the reported date interval, or a date whose year visibly diverges from the chronological sequence of neighboring sessions — this is flagged in a footnote to Table 1, for transparency of the reconstruction.

One limitation remains: the documentation obtained does not resolve the divergence between RQI (2023), according to which the second Normative Resolution of the CFQ, of 1957, created five Regional Councils, and the institutional history of CRQ-X (n.d.), according to which that same Resolution divided the national territory into seven regions. The point remains an open research question.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1. Background: from activity without a profession to a profession without a council

Decree No. 24,693, of 12 July 1934, regulated by Decree No. 57/1935, constitutes the first regulation of the chemist's profession in Brazil. It recognized activities but did not effectively regulate professional practice: the status of chemist was tied to the exercise of the activity and not to the training of whoever performed it (RQI, 2023). The first legal instrument to delimit the exclusive activities of the class more clearly was the Consolidation of Labor Laws (Decree-Law No. 5,452, of 1 May 1943), whose Section XIII of Chapter I of Title III addressed the practice of the chemist's profession.

The problem, however, was structural: the CLT assigned oversight to officials of the Ministry of Labor, and not to chemistry professionals. In the

absence of a dedicated technical council, the activity ended up being performed by professionals from other backgrounds and even by unqualified practitioners without a degree (RQI, 2023). It was from this insufficiency — and not from an abstract corporatist impulse — that the campaign for the creation of a dedicated body was born, led from 1945 onward by entities such as the Chemists' Union of Rio de Janeiro and the Brazilian Chemical Society, with decisive participation from Geraldo Mendes de Oliveira Castro (RQI, 2023).

3.1.2. Law No. 2,800/1956 and the architecture of the System

Sanctioned by Juscelino Kubitschek on 18 June 1956, Law No. 2,800 transferred to the Councils the powers of registration, oversight, and imposition of penalties until then established in the CLT (Brasil, 1956, art. 1). It granted the CFQ and the CRQs legal personality under public law, together with administrative and patrimonial autonomy (art. 2), established the seat of the federal council in the Federal District (art. 3), and defined its composition (art. 4). Three elements deserve analytical emphasis:

- Binding technical composition. Article 5 required that, among the nine substantive federal counselors, at least one third be chemical engineers and one third industrial chemists, agricultural industrial chemists, or chemists, in addition to one chemistry technician.
- Honorary three-year term. Article 7 established that the term of the president and the counselors would be honorary and three years, with annual renewal of one third of the board—a provision whose reading, in light of the longevity observed in some administrations, deserves the attention discussed in Section 3.2.1.
- Choice of the president. Originally, the President of the Republic appointed the president from a three-name list drawn up by the Council itself (art. 4, item “a”). Decree No. 86,593/1981 transferred that choice to the Minister of Labor. Currently, the Council's Plenary makes the choice.

Decree No. 85,877, of 7 April 1981, established rules for the execution of Law No. 2,800/1956, specifying the activities comprised in the practice of the profession, those exclusive to it, and those shared with other professions. This

decree, not the 1956 law, underpins most concrete oversight action.

The effective installation took place in 1957, in Rio de Janeiro, in a room made available by the National Institute of Technology. Professional chemist's card No. 1 in Brazil was issued to Geraldo Mendes de Oliveira Castro (RQI, 2023). A divergence between sources is recorded here, unresolved by the official documentation obtained in this update: according to RQI (2023), the second Normative Resolution of the CFQ, of 1957, created five Regional Councils; according to the institutional history of CRQ-X (n.d.), Normative Resolution No. 2 divided the national territory into seven regions. The two statements may be reconcilable—five councils installed within a design of seven regions—but the documentation consulted does not allow a decision.

Table 1 summarizes the chronological reconstruction, now grounded in the official list and in the internal record “Galeria de Presidentes” provided by the CFQ Presidency Office (2026), which document, session by session, the exercise of the Presidency since 1957.

3.1.3. Profiles of the presidents

3.1.3.1. Geraldo Mendes de Oliveira Castro: the founder



Photo: *Geraldo Mendes de Oliveira Castro* (1957 – 1963).

Adapted from: <https://www.abq.org.br/rqi/2014/775/RQI-775->

[pagina22-Pioneiros-da-Quimica.pdf](#). Image restored with AI.

An industrial chemist who graduated in 1935 from the National School of Chemistry and a rubber specialist, Geraldo Mendes de Oliveira Castro was a leading figure in the campaign to regulate the profession. President of the Federal Council of Chemistry (CFQ) for two consecutive terms (1957–1963), he made the valorization of the Chemistry professional as an agent of scientific and technological development the hallmark of his administration. Among the Council's first normative acts, two stand out: the first Normative Resolution, of 1957, which established the CFQ Internal Regulations, and the second Normative Resolution, which created the first Regional Councils of Chemistry (RQI, 2023). The official record of Ordinary Meetings shows a transitory vacancy in the office in 1960, covered by Secretary Ralpho Rezende Decourt and, subsequently, by Vice-President Paschoal Senide, until Geraldo Mendes returned to the Presidency, as documented through July 1963 (CFQ, Gabinete da Presidência, 2026).

3.1.3.2. Oscar Bergstron Lourenço*: the 1963–1964 transition.

The official record of Ordinary Meetings partly clarifies the period between 1963 and 1967: between August 1963 and April 1964, Vice-President Oscar Bergstron Lourenço held the CFQ Presidency on an interim basis (49th to 54th O.M.), in the transition between the administration of Geraldo Mendes de Oliveira Castro and that of Juvenal Osório de Araújo Dória. Available sources contain no published biography of Oscar Bergstron Lourenço; his record is currently limited to the session minutes provided by the Presidency Office. Oscar was a chemical engineer, Livre-Docente (habilitated lecturer) in Organic Chemistry, and Professor of physics and chemistry at the Polytechnic School of USP; Head of the Department of Chemical Engineering of the Polytechnic School of USP, 1966–1969.

* No image located.

3.1.3.3. Juvenal Osório de Araújo Dória: consolidation



Photo: Juvenal Osório Araújo Dória (1963 – 1970). Courtesy of CFQ – 2026.

The initial phase of structuring the System was followed by a period of institutional consolidation under the presidency of Juvenal Osório de Araújo Dória. The second substantive president of the CFQ, Dória was already chairing Plenary sessions from the 55th Ordinary Meeting onward, around 1964 — revising the date of 1967 previously attributed to his appointment by a secondary source (RQI, 2020), which probably recorded a formal act subsequent to the actual start of his exercise of the office. Dória had previously held the presidency of the Regional Council of Chemistry of the 3rd Region, created in 1957. His administration is remembered above all for the understanding reached with the Federal Council of Pharmacy to define the boundaries of practice between pharmacists and chemists, a subject that, from different perspectives, remains current (RQI, 2020). It was also during his presidency that Normative Resolution No. 23/1969 was issued, still today considered a reference for characterizing chemical departments in industries and commercial companies subject to technical responsibility. Occasional impediments of Dória in 1966 and 1967 were covered by Secretary/Vice-President Jorge da Cunha, acting in the Presidency.



Photo: Peter Löwenberg (1970 – 1976). Courtesy of CFQ – 2026.

The process of consolidating professional attributions reached a decisive milestone with the publication of Normative Resolution No. 36, of 25 April 1974, signed by Peter Löwenberg, who held the Presidency in two periods (c. 1970–1972 and 1973–1976), with Vice-President Paulo Ribeiro acting on an interim basis in the transition between them. Probably the most influential normative act in the history of the CFQ/CRQ System, this resolution replaced NR No. 26, revoked NRs No. 5, 6, 7, 20, and 26, and reorganized professional practice around a set of sixteen activities, correlated with three curricular natures: “Chemistry” (activities 1 to 7), “Technological Chemistry” (activities 1 to 13), and “Chemical Engineering” (activities 1 to 16), in addition to the competencies attributed to the Chemistry Technician (CFQ, 1974). It was also in this resolution, specifically in activity No. 3, that inspection, expert examination (perícia), appraisal, arbitration, and the preparation of opinions, expert reports, and certificates came to be listed as attributions of the Chemistry professional, establishing the normative basis of the judicial and extrajudicial chemical expert practice exercised in Brazil to this day.

3.1.3.5. *Werner Gustav Krauledat and the opening to new modalities*



Photo: Werner Gustav Krauledat (1977 – 1978). Courtesy of CFQ – 2026.

The normative evolution of the System continued as the CFQ broadened the professional categories it recognized. In this context, Normative Resolution No. 46, of 27 January 1978, signed during the administration of Werner Gustav Krauledat — begun in July 1977, after a period of interim exercise by Vice-President Clóvis Martins Ferreira — exemplifies a movement that would repeat itself in the following decades: the recognition of new academic backgrounds arising from the process of industrial diversification. In determining the registration of Food Chemists, Food Technologists, and Food Engineers, the CFQ applied art. 9 of NR No. 36, which authorizes the attribution of competencies to graduates of courses with a similar curricular organization, to a profession then considered to be in “full development” (CFQ, 1978).

3.1.3.6. *Olavo Romanus*



Photo: Olavo Romanus (1978 – 1979).
Courtesy of CFQ – 2026.

Prof. Olavo Romanus (1927–2011) was born in Curitiba and was a chemist whose training was marked by excellence and innovation. A graduate in Industrial Chemistry and Chemical Engineering from the University of Paraná, he complemented his education with postgraduate studies at the Oils Institute of the Ministry of Agriculture, in Rio de Janeiro, and studies in the USA, where he deepened his knowledge of Organic Chemistry and Radioisotopes. He returned to Brazil with a commitment to teaching; he served as an instructor, full professor, and director of the School of Chemistry at the Federal University of Paraná, where he modernized laboratories and transferred the school to the Polytechnic Center. His pioneering work in chromatography, including organizing specialized courses, strengthened the institution's analytical foundations. (CRQ-IX, 2011)

In addition to his academic work, Romanus was a researcher at the Biology Institute of Paraná, a collaborator in the creation of Marine Biology laboratories at UFPR, a member of the Boards of Trustees and of Specialists in Chemistry Teaching, and a federal counselor. He chaired the organization of the 1st Brazilian Symposium on Chromatography (1964) and tirelessly advocated for the defense of the chemistry profession. His

concern with the environment led him to organize studies on atmospheric pollutants.

3.1.3.7. Hebe Helena Labarthe Martelli: the first woman



Photo: Hebe Helena Labarthe Martelli (1979 – 1985). Courtesy of CFQ – 2026.

The institutional expansion promoted by the System coincided, next, with a historic milestone in the composition of its leadership. Admitted in first place to the Industrial Chemistry program of the School of Chemistry of UFRJ — becoming the first woman to achieve that rank — and top student of the class that graduated in 1942, Hebe Helena Labarthe Martelli assumed the presidency of the CFQ on 10 January 1979, after a period of interim exercise by Vice-President Olavo Romanus. As of 2026, she remains the only woman to have held the office. Her first Normative Resolution, NR No. 49, issued on 21 September 1979, aimed to standardize accountability reporting processes to the Federal Court of Accounts. During her administration, NR No. 66 was also issued, exempting professionals in situations of vulnerability from paying the annual fee, along with the expansion of the Regional Councils to Sergipe, Paraná, and Ceará/Piauí, in addition to the signing, in 1982, of the agreement with Novacap for the construction of the CFQ headquarters in Brasília (CFQ, 2026a).

From a historiographical standpoint, however, an asymmetry remains worth noting. Documentation on Hebe Martelli is substantially

scarcer than that on her male peers, and the CFQ published her institutional biography only in July 2026, thirteen years after her death in 2013. This under-documentation of women's trajectories in Brazilian Chemistry constitutes, in itself, an important object of investigation still pending.

3.1.3.8. Jesus Miguel Tajra Adad: thirty-three years



Photo: Jesus Miguel Tajra Adad (1985 – 2018). Courtesy of CFQ – 2026.

Subsequently, Jesus Miguel Tajra Adad, a chemical engineer and industrial chemist trained at UFRJ, took the presidency of the CFQ, with a master's degree in Sanitary Engineering and specializations in Occupational Safety Engineering and Radioisotopes Applied to Biochemistry. Leading the Council between 6 March 1985 and 2018 — taking office one day after the record of interim exercise by Vice-President Roberto Hissa — he presided over the longest administration in the history of the CFQ/CRQ System. During this period, the institutional structure that exists today was consolidated, the number of Regional Councils reached the current 21, and the CFQ headquarters was transferred from Rio de Janeiro to Brasília. In February 2020, he received the unprecedented title of Counselor Emeritus and passed away in June of the same year (CFQ, 2020).

The duration of his administration constitutes an objective historical fact, not a value judgment. Nevertheless, that period is inseparable from the governance discussions developed in Section 3.2.1.

3.1.3.9. José de Ribamar Oliveira Filho: the modernization phase

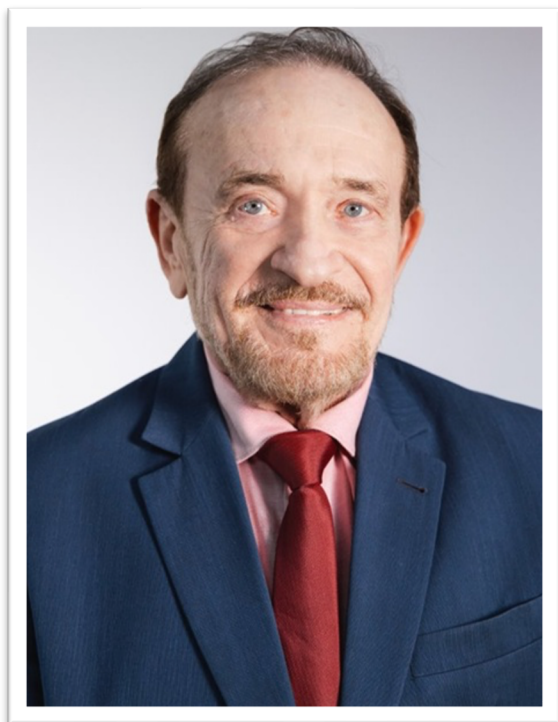


Photo: José de Ribamar Oliveira Filho (2018–present (2026+)).

Courtesy of CFQ – 2026.

Holding a doctorate in Analytical Chemistry from the University of São Paulo (USP) and a professor at the Federal University of Maranhão (UFMA), Professor Dr. José de Ribamar Oliveira Filho was elected president of the Federal Council of Chemistry (CFQ) on 18 April 2018 (O.M. No. 26,777, 607th Meeting) and reappointed, by acclamation, for the 2024–2027 term. At the head of the autarchy, he led a broad process of institutional modernization, marked by the implementation of the 2018–2028 Strategic Plan, the institutionalization of the College of Presidents (Copresi), the creation of the Committee on Institutional and Governmental Relations, and firm action in defense of the CFQ/CRQ System in the face of Constitutional Amendment Proposal No. 108/2019. During the COVID-19 pandemic, he coordinated the Química Solidária initiative, which donated more than 100,000 liters of alcohol and 70% alcohol gel, and created the Chemistry Information Center (CIQ). His administration also strengthened the System's international presence by participating in events such as COP28 (CFQ, 2024).

This commitment to valorizing Chemistry and training ethical, socially responsible professionals

was evident long before his tenure as CFQ president. One of the authors (Gomes), a former student of the Federal University of Maranhão, had the privilege of being his student in the courses Experimental General Chemistry (2004.2) and Environmental Chemistry (2009.2). He taught his classes with high scientific rigor, clarity, and dedication, always accompanied by a genuine concern for the integral education of future chemists. In academic interactions, Professor Ribamar often spoke with students about the importance of the Regional Council of Chemistry for professional practice. These conversations, conducted with enthusiasm and a formative spirit, exerted a lasting influence on the academic and professional trajectory of one of the authors, constituting a testimony to the legacy of a professor who always understood that training chemists meant, above all, training professionals aware of their responsibility to society.

The professional identity of the Brazilian chemist does not lie in Law No. 2,800: it lies in the sedimentation of the Normative Resolutions. Table 2 presents the milestones that, in the authors' understanding, best explain the current design.

3.1.4. The CFQ at seventy: figures and honors

The CFQ/CRQ System comprises 21 Regional Councils, covering the 27 federative units, and more than 230,000 registered chemistry professionals (CFQ, 2026c; Senado Federal, 2026). Its stated mission is to “*promote the full activity of Chemistry, with a view to contributing to the sustainable development of the country*” (CFQ, 2026c). The sector it oversees carries macroeconomic weight: according to Abiquim data released in 2026, the Brazilian chemical industry recorded net revenue of approximately US\$ 158.6 billion in 2024 and accounts for around 11% of industrial GDP (Assembleia Legislativa de Goiás, 2026). This is a statistic from a sector source and should be read with the usual caution applicable to figures released by industry associations.

The seventieth anniversary was marked by a special session in the Federal Senate on 18 June 2026, arising from Request No. 52/2026 (Senator Sérgio Petecão); by a solemn session in the Chamber of Deputies; by the release of a personalized stamp and commemorative postmark by Correios; and by the minting, by the Brazilian Mint, of a medal alluding to the date (Correios, 2026; CFQ, 2026b; Senado Federal, 2026).

3.2. Discussion

3.2.1. Professional education and the attribution problem

NRs No. 342 and 343/2025 have restated, in new language, the question that NR No. 36 had attempted to resolve in 1974: how to attribute legal competencies to graduates of increasingly heterogeneous curricula. The problem has been aggravated by two vectors. The first is the accelerated expansion of distance-learning courses in a field whose formative core is laboratory-based and experimental. The second is the emergence of hybrid programs (computational chemistry, data science applied to chemistry, bioprocess engineering) that do not fit naturally into the three curricular natures designed in 1974.

3.2.2. Chemical safety, controlled products, and technical responsibility

NR No. 335/2025, by regulating the Safety Data Sheet for Chemical Products (FDS) and the Safety Data Sheet for Hazardous Chemical Waste (FDSR), signals one of the System's most promising axes of action: chemical safety as a public good. Here, technical responsibility ceases to be a registry formality and becomes an instrument for protecting life—including the life of the exposed worker. A professional council that takes this axis seriously finds its most robust social justification here.

3.2.3. Green chemistry, bioeconomy, and the next decade

The CFQ's eighth decade coincides with three simultaneous transitions: the energy transition (advanced biofuels, low-carbon hydrogen, sustainable aviation fuels), the materials transition (chemical recycling, recovery of rare earths and critical metals, circular economy), and the digital transition (machine learning applied to materials discovery and process control, autonomous laboratories). A professional council that arrives late at these frontiers does not merely lose relevance: it creates a vacuum of technical responsibility precisely where the risk is greatest.

4. CONCLUSIONS

Seventy years after the founding Law, the balance is favorable and needs no retouching. The CFQ/CRQ System gave the Brazilian chemistry profession what it lacked in 1956: a legal boundary, a dedicated adjudicating body, and a mechanism for recognizing new modalities capable of keeping pace — albeit with delay —

with the field's diversification. The trajectories gathered in this text (Geraldo Mendes, Oscar Bergstron Lourenço, Juvenal Dória, Löwenberg, Krauledat, Hebe Martelli, Jesus Miguel, and Ribamar Oliveira) are, each in its own way, chapters of that construction.

The direct collaboration of the CFQ Presidency Office made it possible, in this update, to fill the previously recorded chronological gap of 1963–1967: the period is today documented by dated Ordinary Meetings, with the interim exercise of Oscar Bergstron Lourenço (1963–1964) and the rise of Juvenal Dória to the full Presidency already around 1964.

Two tasks remain proposed to the community. The first is historiographical: to resolve the remaining divergence regarding the number of Regional Councils created in 1957 (five or seven) and to recover under-recorded trajectories, beginning with that of Hebe Martelli. The second is political and technical: to face, calmly, the debate on the model for selecting leaders, and to anticipate the energy, materials, and digital transitions, so that technical responsibility in chemistry continues to mean, in the eighth decade, what it meant in the first.

That, and not the medal, is the heritage being celebrated.

5. DECLARATIONS

5.1. Study Limitations

- Methodological limitations: the chronology in Table 1 depends on institutional records provided by the CFQ Presidency Office, which the authors did not audit against an independent primary archive; two probable typographical inconsistencies in the source document were identified and flagged but not resolved.
- Documentary sampling limitation: the divergence between RQI (2023) and CRQ-X (n.d.) regarding the number of Regional Councils created in 1957 remains unresolved.
- Generalization limitation: the biographies of the presidents have uneven documentary depth, reflecting historical asymmetries of record-keeping (notably in the cases of Hebe Martelli and Oscar Bergstron Lourenço), and not an editorial choice by the authors.
- Scope limitation: the discussion of the System's contemporary challenges (Section 3.2) is necessarily selective and reflects the authors' perspective as

professionals registered in the CFQ/CRQ System.

5.2. Acknowledgments

The authors thank the Presidency Office of the Federal Council of Chemistry for providing the official list of presidents and the internal record “Galeria de Presidentes”, essential to the chronological reconstruction presented in this communication; the Associação Científica Araucaria for editorial support; and the Revista de Química Industrial (ABQ), whose “Pioneiros da Química” series preserves a substantial part of the memory reconstructed here.

Special thanks to our colleague Laila Kudsi — Analyst at the Communications Office, CFQ.

5.3. Funding Sources

The authors funded this research. No external funding was received.

5.4. Conflicts of Interest

De Boni, L. A. B. is a chemistry professional registered with CRQ-V and Managing Editor of the journal *Tchê Química*. He received no funding from the Federal Council of Chemistry or from any Regional Council of Chemistry for the preparation of this text and holds no elective office in the CFQ/CRQ System.

Gomes, P. R. B. is a tenured professor at the Federal Institute of Pará, Paragominas Campus. He received no funding from the Federal Council of Chemistry or from any Regional Council of Chemistry for the preparation of this text and holds no elective office in the CFQ/CRQ System.

5.5. Data Availability

All primary normative and biographical sources cited in this study are publicly accessible and are referenced in Section 7. The internal record “Galeria de Presidentes”, provided by the CFQ Presidency Office, is available upon request to the corresponding author, subject to CFQ authorization for redistribution.

5.6. Author Contributions

De Boni, L. A. B.: Conception and Design (CD), Data Collection (DC), Data Analysis and Interpretation (DAI), Manuscript Writing (MW), Final Approval (FA).
Gomes, P. R. B.: Data Analysis and Interpretation (DAI), Manuscript Writing (MW), Final Approval (FA).

Code	English	Português
CD	Conception and Design	Concepção e Design
DC	Data Collection	Coleta de Dados
DAI	Data Analysis and Interpretation	Análise e Interpretação de Dados
MW	Manuscript Writing	Escrita do Manuscrito
CR	Critical Review	Revisão Crítica
FA	Final Approval	Aprovação Final

5.7. AI Tools Declaration

Tool: Claude (Anthropic). Purpose: support for cross-checking dates among documentary sources provided by the authors, drafting revisions of the manuscript, and reformatting according to the journal template. It was not used for data fabrication, statistical analysis, or interpretation of historical results, which remain the exclusive responsibility of the authors. All generated content was reviewed and substantially verified by the corresponding author before submission.

5.8. Research Integrity Statement

No data fabrication; no falsification of results; no selective reporting; original work; not previously published; methods conducted ethically.

5.9. Originality and Plagiarism Statement

This research was previously published in Portuguese by the *Priódico Tchê Química*, DOI 10.52571/PTQ.v23.n53.2026_04_BONI_pgs_42_54.pdf. This is its first publication in English.

5.10. Open Access License

This article is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, provided that you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

Este artigo está licenciado sob uma Licença Internacional Creative Commons Atribuição 4.0 (CC BY 4.0), que permite o uso, compartilhamento, adaptação, distribuição e reprodução em qualquer meio ou formato, desde que seja dado o devido crédito aos autores originais e à fonte, com link para a licença. Para ver uma cópia desta licença, visite <http://creativecommons.org/licenses/by/4.0/>.

6. STUDIES INVOLVING HUMANS AND

ANIMALS

Not applicable. This is historical-institutional documentary research, based exclusively on legal, normative, and institutional sources that are publicly accessible or formally provided by the CFQ, without collecting data from humans or animals and without using sensitive personal information about living individuals beyond already published biographical facts. There was, therefore, no need for approval by a Research Ethics Committee.

6.1. Ethics Committee Approval

Not applicable.

6.2. Informed Consent

Not applicable.

7. REFERENCES

1. Assembleia Legislativa de Goiás. (2026). Legado e o futuro da química. Portal da Alego. <https://portal.al.go.leg.br/noticias/165522/legado-e-o-futuro-da-quimica>
2. Brasil. (1934). Decreto nº 24.693, de 12 de julho de 1934. Diário Oficial da União.
3. Brasil. (1943). Decreto-Lei nº 5.452, de 1º de maio de 1943. Aprova a Consolidação das Leis do Trabalho. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/decreto-lei/del5452.htm
4. Brasil. (1956). Lei nº 2.800, de 18 de junho de 1956. Cria os Conselhos Federal e Regionais de Química. Diário Oficial da União. https://www.planalto.gov.br/ccivil_03/leis/l2800.htm
5. Brasil. (1981a). Decreto nº 85.877, de 7 de abril de 1981. Diário Oficial da União.
6. Brasil. (1981b). Decreto nº 86.593, de 17 de novembro de 1981. Diário Oficial da União.
7. Conselho Federal de Química. (1969). Resolução Normativa nº 23, de 17 de dezembro de 1969. CFQ.
8. Conselho Federal de Química. (1974). Resolução Normativa nº 36, de 25 de abril de 1974. CFQ.
9. Conselho Federal de Química. (1978). Resolução Normativa nº 46, de 27 de janeiro de 1978. CFQ.
10. Conselho Federal de Química. (2020). CFQ se despede de Jesus Miguel, o presidente que deu identidade ao Sistema. <https://cfq.org.br/noticia/cfq-se-despede-de-jesus-miguel-o-presidente-que-deu-identidade-ao-sistema/>
11. Conselho Federal de Química. (2024). Gestão do presidente José de Ribamar Oliveira Filho no Sistema CFQ/CRQs é marcada por avanços na área Química do Brasil. <https://cfq.org.br/noticia/gestao-do-presidente-jose-de-ribamar-oliveira-filho/>
12. Conselho Federal de Química. (2026a). Quem foi Hebe Martelli, a primeira mulher a presidir o CFQ. <https://cfq.org.br/noticia/quem-foi-hebe-martelli-a-primeira-mulher-a-presidir-o-cfq/>
13. Conselho Federal de Química. (2026b). Medalha comemorativa aos 70 anos do CFQ é lançada pela Casa da Moeda. <https://cfq.org.br/noticia/medalha-comemorativa-aos-70-anos-do-cfq-e-lancada-pela-casa-da-moeda/>
14. Conselho Federal de Química. (2026c). Sobre o CFQ. <https://cfq.org.br/sobre-o-cfq/>
15. Conselho Federal de Química, Gabinete da Presidência. (2026d). Galeria de Presidentes [Documento institucional interno; relação oficial de presidentes do CFQ]. Comunicação institucional aos autores em resposta à solicitação de 22 de junho de 2026, 25 de junho de 2026.
16. Conselho Regional de Química da IV Região. (2026). Resoluções Normativas. <https://crqsp.org.br/resolucoes-normativas/>
17. Conselho Regional de Química da X Região. (n.d.). Nossa história. <https://www.crqx.org.br/nossa-historia/>
18. Correios. (2026). Selo homenageia os 70 anos do Conselho Federal de Química. Sala de Imprensa dos Correios. <https://saladeimprensa.correios.com.br/arquivos/14146>
19. Revista de Química Industrial. (2020). Pioneiros da Química: Juvenal Osório de Araújo Dória; Expedito José de Sá Parente; Walter Borzani; Franklin Jorge Gross; Hervásio Guimarães de Carvalho; Paul Le Cointe. RQI, 769 (4º trimestre), 19–33. Associação Brasileira de Química.
20. Revista de Química Industrial. (2023). Pioneiros da Química: Geraldo Mendes de Oliveira Castro; José Eduardo Alves Filho; Annibal Ramos de Mattos. RQI, 775 (2º semestre), 22–27. Associação Brasileira de Química.
21. Santos, N. P. dos, Pinto, A. C., & Alencastro, R. B. de. (2006). Fazemos Químicos: a “certidão de nascimento” dos cursos de química de nível superior no Brasil. Química Nova, 29(3), 621–626. <https://doi.org/10.1590/S0100-40422006000300035>
22. Senado Federal. (2026). Senado celebrará Conselho Federal de Química em sessão especial. Agência Senado. <https://www12.senado.leg.br/noticias/materias/2026/04/08/senado-celebrara-conselho-federal-de-quimica-em-sessao-especial>
23. Silva, A. P. da, Santos, N. P. dos, & Afonso, J. C. (2006). A criação do curso de engenharia química na Escola Nacional de Química da Universidade do Brasil. Química Nova, 29(4), 881–888. <https://doi.org/10.1590/S0100-40422006000400044>
24. Conselho Regional de Química da 9ª Região. (2011). Informativo CRQ-IX (Vol. 1, January/February/March). Curitiba-PR. Retrieved from <https://crq9.gov.br/sites/default/files/anexos/2011%20-%201.pdf>

Table 1. Documented chronology of the presidencies of the Federal Council of Chemistry (1957–2026), based on the official list and on the internal record “Galeria de Presidentes” (CFQ, Gabinete da Presidência, 2026).

Period	President / Acting officer	Documentary evidence (O.M. = Ordinary Meeting / Reunião Ordinária)
08.07.1957 – c. 08.1963	Geraldo Mendes de Oliveira Castro (founder; two consecutive terms)	President at the 1st O.M. (08.07.1957), still present at the 25th O.M. (29.05.1963) and at the 48th O.M. (03.07.1963). Vacancy of the office on 27.04.1960 (22nd O.M.), with Secretary Ralpo Rezende Decourt acting, followed by Vice-President Paschoal Senide acting (23rd and 24th O.M., 27.04–08.06.1960).
14.08.1963 – 22.04.1964	Oscar Bergstron Lourenço (Vice-President, acting in the Presidency)	49th O.M. (14.08.1963) and 54th O.M. (22.04.1964).
c. 1964 – 12.11.1969	Juvenal Osório de Araújo Dória	President at the 55th O.M. (shortly after the 54th O.M., c. 1964), with documented presence until at least the 95th O.M. (12.11.1969). Occasional impediments were covered by Secretary Jorge da Cunha acting (65th O.M., 09.03.1966; 74th O.M., c. 1967; 77th O.M., 25.10.1967) and, in 1969, by Vice-President Peter Löwenberg acting (92nd O.M., c. 13.06.1969; 93rd O.M., 17.06.1969), with Dória's return to the Presidency recorded at the 94th O.M. (15.10.1969) and at the 95th O.M. (12.11.1969).
23.04.1970 – 02.07.1972	Peter Löwenberg (Vice-President; later President)	Vice-President acting in the Presidency at the 99th and 100th O.M. (23.04 and 20.05.1970); assumes the office as full President at the 101st O.M. (24.06.1970). The term ends around 02.07.1972 (134th O.M.), when Vice-President Paulo Ribeiro begins to exercise the Presidency due to the end of the term.
02.07.1972 – 12.09.1973	Paulo Ribeiro (Vice-President, acting; end of Löwenberg's term)	134th O.M. (02.07.1972) and 135th O.M. (15.08.1973).
12.09.1973 – c. 1976	Peter Löwenberg (second term)	President at the 136th O.M. (12.09.1973); signs NR No. 36, of 25.04.1974 (CFQ, 1974).
c. 1976 – 15.07.1977	Clóvis Martins Ferreira (Vice-President, acting) / Werner Gustav Krauledat	Clóvis Martins Ferreira acting at the 171st O.M. (08.10.1976); Krauledat assumes the office as President at the 181st O.M. (15.07.1977) and signs NR No. 46, of 27.01.1978 (CFQ, 1978).
1978 – 10.01.1979	Olavo Romanus (Vice-President, acting)	189th O.M. (28.04.1978) and 197th O.M. (15.12.1978).
10.01.1979 – 05.03.1985	Hebe Helena Labarthe Martelli (first and, as of 2026, only woman to preside over the CFQ)	President at the 198th O.M. (10.01.1979) until at least the 236th O.M. (19.03.1982); brief exercise by Samuel Klein at the 235th O.M. (05.02.1982). Installs CRQ-X on 23.11.1983 (CRQ-X, n.d.).
05.03.1985	Roberto Hissa (Vice-President, acting)	Record dated 05.03.1985, the eve of Jesus Miguel Tajra Adad's inauguration.
06.03.1985 – 2018	Jesus Miguel Tajra Adad	President at the 269th O.M. (06.03.1985); presence documented in successive O.M. up to the 22,767th O.M. (03.12.2014, 2015–2018 term). 33 years at the head of the autarchy; first Counselor Emeritus of the CFQ (CFQ, 2020).
18.04.2018 – present	José de Ribamar Oliveira Filho	Elected at O.M. No. 26,777 (607th Meeting, 18.04.2018), 2018–2021 term; reappointed by acclamation for the 2024–2027 term (CFQ, 2024).

Notes: intervals marked with “c.” are inferred from the sequence of neighboring Ordinary Meetings. The internal record “Galeria de Presidentes” presents three probable transcription inconsistencies, flagged here for transparency of the chronological reconstruction: (a) the 25th O.M. is dated 29.05.1963 and the 48th O.M. 03.07.1963 — an interval of five weeks for 23 sessions is incompatible with the pace observed in the rest of the series, suggesting a typing error in one of the two session numbers or dates; (b) the 74th O.M. is dated “14.06.1997” in the original document, which is chronologically incompatible with the sequence (65th O.M. in 1966; 77th O.M. on 25.10.1967) — most probable reading: 14.06.1967; (c) the 92nd O.M. is dated 13.08.1969 in the original document, later than the date of the 93rd O.M. (17.06.1969) — a chronologically incompatible sequence, suggesting a typing error in the month (most probable reading: 13.06.1969). The three points were communicated to the CFQ Presidency Office for confirmation against the primary archive.

Table 2. Selected normative milestones in the regulation of the chemistry profession in Brazil.

Year	Milestone
1934	Decree No. 24,693, regulated by Decree No. 57/1935: first regulation of the chemist's profession; establishes the figure of the "licensed chemist".
1943	Decree-Law No. 5,452 (CLT), Title III, Chap. I, Section XIII: first clear delimitation of exclusive activities; oversight assigned to the Ministry of Labor.
1956	Law No. 2,800: creates the CFQ and the CRQs and transfers oversight to them; 18 June becomes the National Day of the Chemistry Professional.
1957	Installation of the CFQ; NR No. 1 (internal regulations) and NR No. 2 (creation of the first regional councils). See the divergence between sources discussed in Section 3.1.2.
1969	NR No. 23: characterizes, for the purposes of arts. 334-b and 341 of the CLT, the chemical departments of industries and commercial companies subject to technical direction and responsibility.
1974	NR No. 36: list of 16 professional activities; curricular natures Chemistry, Technological Chemistry, and Chemical Engineering; attributions of the Chemistry Technician; enshrines expert examination (perícia) as an attribution (item 03).
1977–1984	NR No. 44/1977 (biological agents in water and effluent control); NR No. 46/1978 (food); NR No. 76/1984 (revokes the sole paragraph of art. 2 of NR No. 36).
1981	Decree No. 85,877: regulates Law No. 2,800, specifying exclusive and shared activities. Decree No. 86,593: transfers the choice of the CFQ president to the Minister of Labor.
1987–1992	NR No. 105/1987 and NR No. 122/1990 (legal entities subject to registration); NR No. 133/1992 (technical responsibility).
2004	NR No. 194 (updates arts. 8 and 9 of NR No. 36) and NR No. 198 (defines the professional modalities in the field of Chemistry).
2019	NR No. 287: regulates oversight, penalties, and administrative proceedings throughout the System.
2025	NR No. 334 (technical responsibility); NR No. 335 (FDS and Safety Data Sheet for Hazardous Chemical Waste); NRs No. 342 and 343 (granting of attributions to graduates of higher education and technical courses).
2026	NR No. 344 (new Identity Card of the Chemistry Professional); NR No. 346 (institutional actions for the System's 70 years).

Source: prepared by the authors from Brasil (1934, 1943, 1956, 1981a, 1981b) and the Normative Resolutions of the CFQ (CRQ-IV, 2026).



CHARACTERIZATION OF TICKS IN THE GRAN MENDOZA AREA, MENDOZA, ARGENTINA

CARACTERIZACIÓN DE GARRAPATAS EN LA ZONA DE GRAN MENDOZA, MENDOZA, ARGENTINA

YAMÍN, Paula¹; DI CATALDO, Sophia²; VASCONCELOS, Daniela³; QUINTERO, Cristián Andrés^{4,*}

¹Universidad Juan Agustín Maza, Faculty of Veterinary and Environmental Sciences, Argentina.

² Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), IMBECU-CCT Mendoza, Argentina. ORCID: 0000-0001-5917-7175

³ Universidad Juan Agustín Maza, Faculty of Veterinary and Environmental Sciences, Veterinary Endocrinology Consultation Service, Argentina

⁴ Universidad Juan Agustín Maza, Laboratory of Molecular and Cellular Biology, Argentina. ORCID: 0000-0003-4365-4189

Corresponding author: cquintero@umaza.edu.ar

Received 12 May 2026; received in revised form 30 June 2026; accepted 14 August 2026

ABSTRACT

Background: Vector-borne diseases are increasingly important because they are emerging and re-emerging. Of the 867 tick species reported worldwide, 10% (86 species) have public health implications; 58 parasitize dogs, and 12 have been documented in Argentina. Tick-borne agents are increasingly relevant in the Cuyo region, with implications for both public health and domestic animal health. In Mendoza, the *Rhipicephalus sanguineus* complex and *Amblyomma tigrinum* have been documented. **Aim:** This study aimed to determine whether one tick genus predominated over the other, compared with previous studies in the region. **Methods:** We collected ticks from dogs attending municipal vaccination campaigns and veterinary clinics in several departments of the Greater Mendoza area (Ciudad/Capital, Luján de Cuyo, Godoy Cruz, and Guaymallén). Specimens were preserved in 70% (v/v) ethanol in sealed containers until analysis. Identification was performed using a stereomicroscope and the taxonomic keys of Nava. **Results:** The highest number of ticks was obtained from Ciudad/Capital, followed by Luján de Cuyo, Godoy Cruz, and Guaymallén. A total of 439 specimens were collected and classified by genus, species, and sex. Of these, 94.46% (415 ticks) corresponded to the *Rhipicephalus sanguineus* complex, including 193 females (43.96%) and 222 males (50.5%). The remaining 5.48% (24 ticks) were identified as *Amblyomma tigrinum*, including 17 females (3.89%) and 7 males (1.59%). **Discussion:** These findings confirm the marked predominance of the *Rhipicephalus sanguineus* complex among ticks collected from dogs in the Greater Mendoza area.

Keywords: Ticks; *Rhipicephalus sanguineus* complex; *Amblyomma tigrinum*; dogs; Mendoza.

RESUMEN

Antecedentes: Las enfermedades transmitidas por vectores son de creciente importancia debido a su naturaleza emergente y reemergente. De las 867 especies de garrapatas reportadas en todo el mundo, el 10% (86 especies) tienen implicaciones para la salud pública; 58 de estos parasitan perros, y 12 han sido documentados en Argentina. Los agentes transmitidos por garrapatas son cada vez más relevantes en la región de Cuyo, con implicaciones tanto para la salud pública como para la salud de los animales domésticos. En Mendoza se ha documentado la presencia del complejo *Rhipicephalus sanguineus* y *Amblyomma tigrinum*. **Objetivo:** El objetivo de este estudio fue determinar si un género de garrapatas predominaba sobre el otro, en comparación con estudios previos realizados en la región. **Métodos:** Se recolectaron garrapatas de perros que asistieron a campañas municipales de vacunación y clínicas veterinarias en varios departamentos del Gran Mendoza (Ciudad/Capital, Luján de Cuyo, Godoy Cruz y Guaymallén). Las muestras se conservaron en etanol al 70% (v/v) en recipientes sellados hasta el análisis. La identificación se realizó mediante microscopio estereoscópico y las claves taxonómicas de Nava. **Resultados:** El mayor número de garrapatas se obtuvo de Ciudad/Capital, seguido de Luján de Cuyo, Godoy Cruz y Guaymallén. Se recolectaron un total de 439 especímenes clasificados por género, especie y sexo. De ellas, el 94,46% (415 garrapatas) correspondieron al complejo *Rhipicephalus sanguineus*, incluyendo 193 hembras (43,96%) y 222 machos (50,5%). El 5,48% restante (24 garrapatas) fueron identificados como *Amblyomma tigrinum*, incluidas 17 hembras (3,89%) y 7 machos (1,59%). **Discusión:** Estos hallazgos confirman el marcado predominio del complejo *Rhipicephalus sanguineus* entre las garrapatas recolectadas en perros en el área del Gran Mendoza.

Palabras clave: Garrapatas; complejo *Rhipicephalus sanguineus*; *Amblyomma tigrinum*; perros; Mendoza.

1. INTRODUCTION

Vector-borne diseases are increasingly important because they are emerging and re-emerging. They account for approximately 17% of infectious diseases affecting humans and cause more than 700,000 deaths annually (Cabrera Orrego, 2021).

After mosquitoes, ticks are among the most important arthropod vectors of agents that can cause disease in domestic and wild animals and humans (Nava *et al.*, 2017). Of the 867 tick species reported worldwide, 10% (86 species) have implications for public health; 58 of these parasitize dogs, and 12 have been documented in Argentina (Mera y Sierra *et al.*, 2017; 8. Nava, S., & Cicuttin, G. L., 2025). Beyond their effects on host health, tick infestations are associated with economic losses in livestock and their by-products, substantial prevention and treatment costs, and increasing resistance to acaricides (Jongejan & Uilenberg, 2004). However, their main concern for public and veterinary health is their capacity to transmit pathogenic microorganisms of viral, parasitic, and bacterial origin. Frequently reported agents include the bacteria *Rickettsia rickettsii*, *R. conorii*, *Ehrlichia canis*, and *Mycoplasma haemocanis*, as well as the parasites *Babesia canis* and *Hepatozoon canis* (Álvarez Romina, 2017).

Tick-borne agents are increasingly relevant in the Cuyo region, with implications for public health and domestic animal health

(Fantozzi *et al.*, 2018). In Mendoza Province, several of these agents have been reported, including members of the genera *Ehrlichia*, *Anaplasma*, *Mycoplasma*, *Babesia*, *Hepatozoon*, and *Rickettsia* (Bergas Cristina, 2018; Vasconcelos, 2018, Di Cataldo & Guevara, 2024).

In Mendoza, the *Rhipicephalus sanguineus* complex and *Amblyomma tigrinum* have been documented (Bergas Cristina, 2018; Fantozzi *et al.*, 2018; Vasconcelos, 2018). Within the *R. sanguineus* complex, two lineages have been described: a tropical lineage, distributed in tropical and subtropical regions including northern Argentina, and a temperate lineage, distributed in temperate regions of Argentina, Chile, and Uruguay. The latter has been characterized as more suitable for transmitting *Rickettsia massiliae* (Fantozzi *et al.*, 2018; Monje *et al.*, 2016).

Despite the importance of ticks in the transmission and spread of infectious agents, there is little information available for the province of Mendoza. This study aimed to characterize ticks collected from dogs attending veterinary clinics and/or municipal vaccination campaigns at different sites in Greater Mendoza and to determine whether one tick group predominated, as reported in previous studies.

2. MATERIALS AND METHODS

2.1. Methods

2.1.1 Tick collection and identification

From August to December 2022, dogs attending municipal vaccination campaigns and veterinary clinics located in departments of the Greater Mendoza area were analyzed for ectoparasites (Ciudad/Capital, Luján de Cuyo, Godoy Cruz, and Guaymallén; Figure 1)..

Ticks were collected using forceps following the left-hand technique for a defined period of 5 minutes, examining body areas most frequently affected by ticks, including the ears, interdigital spaces, axillae, and inguinal folds (Marchiondo *et al.*, 2013). Specimens were preserved in 70% (v/v) ethanol in sealed containers until analysis (Vasconcelos, 2018). This preservation procedure was intended to maintain specimen integrity and DNA suitable for subsequent identification.

Species and sex identification were performed using a Luxeo 6Z stereomicroscope (Labomed), following the taxonomic keys of Nava *et al.* (2017).

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1 Collection areas

Ticks were collected from areas with highly variable socioeconomic conditions, ranging from districts of Greater Mendoza characterized by deprivation and overcrowding to areas where animals had access to greater levels of veterinary care, including vaccination, deworming, and coat maintenance.

Among the sampling areas, Ciudad/Capital yielded the highest number of ticks, where the largest number of dogs attended the collection sites, followed by Luján de Cuyo, Godoy Cruz, and Guaymallén, as shown in Figure 1.

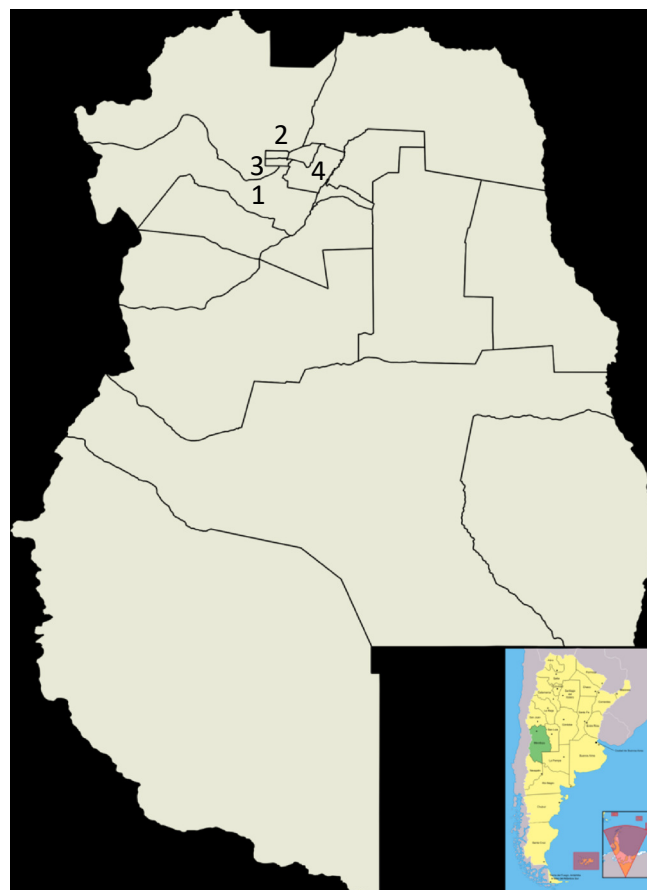


Figure 1. Map of Mendoza Province showing the departments from which samples were obtained. 1- Luján de Cuyo, 2, Ciudad de Mendoza, 3 Godoy Cruz, 4, Guaymallén. The inset shows a map of Argentina, with Mendoza marked in green.

3.1.2 Characteristics of the animals

All ticks (439 specimens) were obtained from dogs brought by their owners to the different collection sites. Among the animals examined, small- and medium-sized dogs with both long and short coats predominated. The general condition of the animals varied considerably according to the collection area; some animals had poor body condition (below 2.5 on a scale of 2 to 5) and did not have up-to-date health care plans.

3.1.3 The *Rhipicephalus sanguineus* complex was the most frequently identified tick group in Mendoza.

This tick complex is important because it vectors zoonotic pathogens that may affect both human and animal health (Fantozzi *et al.*).

In Argentina, the ticks that affect our pets, especially dogs, belong to the *Rhipicephalus sanguineus* complex and to different species of *Amblyomma* (Fantozzi *et al.*).

Of the 439 specimens collected, ticks were identified and classified by taxonomic group and sex. Figure 2 shows specimens of the *Rhipicephalus sanguineus* complex.

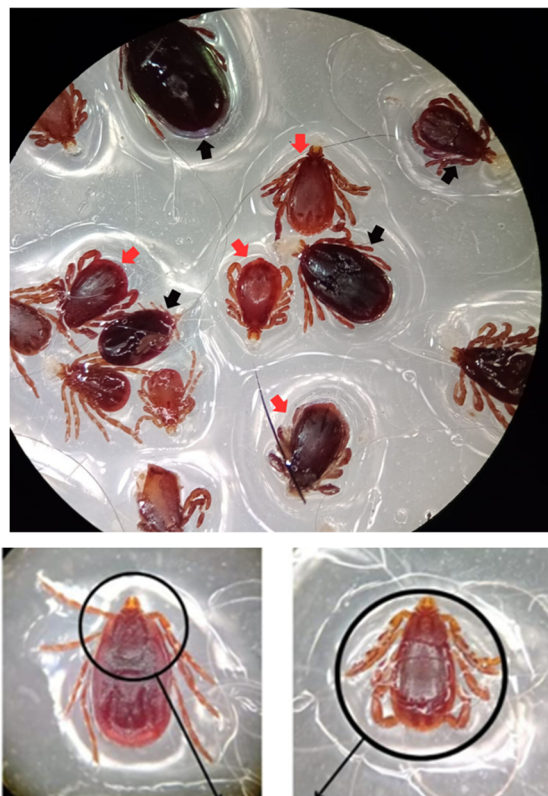


Figure 2. Upper panel. Specimens of the *Rhipicephalus sanguineus* complex. Images obtained using a Luxeo 6Z stereomicroscope (Labomed). Male individuals are indicated by black arrows and female individuals by red arrows. Lower panel: Image obtained using a Luxeo 6Z stereomicroscope (Labomed). Male (left) and female (right) specimens of the *Rhipicephalus sanguineus* complex.

To a lesser extent, *Amblyomma tigrinum* was also found in several cases; typical samples are shown in Figure 3.

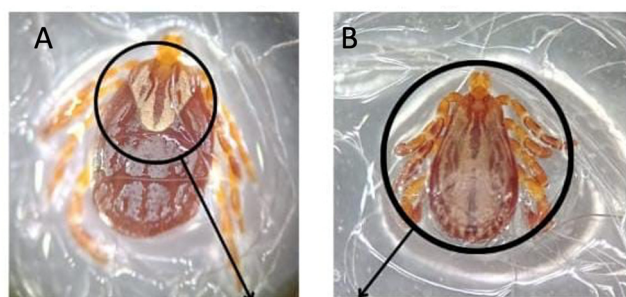


Figure 3. Image obtained using a Luxeo 6Z stereomicroscope (Labomed). A-Male and B-female specimens of *Amblyomma tigrinum*.

Specimen identification was based on morphological characteristics of the capitulum, particularly the shape and configuration of the basis capituli (Figure 4). Specimens assigned to the *Rhipicephalus sanguineus* complex exhibited the characteristic hexagonal basis capituli, with distinct lateral angles, whereas specimens identified as *Amblyomma tigrinum* showed a broader and more rectangular basis capituli, lacking the characteristic hexagonal outline observed in *Rhipicephalus*. These differences, together with other external morphological characters, supported the identification of the specimens.

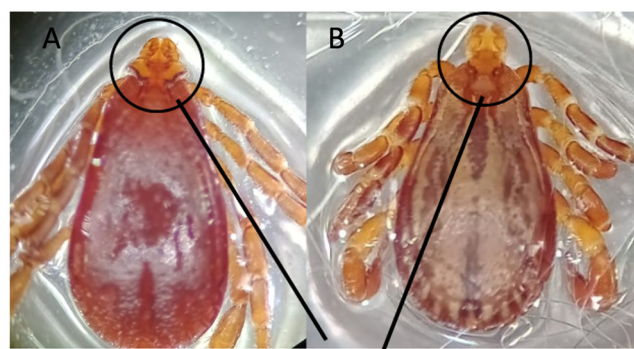


Figure 4. Differences in the basis capituli between a specimen of the *Rhipicephalus sanguineus* Complex (A) and a specimen of *Amblyomma tigrinum* (B)

3.2. Discussions

In Argentina, ticks affecting companion animals, particularly dogs, include the *Rhipicephalus sanguineus* complex and various *Amblyomma* species (Fantozzi *et al.*, 2018). In Mendoza, both groups affecting domestic dogs have been documented (Bergas Cristina, 2018; Fantozzi *et al.*, 2018; Vasconcelos, 2018).

Of the 439 specimens collected, ticks were identified and classified by taxonomic group and sex (Figure 5).

Of the specimens examined, 94.46% (415 ticks) corresponded to the *Rhipicephalus sanguineus* complex, including 193 females (43.96%) and 222 males (50.5%) (Figures 2). The remaining 5.48% (24 ticks) were identified as *Amblyomma tigrinum*, including 17 females (3.89%) and 7 males (1.59%) (Figure 3). No juvenile forms (larvae) were observed during the study.

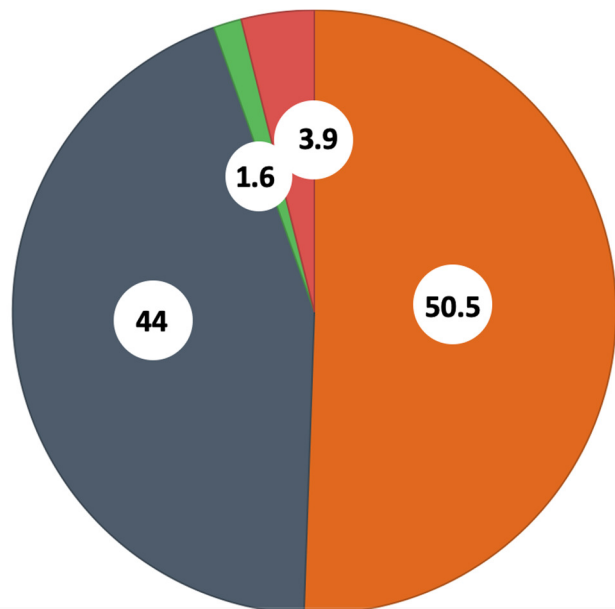


Figure 5. Percentage distribution of identified tick groups by sex. The graph shows the tick groups identified in the present study. Orange male *Rhipicephalus sanguineus*, grey female *Rhipicephalus sanguineus*, green male *Amblyomma tigrinum*, red female *Amblyomma tigrinum*

4. CONCLUSIONS

Identifying tick vectors in a region provides relevant information for assessing the potential occurrence of tick-borne pathogens and supports epidemiological surveillance. In the present study, the *Rhipicephalus sanguineus* complex represented 94.46% of all collected ticks, in agreement with previous reports from Mendoza (Bergas Cristina, 2018; Fantozzi *et al.*, 2018; Vasconcelos, 2018). The predominance of this complex highlights the importance of continued surveillance of ticks and tick-borne pathogens affecting both animals and humans. The data from this study may contribute to developing appropriate ectoparasite prevention and control strategies across the province's departments. Further studies should focus on molecular detection and characterization of pathogens carried by these arthropod vectors and on developing integrated surveillance and control measures.

Overall, these findings provide baseline information on the distribution of ticks collected from dogs in the Greater Mendoza area and support the need for continued surveillance of arthropod-borne pathogens and appropriate prevention and control measures.

5. DECLARATIONS

5.1. Study Limitations

Besides the sample size, no other limitations were known at the time of the study.

5.2. Acknowledgments

We would like to thank Universidad JA Maza for its support.

5.3. Funding source

The Agencia Nacional de Promoción de la Investigación, el Desarrollo Tecnológico y la Innovación funded this work (Grant: PICTO UUMM-2019-0044).

5.4. Competing Interests

The authors declare no financial, professional, or personal conflicts of interest that could have influenced the content or conclusions of this manuscript. All authors are affiliated solely with academic institutions.

5.5. Open Access

This article is licensed under a Creative Commons Attribution 4.0 (CC BY 4.0) International License, which permits use, sharing, adaptation, distribution, and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license unless indicated otherwise in a credit line to the material. Suppose material is not included in the article's Creative Commons license, and your intended use is not permitted by statutory regulation or exceeds the permitted use. In that case, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

7. REFERENCES:

1. Monje LD, Linares MC, Beldomenico PM. Prevalence and infection intensity of *Rickettsia massiliae* in *Rhipicephalus sanguineus sensu lato* ticks from Mendoza, Argentina. *Microbes Infect.* 2016 Nov;18(11):701-705. doi: 10.1016/j.micinf.2016.06.008. Epub 2016 Jul 7. PMID: 27394145.
2. Ticks of the Southern Cone of America Diagnosis, Distribution, and Hosts with Taxonomy, Ecology and Sanitary Importance. 1st Edition - February 4, 2017. Santiago Nava, Jose M. Venzal, Daniel González Acuña, Thiago F. Martins, Alberto A Guglielmone.
3. Fantozzi, María Cecilia; Linares, Maria Cielo; Cuervo Bustamante, Pablo Fernando; Romoli, Andrés; Vittaz, Diego; *et al.*; Especies de garrapatas (Acari: Ixodidae) parásitas de perros (*Canis familiaris*) en zonas urbanas del Gran Mendoza, Argentina; Facultad de Ciencias Veterinarias, Universidad Nacional del Litoral; Fave Ciencias Veterinarias; 17; 1; 6-2018; 25-29
4. Portillo A, de Sousa R, Santibáñez S, Duarte A, Edouard S, Fonseca IP, Marques C, Novakova M, Palomar AM, Santos M, Silaghi C, Tomassone L, Zúquete S, Oteo JA. Guidelines for the Detection of *Rickettsia* spp. *Vector Borne Zoonotic Dis.* 2017 Jan;17(1):23-32. doi: 10.1089/vbz.2016.1966. PMID: 28055574.
5. VIGILANCIA DE GARRAPATAS Y EMERGENCIA DE ZOONOSIS EN MENDOZA, ARGENTINA. TICK SURVEILLANCE AND ZOONOSES EMERGENCE IN MENDOZA, ARGENTINA. R. Mera y Sierra; A. Romoli; A. Sarrión; M. Granzotto; D. Vasconcelos y G. Neira Centro de Investigación en Parasitología Regional, Universidad Juan Agustín Maza. Mendoza. Argentina.
6. Bontti, S. (2018). Evidencia serológica de *Rickettsiosis* en pacientes con sospecha de fiebre manchada en la provincia de Mendoza.
7. Labruna MB. Ecology of *rickettsia* in South America. *Ann N Y Acad Sci.* 2009 May;1166:156-66. doi: 10.1111/j.1749-6632.2009.04516.x. PMID: 19538276.
8. Nava, S., & Cicuttin, G. L. (2025). Garrapatas y zoonosis bacterianas asociadas en Argentina. *Medicina (Buenos Aires)*, 85(5), 1093-1107.
9. Patrick S. Sebastian, Fernando S. Flores, María N. Saracho-Bottero, Evelina L. Tarragona, José M. Venzal, Santiago Nava, Molecular detection of rickettsial bacteria in ticks of the genus *Ixodes* from the Southern Cone of America, *Acta Tropica*, Volume 210, 2020, 105588, ISSN 0001-706X, <https://doi.org/10.1016/j.actatropica.2020.105588>.
10. DI CATALDO, Sophia y GUEVARA, Manuel Alejandro. Detección molecular de *Hepatozoon canis* en perros de Mendoza, Argentina. *Rev. investig. vet. Perú* [online]. 2024, vol.35, n.3, e26059. Epub 30-Jun-2024. ISSN 1609-9117. <https://doi.org/10.15381/rivep.v35i3.26059>.
11. PREVALENCIA DE HEPATOZOON SPP. EN GARRAPATAS, MEDIANTE EL MÉTODO FROTIS DE HEMOLINFA. Universidad Juan Agustín Maza. Autor: Vasconcelos Daniela Director: Vet. Neira Gisela. Mendoza 2018
12. A.A. Marchiondo a,*, P.A. Holdsworth b, L.J. Fourie c, D. Rugg a, K. Hellmann d, D.E. Snyder e, M.W. Dryden f (Ed.). (2013). Asociación Mundial para el Avance de la Parasitología Veterinaria (WAAVP) segunda edición: Pautas para evaluar la eficacia de los parasiticidas para el tratamiento, prevención y control de infestaciones por pulgas y garrapatas en perros y gatos. ELSEVIER.
13. Javier López Del P., K. A. V. y. T. A. A. (2007). Evidencia clínica y serológica de *rickettsiosis* canina en Chile Javier López Del P., Katia Abarca V. y Teresa Azócar A. SOCHINF (Sociedad Chilena De Infectología).

Call for papers

www.sscon.org



Conselho Nacional de Desenvolvimento
Científico e Tecnológico

Process: 440182/2025-5

SOUTHERN SCIENCE
CONFERENCE

UNIVERSIDADE DE
VASSOURAS

SOUTHERN SCIENCE
CONFERENCE



UM

UNIVERSIDAD
DE MENDOZA



UNIVERSIDADE DE
VASSOURAS