

REVISTA CIE

REVISTA DE INVESTIGACIÓN EDUCATIVA

Bienestar, Educación y Transformación Social:

Perspectivas desde la
Investigación Contemporánea



BIENESTAR



EDUCACIÓN



TRANSFORMACIÓN
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Vol.2, No. 2

Julio - Diciembre 2026

ISSN: 3061 - 8657

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Revista CIE. Año 2026, Volumen 2, Número 2, julio-diciembre. Publicación semestral editada por la Facultad de Medicina de Tampico de la Universidad Autónoma de Tamaulipas, a través del Centro de Investigación Educativa, Centro Universitario Sur, Tampico, Tamaulipas, México, CP. 89337. Tels. (833) 2 41 20 00, ext. 3315. Página web: <https://revistacie.uat.edu.mx/> y correo electrónico: revistacie@uat.edu.mx. Editor responsable: Dra. Miriam Janet Cervantes López. Reserva de Derechos Uso Exclusivo: 04-2024-120213161900-102, ISSN electrónico: 3061-8657, ambos otorgados por el Instituto Nacional del Derecho de Autor; Responsable de la última actualización de este número: Dra. Miriam Janet Cervantes López. Fecha de la última modificación: 14 de agosto de 2026.

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EDITORIAL

Well-Being, Education, and Social Transformation: Perspectives from Contemporary Research

It is a privilege to present this volume of the CIE Journal of Educational Research of the Faculty of Medicine of Tampico “Dr. Alberto Romo Caballero” at the Autonomous University of Tamaulipas. This new issue reaffirms the journal’s editorial commitment to disseminating high-quality scientific research that contributes to understanding and addressing contemporary challenges through an interdisciplinary perspective, integrating contributions from education, health sciences, and social well-being.

The title of this volume, Well-Being, Education, and Social Transformation: Perspectives from Contemporary Research, reflects the convergence of the studies featured in this issue. In a context characterized by ongoing social and educational transformations, as well as emerging health-related challenges, scientific research has become an essential tool for generating knowledge, informing decision-making, and promoting evidence-based actions.

Within the field of health, this issue includes studies focused on well-being promotion and risk prevention. Notably, it features research examining the effects of 16:8 intermittent fasting combined with caloric restriction on metabolic indicators among university students, providing valuable insights into strategies aimed at improving health and promoting healthy lifestyles.

Additionally, this volume includes a study examining university students’ knowledge and use of contraceptive methods, a topic of particular relevance for strengthening sexual and reproductive health education

and promoting informed decision-making among young adults.

This perspective is further complemented by a state-of-the-art review of musculoskeletal disease as an extrahepatic manifestation associated with hepatitis C virus infection. The review provides an up-to-date overview of this condition and highlights the importance of biomedical research in strengthening comprehensive healthcare.

In the field of education, this issue includes a study on teaching performance and the development of mathematical competencies among sixth-grade primary school students, emphasizing the influence of pedagogical practice on learning outcomes. Likewise, it presents research analyzing the impact of the COVID-19 pandemic on the Business Management Engineering program at the Higher Technological Institute of Pánuco, contributing to a deeper understanding of the adaptation and transformation processes experienced in higher education.

Although they address diverse realities, the studies gathered in this volume share a common purpose: generating knowledge that contributes to individual well-being, the strengthening of education, and the development of healthier and more resilient societies. We are confident that the contributions featured in this issue will enrich academic dialogue, inspire new lines of inquiry, and serve as a valuable reference for researchers, educators, students, and professionals committed to evidence-based social transformation.

Sincerely
Dra. Miriam Janet Cervantes López
Editor in Chief



Effects of 16/8 intermittent fasting combined with caloric restriction on cholesterol, triglycerides, and BMI in university students

Efectos del ayuno intermitente 16/8 combinado con restricción calórica sobre colesterol, triglicéridos e IMC en universitarios

Melba Fernández Rojas, Aryam Bernadette Wilson Ortiz, Alejandra Flores Reyes, Iván de Jesús Zapata Juárez*

Abstract

Intermittent fasting has emerged as a promising strategy for weight reduction and improvement of the lipid profile. This descriptive cross-sectional study aims to analyze the effects of the 16/8 intermittent fasting protocol combined with caloric restriction on total cholesterol levels, triglycerides, and body mass index (BMI) in university students. Twenty participants (18-22 years old) without chronic diseases and with a BMI between 23.6 and 43.4 kg/m² were recruited. Participants were assigned to two groups: one experimental (intermittent fasting with 25% caloric restriction) and one control (only hypocaloric diet). The study lasted for 4 weeks, with measurements of cholesterol, triglycerides, and BMI taken at the beginning and end, in addition to the administration of questionnaires to assess side effects. Minimal differences in cholesterol and triglycerides were found between the groups, although the experimental group showed a significant reduction in BMI and a slight increase in triglycerides. These results suggest that while intermittent fasting has benefits for BMI, its impact on the lipid profile may be variable.

Keywords: intermittent fasting; caloric restriction; university students; total cholesterol and triglycerides; BMI

Resumen

El ayuno intermitente ha emergido como una estrategia prometedora para la reducción de peso y la mejora del perfil lipídico. Este estudio transversal descriptivo tiene como objetivo analizar los efectos del protocolo de ayuno intermitente 16/8 combinado con restricción calórica sobre los niveles de colesterol total, triglicéridos y el índice de masa corporal (IMC) en estudiantes universitarios. Se reclutaron 20 participantes (18-22 años) sin enfermedades crónicas, con un IMC entre 23.6 y 43.4 kg/m². Los participantes fueron asignados a dos grupos: uno experimental (ayuno intermitente con restricción calórica del 25%) y otro control (solo dieta hipocalórica). El estudio tuvo una duración de 4 semanas, con mediciones de colesterol, triglicéridos y IMC al inicio y al final, además de la aplicación de cuestionarios para evaluar efectos secundarios. Se encontraron diferencias mínimas en colesterol y triglicéridos entre los grupos, aunque el grupo experimental presentó una reducción significativa en IMC y un leve aumento en triglicéridos. Estos resultados sugieren que, si bien el ayuno intermitente tiene beneficios en el IMC, su impacto en el perfil lipídico puede ser variable.

Palabras clave: ayuno intermitente; restricción calórica; universitarios; colesterol total y triglicéridos; IMC

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Fecha de recepción: 17/junio/2025 | **Fecha de aceptación:** 09/enero/2026 | **Fecha de publicación:** 14/agosto/2026

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INTRODUCTION

Fasting, defined as the voluntary restriction of food intake for a specified period, has historically been associated with religious practices and cultural traditions (Goldibi, 2017). In recent years, intermittent fasting (IF) has gained increasing attention as a strategy for weight loss and as a potential tool for the prevention and management of metabolic diseases (Barbera-Saz, 2020). Several studies have reported short- and medium-term benefits of IF on lipid profiles; however, conclusive evidence regarding its long-term effects remains limited, underscoring the need for further safety research (Antoni, 2017). Despite these limitations, IF has been shown to improve overall health and quality of life, as reflected in reductions in insulin resistance, total body mass, adiposity, and inflammatory markers (Xie, 2022).

Importantly, IF does not appear to adversely affect hematological parameters, including hemoglobin levels and blood cell counts, either before or after intervention. Nevertheless, IF is not suitable for all individuals, and its implementation should be personalized to achieve optimal outcomes and minimize potential risks, particularly among individuals with conditions such as diabetes (Santana-Choez, 2021).

The principal value of IF lies in its capacity to reduce body mass index (BMI), as well as glucose, cholesterol, triglycerides, and other lipid levels—biomarkers closely associated with the development of chronic diseases (Santana-Choez, 2021). Within

this framework, a four-week community-based intervention trial was conducted to evaluate the effects of IF in university students. This population was selected because surveys indicate that many students engage in prolonged fasting as part of their lifestyle. Combined with diets that are often imbalanced in both macro- and micronutrient composition, this makes them a particularly relevant group for study. Notably, no significant differences were observed between students in health-related fields and those in other disciplines regarding improvements in dietary habits, suggesting that knowledge of nutrition and metabolism is not a determining factor in this context (Baydemir, 2018).

National survey data indicate that the Mexican population has a high prevalence of cardiovascular risk factors, including hypercholesterolemia, which affects 30.4% of individuals and is reflected in abnormal lipid profiles, including total cholesterol and triglycerides (National Health and Nutrition Survey ENSANUT, 2018). Additionally, Mexico faces a high prevalence of overweight and obesity among adolescents, estimated at 24%. Only one in three adolescents regularly consumes fruits and eggs, and only one in four includes vegetables and legumes in their diet. Overall, a higher intake of low-nutritional-quality foods compared to recommended options has been observed. Dyslipidemia also shows a considerable prevalence, reaching 24.7% in the general population and 16.4% among individuals aged 20 to 39 years.

The prevalence of elevated triglyceride levels in adults reaches 47.2%, and the incidence of dyslipidemia has been shown to increase with age (National Health and Nutrition Survey on COVID-19, 2022). Given that habits formed during early life and young adulthood are closely linked to an increased risk of developing cardiovascular diseases, understanding their impact on key biomarkers—such as triglycerides, cholesterol, and other lipids—is essential.

Regular physical activity and dietary modifications are effective interventions for reducing risks associated with obesity, including cardiovascular diseases and dyslipidemias (GM, 2015). Although hypocaloric diets remain the primary treatment for individuals with overweight or obesity, alternative methods and strategies, such as intermittent fasting, have emerged. This approach involves alternating periods of caloric restriction or fasting without necessarily producing a sustained overall caloric deficit (LMT, 2015). IF has been documented not only to promote weight loss but also to improve parameters associated with type 2 diabetes, cardiovascular diseases, and cancer (Santana-Choez, 2021).

In the university context, students often engage in intermittent fasting unintentionally due to demanding academic schedules, particularly those with high academic performance, who frequently neglect proper nutrition. Interestingly, no significant differences have been observed between health sciences students and those in other disciplines regarding improvements in dietary habits, suggesting

that nutritional knowledge does not necessarily translate into healthier dietary practices (Baydemir, 2018).

METHODS, TECHNIQUES, AND INSTRUMENTS

A pilot intervention study with a quasi-experimental design and pre- and post-intervention measurements was conducted using a quantitative approach. The aim was to evaluate the effects of a 16:8 intermittent fasting (IF) regimen combined with caloric restriction on body mass index (BMI), waist circumference, and lipid profile in university students. This design was deemed appropriate given the exploratory nature of the study and the need to assess the feasibility and preliminary effects of the intervention in a young population without diagnosed chronic diseases.

The sample consisted of 20 university students, both men and women, aged 18 to 22 years, recruited through non-probabilistic convenience sampling. Inclusion criteria were a baseline BMI between 23.6 and 43.4 kg/m², absence of chronic disease, no use of medications affecting lipid metabolism, and willingness to adhere to the four-week protocol. Exclusion criteria included a previous diagnosis of diabetes mellitus, eating disorders, pregnancy, or lactation.

Participants were randomly allocated into two groups, both subjected to an equivalent caloric restriction (25% of total daily energy requirements): (a) an intervention group that followed a 16:8 intermittent fasting protocol, with an eating window from 12:00 to 20:00;

(b) a control group that maintained a continuous hypocaloric diet without fasting periods.

The intervention period lasted four weeks. Anthropometric and biochemical measurements were obtained at baseline and at the end of the study. BMI was calculated from weight and height measured using calibrated instruments, and waist circumference was determined using a flexible measuring tape at the midpoint between the lower costal margin and the iliac crest. Biochemical analyses of total cholesterol and triglycerides were conducted using fasting venous blood samples processed in a certified clinical laboratory.

Additionally, a structured questionnaire on adverse effects was administered to document symptoms associated with the intervention, including headache, fatigue, halitosis, and difficulty concentrating, in order to assess protocol tolerability.

Statistical analysis was performed using descriptive statistics, including means, standard deviations, and percentages. Within-group comparisons of pre- and post-intervention measurements were conducted using Student's paired t-test, whereas between-group comparisons were performed using the independent samples Student's t-test. A statistical significance level of $p < 0.05$ was established. Given the small sample size, findings were interpreted with caution, acknowledging the pilot nature of the study.

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

participants provided informed consent prior to inclusion, and data confidentiality and ethical standards were strictly maintained.

RESULTS AND DISCUSSION

Participants in the intervention group exhibited a significant reduction in body mass index (BMI), with a 51% improvement compared to the control group (51% vs 49%). Notably, all individuals in the intervention group experienced weight loss, ranging from 1 to 5.5 kg (Table 1).

Table 1. Comparison of BMI (kg/m^2) Before and After the Intervention

Group	N	Initial mean	Initial SD	Final mean	Final SD	Mean difference	p-value
Intervention	10	29.07	4.58	28.9	4.02	-0.17	0.040*
Control	10	30.9	4.17	29.9	4.47	-1.0	0.382

Source: Authors' own elaboration, 2024

Data analysis revealed a marked reduction in waist circumference in both groups, with the intervention group demonstrating greater benefit. Specifically, this group exhibited a 56% reduction, compared to a 44% decrease in the control group. The absolute reduction ranged from 2 to 4 cm (Table 2).

Table 2. Comparison of Waist Circumference (cm) Before and After the Intervention

Group	N	Initial Mean	Initial SD (Std. Dev.)	Final Mean	Final SD (Std. Dev.)	Mean Difference	p-value
Intervention	10	102.2	8.5	98.0	7.9	-4.2	0.021*
Control	10	101.5	7.6	99.8	8.0	-1.7	0.120

Source: Own elaboration, 2024.

Statistical analysis using the independent samples Student's t-test demonstrated a significant reduction in waist circumference in the intervention group ($p = 0.021$), whereas the control group did not exhibit a statistically significant decrease ($p = 0.120$). This

finding further supports the evidence that intermittent fasting may be particularly effective in reducing visceral adiposity, which is closely associated with an increased risk of metabolic and cardiovascular diseases.

Regarding total cholesterol levels, a modest reduction was observed in both groups, with the intervention group demonstrating a statistically significant difference in mean values ($p = 0.041$). However, some participants with higher baseline BMI exhibited isolated increases in cholesterol levels, which may be explained by enhanced mobilization of fatty acids and redistribution of lipid metabolism during fasting periods, as suggested in previous studies (Krauss et al., 2010) (Table 3).

Table 3. Comparison of Total Cholesterol Levels (mg/dL) Before and After the Intervention

Group	N	Initial Mean	Initial SD (Std. Dev.)	Final Mean	Final SD (Std. Dev.)	Mean Difference	p-value
Intervention	10	102.2	8.5	98.0	7.9	-4.2	0.021*
Control	10	101.5	7.6	99.8	8.0	-1.7	0.120

Source: Own elaboration, 2024.

With respect to triglyceride levels, a moderate increase was observed in the intervention group, contrary to expectations. This finding may be associated with the mobilization of fatty acids during prolonged periods of caloric restriction and fasting, potentially leading to a transient rise in circulating triglyceride concentrations, as suggested by previous studies (Furman et al., 2019; Navea-Cuadra et al., 2022). This phenomenon underscores the importance of comprehensive lipid profile monitoring and highlights the need to consider

intervention duration when evaluating long-term trends (Table 4).

Table 4. Comparison of Triglyceride Levels (mg/dL) Before and After the Intervention

Group	N	Initial mean	Initial SD	Final mean	Final SD	Mean difference	p-value
Intervention	10	93.1	22.3	105.3	15.4	+12.2	0.032*
Control	10	106.3	21.3	106.4	22.4	+0.1	0.544

Source: Own elaboration, 2024.

The findings of this study suggest that 16:8 intermittent fasting combined with caloric restriction may constitute an effective strategy for reducing body mass index (BMI) and waist circumference in university students with overweight or obesity. However, the impact of this intervention on total cholesterol and triglyceride levels was less consistent. Although modest reductions in total cholesterol were observed, an increase in triglyceride levels was also identified within the intervention group. These results indicate that intermittent fasting exerts a variable effect on the lipid profile, underscoring the need for continuous monitoring during prolonged interventions.

These findings are consistent with previous studies (Catenacci et al., 2016; Jensen et al., 2014), which have demonstrated that intermittent fasting can be an effective approach for weight loss and reduction of abdominal adiposity, particularly when combined with caloric restriction. In the present study, the reduction in BMI within the intervention group reached statistical significance ($p < 0.05$), whereas the decrease in the control group was smaller and not statistically significant. This suggests that intermittent

fasting may potentiate the effects of caloric restriction on BMI, although outcomes may vary depending on individual characteristics and intervention design.

With regard to total cholesterol levels, a modest decrease was observed in both groups; however, the mean difference reached statistical significance only in the intervention group. It is noteworthy that some participants with higher baseline BMI exhibited transient increases in cholesterol levels. This phenomenon may be explained by enhanced mobilization of fatty acids and the redistribution of lipid metabolism during fasting periods (Krauss et al., 2010). Such responses have been documented in the literature, suggesting that metabolic adaptations to intermittent fasting may depend on baseline body composition and individual energy balance.

In relation to triglyceride levels, a moderate increase was observed in the intervention group, contrasting with prior evidence. This finding may be attributed to the release of fatty acids during prolonged periods of caloric restriction and fasting, potentially leading to a transient elevation in circulating triglyceride concentrations. This mechanism has been described in studies such as those by Furman et al. (2019) and Navea-Cuadra et al. (2022) and highlights the importance of comprehensive lipid monitoring, as well as the consideration of intervention duration when evaluating longer-term effects.

Regarding waist circumference, the significant reduction observed in the intervention group

represents a clinically relevant outcome, given the strong association between visceral adiposity and the risk of metabolic and cardiovascular diseases (Després, 2012). The magnitude of reduction aligns with previous evidence supporting the role of intermittent fasting in decreasing abdominal fat, although this effect may be influenced by adherence to the protocol and individual metabolic variability.

Finally, it is important to note that approximately half of the participants reported mild adverse effects, including headache, fatigue, halitosis, and difficulty concentrating. These symptoms may affect adherence and long-term sustainability of intermittent fasting regimens. Similar findings have been reported by Santana-Choez et al. (2021), who emphasize the importance of tailoring intermittent fasting protocols to maximize benefits while minimizing potential risks.

Overall, the results of this pilot trial reinforce the evidence that intermittent fasting may offer additional benefits in reducing body weight and waist circumference when combined with caloric restriction. Nevertheless, they also highlight the necessity for larger-scale and longer-duration studies to evaluate its sustained effects on lipid profile and overall metabolic health.

CONCLUSIONS

The findings of this pilot study suggest that a 16:8 intermittent fasting regimen combined with moderate caloric restriction may contribute more effectively to reductions in body mass index (BMI)

and waist circumference in university students with overweight or obesity, compared with a hypocaloric diet alone.

However, the observed effects on total cholesterol and triglyceride levels were heterogeneous. In some cases, a transient increase in triglycerides was identified, likely associated with enhanced fatty acid mobilization during fasting periods. Additionally, mild adverse symptoms were reported, which may compromise long-term adherence to the intervention protocol.

These findings underscore the importance of considering metabolic individual variability and ensuring professional supervision when implementing intermittent fasting strategies. Furthermore, they highlight the need for larger-scale studies with extended follow-up periods to robustly assess the impact of such interventions on lipid profiles and the long-term sustainability of their metabolic effects.

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Knowledge and use of contraceptive methods among university students at public universities

Conocimiento y uso de métodos anticonceptivos en estudiantes universitarios en universidad pública

Amilcar Jesús Huerta Esquivel, Ian Yael Contreras Hernández, Cecilia Estefanía Hernández
Martínez*

Abstract

Adequate knowledge about contraceptive methods is fundamental for preventing sexually transmitted infections and unplanned pregnancies, particularly among university students. The objective of this study was to analyze the level of knowledge about the use and effectiveness of contraceptive methods among students from different faculties of the Autonomous University of Tamaulipas, as well as to evaluate its relationship with their academic area of study. A quantitative, observational, cross-sectional study was conducted with 365 students from the faculties of Medicine, Nursing, and Engineering. Data collection was carried out using a questionnaire adapted from the Contraception Module of the National Survey of Demographic Dynamics, which included sociodemographic variables and an instrument for assessing contraceptive knowledge. Statistical analysis was performed using descriptive statistics and Pearson's chi-squared test. The results showed that a considerable proportion of the students had an insufficient level of knowledge, with statistically significant differences observed among the faculties, and better results in health-related fields. It is concluded that the level of knowledge about contraceptive methods in the university population studied is limited and is associated with academic training, which highlights the need to strengthen comprehensive sexual education strategies in the university setting.

Keywords: contraceptive knowledge; university students; sex education; sexually transmitted infections; reproductive health

Resumen

El conocimiento adecuado sobre los métodos anticonceptivos constituye un elemento fundamental para la prevención de infecciones de transmisión sexual y embarazos no planificados, particularmente en población universitaria. El objetivo del presente estudio fue analizar el nivel de conocimiento sobre el uso y la funcionalidad de los métodos anticonceptivos en estudiantes de distintas facultades de la Universidad Autónoma de Tamaulipas, así como evaluar su relación con el área académica de adscripción. Se realizó un estudio cuantitativo, observacional y de corte transversal, en el que participaron 365 estudiantes de las facultades de Medicina, Enfermería e Ingeniería. La recolección de datos se efectuó mediante un cuestionario adaptado del Módulo de Anticoncepción de la Encuesta Nacional de la Dinámica Demográfica, el cual incluyó variables sociodemográficas y un instrumento de evaluación del conocimiento anticonceptivo. El análisis estadístico se llevó a cabo mediante estadística descriptiva y la prueba de Chi-cuadrada de Pearson. Los resultados evidenciaron que una proporción considerable de los estudiantes presentó un nivel de conocimiento insuficiente, observándose diferencias estadísticamente significativas entre las facultades, con mejores resultados en las áreas relacionadas con la salud. Se concluye que el nivel de conocimiento sobre métodos anticonceptivos en la población universitaria estudiada es limitado y se asocia con la formación académica, lo que resalta la necesidad de fortalecer estrategias de educación sexual integral en el ámbito universitario.

Palabras clave: conocimiento anticonceptivo; estudiantes universitarios; educación sexual; infecciones de transmisión sexual; salud reproductiva

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Fecha de recepción: 17/junio/2025 | **Fecha de aceptación:** 27/febrero/2026 | **Fecha de publicación:** 14/agosto/2026

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INTRODUCTION

Sexual and reproductive health among adolescents and young adults represents a major challenge for contemporary public health, particularly in light of the sustained increase in sexually transmitted infections (STIs), including the human immunodeficiency virus (HIV), as well as the persistent prevalence of unintended pregnancies within this population. Recent reports from international organizations indicate that, following a period of stabilization, a resurgence of preventable STIs has been observed since 2021, associated with unprotected sexual practices, inconsistent use of contraceptive methods, and deficiencies in comprehensive sexual education—especially among individuals aged 18 to 29 years (World Health Organization [WHO], 2023, 2024; Centers for Disease Control and Prevention [CDC], 2023).

Global evidence consistently underscores that access to effective contraceptive methods and adequate knowledge of their use are essential strategies for preventing both STIs and unintended pregnancies. However, these benefits depend largely on the population's level of sexual and reproductive health literacy. Recent studies have shown that self-reported knowledge of contraception does not necessarily translate into correct practices, due to factors such as incomplete information, persistent myths, misperception of risk, and structural educational barriers (Darroch et al., 2020; Kågesten et al., 2021). Within the university context, these challenges acquire particular relevance, as the transition into adulthood is often accompanied by increased

personal autonomy, evolving social dynamics, and heightened sexual activity. Research conducted among university populations in Latin America has documented significant gaps between perceived and actual knowledge of contraceptive methods, as well as risk-related sexual behaviors linked to deficiencies in formal sexual education (De Melo et al., 2022; Gutiérrez-Alvarado et al., 2021). These discrepancies persist even in settings where students report having previously received sexual health information during their earlier education.

Scientific evidence suggests that academic training directly influences levels of knowledge in sexual and reproductive health. Comparative studies indicate that students enrolled in health-related disciplines tend to demonstrate higher levels of technical knowledge regarding contraception than their peers in non-health fields. Nevertheless, such knowledge levels are not always sufficient to ensure safe sexual practices (Pérez-Campos et al., 2022; Kirby et al., 2021). This scenario raises concerns about the effectiveness of traditional sexual education approaches, even within academic programs linked to the health sciences.

In Mexico, recent national data confirm the persistence of these challenges. The National Survey of Demographic Dynamics reports that, although a high proportion of young people claim awareness of contraceptive methods, there remains considerable lack of knowledge regarding their correct use, actual effectiveness, and protection against STIs (National Institute of Statistics and Geography [INEGI], 2023).

Concurrently, national health reports indicate a sustained increase in HIV incidence among young populations, reinforcing the urgency of strengthening evidence-based preventive strategies (National Institute of Public Health [INSP], 2022).

From an international perspective, organizations such as the Pan American Health Organization emphasize the need to implement comprehensive, continuous, and culturally appropriate educational interventions aimed at improving knowledge and informed decision-making in sexual health, particularly within higher education settings (Pan American Health Organization [PAHO], 2022). These recommendations align with systematic reviews highlighting the effectiveness of comprehensive educational programs compared with restrictive or exclusively information-based approaches (Santelli et al., 2017; Cleland et al., 2020).

In this context, it is essential to generate empirical evidence to assess the level of knowledge regarding the use and functionality of contraceptive methods among university students and to analyze its association with academic field of study. Such analyses enable the identification of groups with greater informational vulnerability and provide valuable insights for the design of more effective, interdisciplinary, and prevention-oriented sexual education programs in university settings.

Therefore, the aim of the present study is to analyze the level of knowledge regarding the use and functionality of contraceptive methods among

students from different faculties at the Autonomous University of Tamaulipas, as well as to explore its relationship with academic training, in order to contribute to the strengthening of institutional strategies for the promotion of sexual and reproductive health in university populations.

METHODS, TECHNIQUES, AND INSTRUMENTS

A quantitative, observational, analytical, cross-sectional study was conducted to assess the level of knowledge regarding the use and functionality of contraceptive methods among university students and to examine its association with their academic field of study. The research was carried out between August and December 2024 at the Autonomous University of Tamaulipas, Tampico campus.

The study population comprised approximately 3,800 students enrolled in the Faculties of Medicine, Nursing, and Engineering. The sample size was calculated using the finite population formula, assuming a 95% confidence level, a 5% margin of error, and an expected proportion of 50%, a conservative criterion applied in the absence of prior estimates for the variable of interest. Based on these parameters, a minimum sample size of 350 participants was obtained; however, the final sample included 365 students. An approximately equal distribution across the three faculties was ensured to facilitate inter-group comparisons. A non-probability convenience sampling approach was employed, contingent upon participant availability and voluntary consent.

Eligibility criteria included students of any sex aged 17 years or older who were actively enrolled in any semester within the participating faculties and who provided informed consent. Exclusion criteria comprised students from other faculties, individuals who declined to participate, and those who did not complete the questionnaire in full.

Data collection was performed **באמצעות** a structured questionnaire adapted from the Contraception Module of the National Survey of Demographic Dynamics (ENADID 2018), modified for use in a mixed-sex university population. The instrument consisted of 24 items organized into two sections. The first section included sociodemographic variables—age, sex, faculty affiliation, and semester—as well as questions addressing contraceptive use and preference and self-perceived level of knowledge. The second section comprised 14 multiple-choice items designed to assess objective knowledge regarding correct use, indications, and effectiveness of various contraceptive methods.

Each correct response was assigned one point, yielding a maximum possible score of 14. For analytical purposes, a threshold of at least 60% correct responses was established to define a passing score. Participants were accordingly categorized as “pass” or “fail.” This criterion was used exclusively for comparative analyses across faculties.

The questionnaire was administered in person within university facilities, ensuring the anonymity and confidentiality of all participants. Prior to

administration, participants were informed about the study objectives, the voluntary nature of their participation, and the academic use of the collected data.

Statistical analysis was performed using Microsoft Excel and IBM SPSS version 30.0. Descriptive analyses were initially conducted using absolute and relative frequencies to characterize the study population, contraceptive use, and levels of knowledge. Subsequently, the association between contraceptive knowledge level (pass/fail) and faculty affiliation was evaluated using Pearson’s chi-square test, appropriate for categorical variables. A statistical significance level of $\alpha = 0.05$ was established. The null hypothesis posited no significant differences in knowledge levels between faculties, whereas the alternative hypothesis proposed a statistically significant association between these variables.

The study adhered to fundamental ethical principles governing research involving human participants, ensuring confidentiality, anonymity, and voluntary participation. No personally identifiable information was collected, and all data were used exclusively for academic and scientific purposes.

RESULTS AND DISCUSSION

A total of 365 university students from the Faculties of Medicine, Nursing, and Engineering at the Autonomous University of Tamaulipas participated in the study. The sex distribution indicated a higher proportion of female participants, accounting for

57% (n = 208), compared with 43% (n = 157) male students.

Regarding age, the most represented group was 20 to 22 years, comprising 49% of the total sample (n = 179), followed by the 17–19 age group and those older than 23 years. These demographic characteristics are presented in detail in Table 1.

In terms of contraceptive use, the condom was the most frequently reported method, used by 57.81% of students (n = 211). However, a considerable proportion of participants, corresponding to 26.30% (n = 96), reported not using any contraceptive method. Other methods included oral contraceptive pills (6.03%, n = 22), natural methods (4.38%, n = 16), subdermal implants (2.19%, n = 8), injectable contraceptives (1.92%, n = 7), intrauterine devices (1.10%, n = 4), and contraceptive patches (0.27%, n = 1).

Table 1. *Tabla 1. Características demográficas de la población estudiada (n*

Variable	Category	n	%
Gender	Female	208	57.0
	Male	157	43.0
Age (years)	17 - 19	135	37.0
	20 - 22	179	49.0
	>= 23	51	14.0

Regarding sources of information on contraceptive methods, formal education (primary, secondary, or high school) was identified as the main source by 71.23% of participants (n = 260), followed by the internet (18.9%, n = 69), family members (5.5%, n =

20), and friends (4.4%, n = 16). Analysis of knowledge levels revealed that only 34% of students achieved a passing score (n = 123), whereas 66% failed the assessment (n = 242). When these results were stratified by faculty, notable differences emerged, as detailed in Table 2.

Table 2. *Level of knowledge about contraceptive methods by faculty*

Faculty	Passed n (%)	Failed n (%)	Total
Medicine	59 (50.0)	60 (50.0)	119
Nursing	53 (42.4)	72 (57.6)	125
Engineering	12 (9.9)	109 (90.1)	121

The findings indicate that students from the Faculty of Medicine achieved the highest proportion of passing scores, followed by those from Nursing, whereas the Faculty of Engineering accounted for the largest proportion of students with failing grades.

To examine the association between faculty affiliation and level of knowledge regarding contraceptive methods, Pearson's chi-square test was applied. The calculated χ^2 value was 48.094 with 2 degrees of freedom, exceeding the critical value of 5.991 at a significance level of $p < 0.05$. These results demonstrate a statistically significant association between the variables; therefore, the null hypothesis was rejected.

The findings of the present study indicate that the level of knowledge regarding contraceptive methods among university students was predominantly low, despite the fact that most participants reported

having a moderate to high level of prior knowledge before the administration of the instrument. This discrepancy between subjective perception and objective knowledge is consistent with findings from recent studies conducted in university populations, which have documented a tendency to overestimate personal knowledge in matters related to sexual and reproductive health (De Melo et al., 2022; Pérez-Campos et al., 2022).

The observation that students enrolled in health-related programs achieved better results than those in non-health disciplines aligns with contemporary research indicating that academic training exerts a direct influence on sexual health literacy.

Recent studies conducted in Latin American universities suggest that curricula in Medicine and Nursing, which systematically address topics such as sexuality, STI prevention, and family planning, contribute to higher levels of technical knowledge compared with programs unrelated to the health sciences (Long et al., 2023).

Nevertheless, it is important to emphasize that even among students in health-related fields, the proportion achieving passing scores remained limited. This finding is consistent with national reports highlighting deficiencies in the depth and continuity of formal sexual education, even within health-related academic programs (Sánchez-Meneses et al., 2021; INEGI, 2023). This issue becomes particularly relevant in light of the recent increase in HIV cases and other sexually transmitted infections

among young populations, as reported both in Mexico and internationally (WHO, 2023; CENSIDA, 2024).

The predominance of condom use as the primary contraceptive method is consistent with findings from national surveys and recent university-based studies. However, the substantial proportion of students who reported not using any contraceptive method represents a matter of concern. Current research has linked this behavior to low risk perception, inconsistent use of protective methods, and deficiencies in comprehensive sexual education—factors that increase vulnerability to sexually transmitted infections and unintended pregnancies (WHO, 2024).

Moreover, the fact that formal schooling was identified as the primary source of information, despite the majority of students failing the assessment, suggests that prior educational programs have not succeeded in fostering meaningful and sustained learning. This finding is in line with recent studies that question the effectiveness of traditional sexual education models, emphasizing the need for more participatory, updated, and context-specific pedagogical strategies tailored to the realities of university populations (Gutiérrez-Alvarado et al., 2021).

Among the main limitations of this study are the use of non-probability sampling and the focus on a single institution, which restrict the generalizability of the findings. Nevertheless, the results provide relevant

evidence to inform the design of educational interventions aimed at strengthening contraceptive knowledge among university students, particularly in disciplines not related to the health sciences.

CONCLUSIONS

The present study demonstrated that the level of knowledge regarding the use and functionality of contraceptive methods among university students is insufficient, despite a widespread perception of having adequate information on the subject. This gap between perceived and actual knowledge constitutes a relevant risk factor for sexual and reproductive health within the university population, particularly in a context marked by the recent increase in sexually transmitted infections and the persistent occurrence of unintended pregnancies among young individuals.

Comparative analysis revealed that academic training is significantly associated with contraceptive knowledge levels, with better performance observed among students enrolled in health-related disciplines. However, the findings suggest that enrollment in a health sciences program alone does not ensure sufficient mastery of the topic, highlighting the need to reassess the depth, continuity, and pedagogical approach used to address sexual health content within university curricula.

Furthermore, the identification of formal schooling as the primary source of information—without corresponding adequate knowledge levels—points to structural limitations in traditional sexual education models. This finding underscores the importance of

transitioning toward more comprehensive, updated, and evidence-based educational strategies that promote not only knowledge acquisition but also the development of skills for informed and responsible decision-making.

From an institutional perspective, the results provide relevant insights for the design of intervention programs aimed at strengthening sexual education in university settings, with particular emphasis on students from non-health-related fields. The incorporation of interdisciplinary and preventive approaches could substantially contribute to reducing risky sexual behaviors and improving sexual and reproductive health outcomes in this population.

Finally, although the findings offer valuable evidence, they should be interpreted in light of the study's methodological limitations, particularly the use of non-probability sampling and its restriction to a single institution. In this regard, future research should consider including a broader range of institutions and employing methodological designs that allow for greater generalizability, as well as longitudinal evaluation of the impact of educational interventions on knowledge and use of contraceptive methods.

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Impact of the COVID-19 pandemic on the business management

Engineering Program at ITSP: a case study

Impacto de la pandemia de COVID-19 en Ingeniería en Gestión Empresarial del ITSP: estudio de caso

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Bermúdez, Marina del Carmen Requena Adatao*

Abstract

This study assessed the impact of COVID-19 on the professional training of eighth-semester students enrolled in the Business Management Engineering program at the Instituto Tecnológico Superior de (ITSP). A quantitative, cross-sectional design was employed, using an online questionnaire comprising 21 Likert-scale items, which demonstrated high reliability (Cronbach's $\alpha = 0.916$). The findings revealed mean scores of 3.59 for technological adaptation and digital competencies, 3.58 for satisfaction with academic training, 3.54 for experiences with online learning modalities, and 3.38 for perceived impact on professional development. Key strengths identified included faculty proficiency in virtual platforms, the quality of feedback provided, enhancement of digital skills, and the development of student resilience. Conversely, several areas for improvement were observed, including a decline in academic performance, limited effectiveness of collaborative work, insufficient institutional technological support, and reduced opportunities for professional internships. Overall, distance education mitigated academic disruption and contributed to the strengthening of digital and self-regulation competencies; however, it did not fully replace the practical training required for professional practice.

Keywords: COVID-19; higher education; professional training; Business Management Engineering; digital competencies; online learning

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Fecha de recepción: 19/enero/2026 | **Fecha de aceptación:** 22/mayo/2026 | **Fecha de publicación:** 14/agosto/2026

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Resumen

El presente estudio analiza el impacto del COVID-19 en la formación profesional de estudiantes de octavo semestre de Ingeniería en Gestión Empresarial del ITSP. Se utilizó un enfoque cuantitativo de corte transversal, mediante la aplicación de un cuestionario en línea de 21 ítems con escala Likert, el cual presentó alta fiabilidad ($\alpha = 0.916$). Los resultados evidencian promedios de 3.59 en adaptación tecnológica y competencias digitales, 3.58 en satisfacción con la formación, 3.54 en experiencias con la modalidad en línea y 3.38 en impacto en el desarrollo profesional. Se identifican como principales fortalezas el dominio docente de plataformas virtuales, la calidad de la retroalimentación, el fortalecimiento de competencias digitales y el desarrollo de la resiliencia estudiantil. En contraste, se observan áreas de oportunidad relacionadas con la disminución del rendimiento académico, la limitada eficiencia del trabajo colaborativo, el escaso apoyo tecnológico institucional y la reducción de oportunidades para prácticas profesionales. Se concluye que la educación a distancia permitió mitigar la interrupción académica y fortalecer competencias digitales y de autorregulación; sin embargo, no sustituyó plenamente la formación práctica requerida en el ámbito profesional.

Palabras clave: COVID-19; educación superior; formación profesional; Ingeniería en Gestión Empresarial; competencias digitales; aprendizaje en línea



INTRODUCTION

The COVID-19 pandemic has caused an unprecedented disruption to educational systems worldwide, affecting more than 1.6 billion students across over 190 countries and leading to the widespread closure of educational institutions (UNESCO, 2021). This contingency forced a rapid shift in teaching-learning processes toward digital environments, giving rise to what has been termed emergency remote teaching, characterized by its rapid implementation and limited pedagogical planning (Hodges et al., 2020; Bond et al., 2021).

In this context, most countries adopted multimodal approaches that combined digital platforms, printed materials, and traditional communication media, thereby highlighting both institutional adaptability and existing inequalities in access to education (UNESCO, 2022; Norman et al., 2022).

In Mexico, distance education already had antecedents in open and virtual modalities; however, its development had progressed gradually prior to the pandemic (García-Peñalvo, 2021). The health crisis significantly accelerated digital transformation in higher education, compelling institutions to reconfigure their educational models, requiring faculty to develop new technological competencies, and prompting students to adopt a more autonomous role in their learning processes (Ordorika, 2020; Sánchez-Mendiola et al., 2021). This shift entailed not only technological challenges but also pedagogical, organizational, and socio-emotional ones.

Recent studies consistently indicate that the transition to online education exposed significant digital divides, limitations in access to technological resources, and difficulties in adapting to new learning dynamics (OECD, 2021; Egger & Huber, 2022). Moreover, confinement has been associated with adverse effects on students' emotional well-being, including heightened levels of stress, anxiety, and demotivation, which in turn have negatively impacted academic performance and engagement (Son et al., 2020; Aristovnik et al., 2020; UNESCO, 2021).

Within the domain of professional training, the effects of the pandemic have been particularly significant due to the need to integrate practical experiences, collaborative work, and engagement with real-world contexts. In this regard, recent research suggests that while online education has fostered the development of digital competencies and self-regulated learning, it has also constrained the acquisition of practical and socio-emotional skills that are essential for labor market integration (Bond et al., 2021; Rapanta et al., 2020; Skrbinjek et al., 2024). Furthermore, the reduction in opportunities for internships and enterprise-based projects has generated uncertainty regarding students' professional development (ILO, 2021; OECD, 2021).

Industrial Engineering in Business Management, as a discipline focused on organizational processes, strategic decision-making, and innovation, requires comprehensive training that integrates theoretical

knowledge with practical and collaborative experiences. In this sense, the transition to virtual environments posed a substantial challenge, as it hindered direct interaction, teamwork, and the application of knowledge in real-world settings—elements that are critical for the development of professional competencies (García-Peñalvo, 2021).

Within the institutional context of the Instituto Tecnológico Superior de Pánuco (ITSP), part of the Tecnológico Nacional de México, these challenges were particularly evident among students enrolled in Industrial Engineering in Business Management, especially those in their final semesters. These students were at a critical stage of their professional training, where the limited opportunities for in-person practice and the need to adapt to new educational conditions influenced their perceptions regarding the quality of their academic preparation and their future employability.

Against this backdrop, the present study aims to analyze the impact of the COVID-19 pandemic on the professional training of eighth-semester students in Industrial Engineering in Business Management at ITSP, identifying both the limitations and opportunities arising from the implementation of distance education. This analysis seeks to provide empirical evidence to better understand the effects of pandemic-driven educational transformation and to inform institutional strategies aimed at strengthening the quality of professional training in contexts of uncertainty.

METHODS, TECHNIQUES, AND INSTRUMENTS

This study followed a quantitative approach employing a non-experimental, descriptive, cross-sectional design. Data collection was conducted through a combination of documentary review of specialized literature and fieldwork using a structured questionnaire. Given that the study focused on a single academic program—Industrial Engineering in Business Management—and a specific population of eighth-semester students ($n = 17$), it was methodologically framed as an institutional case study. This approach enabled an in-depth analysis of the effects of the pandemic within a particular educational context, without aiming for statistical generalization to other populations or institutions.

The data collection instrument consisted of an online questionnaire developed using Google Forms, the access link of which was distributed to all students enrolled in the eighth semester of the formal education system. A total of 17 out of 18 students participated, corresponding to a 94% response rate of the target population. The questionnaire comprised 21 items organized into four analytical dimensions: (I) experiences with online learning, (II) level of satisfaction with training, (III) technological adaptation and digital competencies, and (IV) impact on professional development and future perspectives.

Variables were measured using a five-point Likert scale (1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree),

allowing for the standardized quantification of participants' perceptions. Instrument reliability was assessed using Cronbach's alpha coefficient, yielding a value of $\alpha = 0.916$, indicating a high level of internal consistency.

Dimension I, Experiences with Online Learning, consisted of six items designed to examine students' perceptions of the transition to virtual education, including aspects such as motivation, academic performance, instructional adaptation, proficiency in digital tools, academic communication, and the balance of personal responsibilities.

Dimension II, Level of Satisfaction with Training, included five items assessing perceived quality of the educational process during the pandemic, considering factors such as overall satisfaction with teaching, development of competencies, appropriateness of assessment methods, quality of feedback, and effectiveness of collaborative work.

Dimension III, Technological Adaptation and Digital Competencies, comprised four items aimed at evaluating the development of students' technological skills, including the use of virtual platforms, familiarity with digital tools, access to institutional technological support, and the facilitation of collaborative work through digital resources.

Finally, Dimension IV, Impact on Professional Development and Future Perspectives, consisted of six items intended to assess the influence of the

pandemic on professional training, particularly in relation to internship opportunities, acquisition of professional competencies, development of resilience, preparedness for the labor market, limitations in experiential learning, and the impact on soft skills development.

RESULTS AND DISCUSSION

Figure 1, entitled "Mean Scores by Section," indicates that the highest average score was observed in Section III, Technological Adaptation and Digital Competencies ($M = 3.59$), followed closely by Section II, Level of Satisfaction with Training ($M = 3.58$), and Section I, Experiences with Online Learning ($M = 3.54$). In contrast, the lowest mean corresponded to Section IV, Impact on Professional Development and Future Perspectives ($M = 3.38$).

Overall, the findings revealed a relatively homogeneous distribution of student perceptions, with a maximum variation of 0.21 points across dimensions, suggesting a moderate and consistent evaluation of the educational process during the study period. However, within this apparent uniformity, distinct patterns emerged. On the one hand, technological adaptation processes and the development of digital competencies were identified as key strengths. On the other hand, a relative lag was observed in components associated with professional development, particularly those related to the practical application of knowledge. From the students' perspective, this limitation may have implications for their preparedness for labor market

entry and their expectations regarding future professional performance..

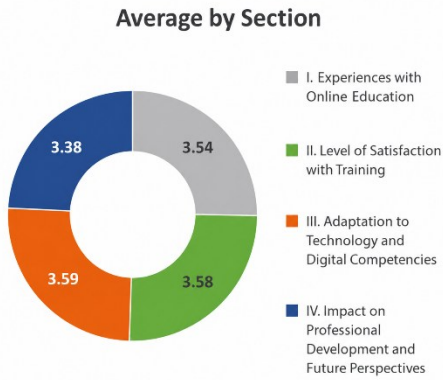


Figure 1. Survey results by section

Figure 2 provides a more detailed examination of item-level performance, allowing for the identification of both the highest- and lowest-rated indicators within each dimension. Regarding the most highly rated items, within Section I, the statement related to instructors' proficiency in virtual platforms and digital tools (Item 4; $M = 4.06$) stood out, suggesting a favorable perception of faculty technological competencies. In Section II, the highest score was observed for Item 10 ($M = 3.82$), associated with the timeliness and usefulness of instructor feedback, highlighting the importance of pedagogical interaction in virtual learning environments.

In Section III, Item 12 ($M = 3.94$) confirmed the strengthening of digital skills during the pandemic period, while in Section IV, Item 18 ($M = 3.94$) emphasized the development of resilience and adaptability as positive outcomes derived from the contingency context.

In contrast, the lowest-rated items revealed critical areas within the educational process. In Section I, Item 2 ($M = 3.24$) reflected a perceived negative impact on academic performance; in Section II, Item 11 ($M = 3.18$) pointed to limitations in the effectiveness of collaborative work; in Section III, Item 14 ($M = 3.31$) suggested a moderate level of satisfaction with institutional technological support; and most notably, in Section IV, Item 16 ($M = 2.76$) highlighted a pronounced perception of reduced opportunities for internships and project-based learning, constituting the primary factor of impact within the professional development dimension.

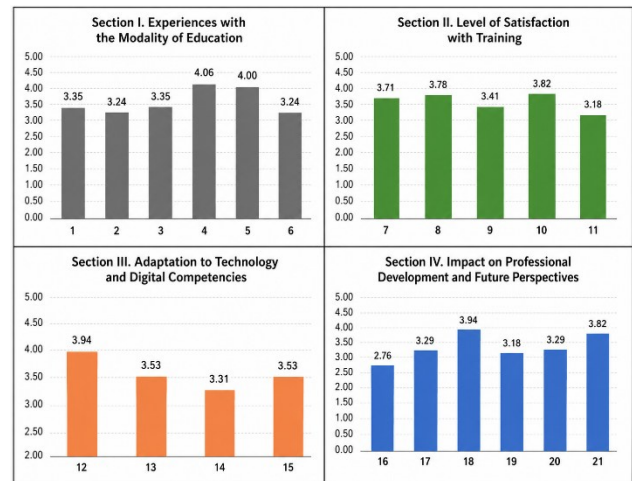


Figure 2. Survey results by section and item

The findings should be interpreted in light of certain methodological limitations. First, the study was restricted to a small sample ($n = 17$), drawn from a single academic program and one institution, which constrains external validity and limits the generalizability of the results to other educational contexts. Second, the cross-sectional design precluded the analysis of temporal changes in the variables examined, particularly with regard to the

development of competencies and the labor market integration of graduates.

Despite these limitations, the high response rate (94% of the target population) and the strong internal consistency of the instrument (Cronbach's $\alpha = 0.916$) reinforce the study's internal validity, enabling the generation of robust and contextually relevant empirical evidence for understanding the phenomenon under investigation and informing institutional decision-making.

The empirical findings support the notion that the transition to virtual learning modalities during the COVID-19 pandemic not only ensured continuity of the educational process but also significantly strengthened students' digital competencies. This is reflected in the highest mean score obtained by the dimension of technological adaptation and digital competencies ($M = 3.59$), as well as in the elevated rating of the item related to the development of digital skills ($M = 3.94$). These results are consistent with recent literature recognizing emergency remote teaching as a catalyst for the accelerated acquisition of technological skills among both students and higher education faculty (Bond et al., 2021). Similarly, it has been argued that this process contributed to advancing the digital transformation of universities, reshaping patterns of academic interaction and learning environments (García-Peñalvo, 2021).

However, these advancements in the technological domain coexist with substantial limitations in the sphere of professional training. In particular, the lower mean observed in the dimension impact on

professional development and future perspectives ($M = 3.38$), together with the notably low score for the item referring to reduced opportunities for internships and project-based learning ($M = 2.76$), indicates that virtual instruction was unable to fully substitute the practical experiences required in students' professional formation.

This finding aligns with recent studies documenting how lockdown measures significantly restricted access to professional and workplace experiences, thereby generating uncertainty regarding students' future career development (Egger & Huber, 2022). Likewise, the reduction of hands-on learning opportunities and the limited ability to apply theoretical knowledge in real-world contexts have been identified as major concerns among university students during the pandemic (Aristovnik et al., 2020).

Regarding the perceived quality of the educational process, the results indicate a moderately positive evaluation ($M = 3.58$), particularly in aspects related to instructor feedback and proficiency in digital tools. The high score obtained for the item on timely feedback ($M = 3.82$) suggests that pedagogical interaction remained a central element even within virtual learning environments. This observation is consistent with prior research emphasizing the importance of faculty adaptability and effective use of technological resources as key factors in sustaining educational continuity during crisis situations (Pokhrel & Chhetri, 2021).

Moreover, the quality of teacher–student interaction has been identified as a critical determinant of student motivation and academic engagement in non-face-to-face learning settings (Rapanta et al., 2020).

Nevertheless, alongside these positive aspects, several areas for improvement emerge, reflecting underlying structural challenges within the educational process. These include the perceived decline in academic performance, limitations in the effectiveness of collaborative work, and only moderate satisfaction with institutional technological support. These findings are situated within a broader context marked by persistent digital divides and unequal access to technological resources, which have been widely recognized as significant barriers to ensuring equitable educational experiences during the pandemic (Norman et al., 2022). Additionally, the reduction in face-to-face interaction has been associated with adverse effects on the development of socio-emotional and collaborative skills, which are essential components of comprehensive higher education training (UNESCO, 2021).

Finally, one of the most noteworthy findings is the strengthening of students' resilience and adaptive capacity, as reflected in the high rating of the corresponding item ($M = 3.94$). This suggests that, beyond the structural constraints imposed by the pandemic, the context of uncertainty fostered the development of transversal competencies related to self-regulation and the management of complex situations.

This premise aligns with recent studies highlighting the role of the pandemic as a catalyst for the development of adaptive capacities among students, with potentially positive implications for their future professional performance (Skrbinjek et al., 2024).

CONCLUSIONS

The evidence analyzed indicates that the health emergency constituted a turning point in the configuration of educational processes in technological higher education, revealing both the adaptive capacity of the educational system and its structural limitations. In this context, the need to reconceptualize pedagogical models toward more flexible, resilient, and technologically integrated frameworks becomes evident—approaches that move beyond the merely emergency-driven character of virtual instruction.

From a formative perspective, the study confirms the relevance of strategically incorporating digital technologies not only as supportive tools but as structural components of the educational process. However, such integration must be aligned with mechanisms that ensure meaningful engagement with real-world practice environments, thereby preventing fragmentation between theoretical knowledge and its professional application.

At the institutional level, the findings underscore the importance of strengthening technological infrastructure, as well as systems for academic and socio-emotional support, in order to reduce disparities in access, retention, and student

performance. Additionally, the consolidation of pedagogical strategies oriented toward collaborative work in digital environments is highlighted as a key element for comprehensive education.

From a prospective standpoint, the design of hybrid models that effectively balance face-to-face and virtual modalities is identified as a priority. In this regard, the implementation of simulation environments, virtual laboratories, and project-based learning schemes emerges as a viable approach to reinforce the practical dimension of professional training.

Finally, given the contextual nature of the study, there is a recognized need to expand future research toward comparative and longitudinal designs that allow for the assessment of the evolution of professional competencies in post-pandemic scenarios. Such efforts will contribute to the development of more robust empirical foundations for decision-making in educational policy and for the consolidation of training models suited to contexts characterized by high levels of uncertainty.

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Teacher performance and the development of mathematical competencies in sixth-grade primary education

Desempeño docente y desarrollo de competencias matemáticas en sexto grado de educación primaria

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Abstract

The present study aimed to describe the correspondence between classroom teaching performance and the development of mathematical competencies among sixth-grade primary school students. A quantitative, observational, cross-sectional, and descriptive design was employed, involving a non-probabilistic sample of 13 teachers and 395 students from public primary schools in School District 095 in Tampico, Tamaulipas, Mexico. Both variables were assessed using structured observation instruments organized into four-level ordinal scales, aligned with national curricular standards. Data analysis was conducted using descriptive statistics, including frequencies, overall performance levels, and patterns of correspondence. The results indicated that teaching performance was predominantly concentrated at the “good” level, whereas students’ mathematical competencies were mostly classified at the “elementary” level. Although a descriptive trend of correspondence between the two variables was observed, the findings do not allow for the establishment of a statistical association or causal relationship. It is concluded that teaching performance represents a relevant component for understanding the development of mathematical competencies; however, the results should be interpreted with caution due to the methodological limitations of the study.

Keywords: teaching performance; mathematical competencies; primary education; sixth grade; descriptive analysis

Resumen

El presente estudio tuvo como propósito describir la correspondencia entre el desempeño docente en el aula y el desarrollo de competencias matemáticas en estudiantes de sexto grado de educación primaria. Se realizó una investigación cuantitativa, observacional, transversal y descriptiva, con una muestra no probabilística de 13 docentes y 395 estudiantes de escuelas primarias públicas de la Zona Escolar 095 de Tampico, Tamaulipas. Ambas variables fueron evaluadas mediante instrumentos estructurados de observación, organizados en escalas ordinales de cuatro niveles de logro y alineados con referentes curriculares nacionales. El análisis se efectuó mediante estadística descriptiva, considerando frecuencias, niveles globales de desempeño y tendencias de correspondencia. Los resultados mostraron que el desempeño docente se concentró principalmente en el nivel “bueno”, mientras que las competencias matemáticas de los estudiantes se ubicaron mayoritariamente en el nivel “elemental”. Aunque se observó una tendencia descriptiva de correspondencia entre ambas variables, los hallazgos no permiten establecer asociación estadística ni relación causal. Se concluye que el desempeño docente es un componente relevante para comprender el desarrollo de competencias matemáticas; no obstante, los resultados deben interpretarse con cautela por las limitaciones metodológicas del estudio.

Palabras clave: desempeño docente; competencias matemáticas; educación primaria; sexto grado; análisis descriptivo

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Fecha de recepción: 17/agosto/2025 | **Fecha de aceptación:** 06/mayo/2026 | **Fecha de publicación:** 14/agosto/2026

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INTRODUCTION

The development of mathematical competencies in primary education represents one of the major challenges faced by contemporary educational systems, particularly in sixth grade, a stage during which students consolidate foundational learning and acquire the skills necessary to successfully navigate subsequent levels of education. Numerous studies have demonstrated that teaching quality and teacher performance significantly influence student learning outcomes, especially when pedagogical practices promote complex cognitive processes such as mathematical reasoning, argumentation, modeling, and problem-solving (Darling-Hammond et al., 2020; Hattie, 2017).

Within this context, teacher performance has gained increasing prominence in competency-based curricular approaches, which advocate educational practices centered on active learning, student engagement, and the meaningful construction of knowledge. From this perspective, mathematical competencies are understood as the ability to mobilize knowledge, skills, and attitudes to address and solve problems across diverse contexts, extending beyond the mere mechanical application of procedures or algorithms (Niss & Højgaard, 2019; Kilpatrick et al., 2016). Strengthening these competencies is essential not only for students' future academic achievement but also for their effective participation in social and professional life, as evidenced by large-scale international assessments such as the Programme for International Student Assessment (PISA) (OECD, 2019).

Mathematics education has undergone significant transformation over recent decades. Traditional content-centered models have progressively given way to pedagogical approaches that emphasize interaction, reflection, argumentation, and the social construction of knowledge. This shift has redefined the role of teachers, who now function as facilitators and mediators of learning, fostering educational environments that support the development of competencies and higher-order mathematical thinking (Hill et al., 2005; Muijs et al., 2014). In this regard, a growing body of research has documented that factors such as subject-matter expertise, pedagogical content knowledge, and the implementation of appropriate instructional strategies are associated with improved mathematics learning outcomes (Blömeke et al., 2016).

Despite these theoretical and empirical advances, important questions remain regarding how teacher performance manifests within specific educational contexts and how it relates to the development of students' mathematical competencies. Although the international literature has provided substantial evidence on this topic, there remains a limited body of research situated within local primary education settings that can elucidate these dynamics in light of the particular conditions characterizing each educational environment. In the case of School District 095 of primary education, located in Tampico, Tamaulipas, a need has been identified for systematic information that would allow the assessment of teacher performance levels and the

degree of mathematical competency development among sixth-grade students.

The importance of this issue lies in the fact that institutional initiatives aimed at teacher training and professional development are generally based on professional performance standards whose impact on student learning must be documented through contextually grounded empirical evidence. Furthermore, several authors have emphasized that the assessment of both teacher performance and student competencies requires rigorous procedures and technically sound instruments in order to generate valid information for educational decision-making (Shavelson, 2018; Pellegrino & Hilton, 2013).

Accordingly, the following research question arises: What are the levels of teacher performance and mathematical competency development among sixth-grade primary school students belonging to School District 095? Addressing this question is relevant for understanding the educational conditions of the context under study and generating evidence that may inform pedagogical improvement processes.

Therefore, the objective of the present study is to describe the levels of teacher performance and mathematical competency development among sixth-grade primary school students and to explore the observed correspondence between these variables through a systematic process of contextualized data collection and analysis.

METHODS, TECHNIQUES AND INSTRUMENTS

This study was conducted using a quantitative approach with an observational, cross-sectional, and descriptive design. The research aimed to describe the levels of teacher performance and the development of mathematical competencies among sixth-grade primary school students, as well as to explore the observed correspondence between these variables within a specific educational context. Given the nature of the design, no instructional interventions were implemented, and no comparison groups were established.

The study population consisted of sixth-grade teachers and students enrolled in public primary schools within School District 095, located in Tampico, Tamaulipas, Mexico. A non-probability purposive sampling strategy was employed, based on accessibility and pedagogical relevance criteria. The sample included 13 classroom teachers and a total of 395 students. Sixth grade was selected because of its importance in consolidating fundamental mathematical learning prior to students' transition to secondary education.

The teacher performance variable was conceptualized as the set of pedagogical practices implemented by teachers to support student learning. To measure this variable, a structured observation instrument was developed in the form of a double-entry matrix comprising 25 indicators distributed across five dimensions: lesson planning, learning environment management, curriculum management,

instructional management, and assessment. Each indicator was rated using a four-level ordinal scale: insufficient, basic, good, and excellent. The sum of the scores obtained allowed the determination of an overall teacher performance level for each participant.

Mathematical competencies were defined as students' ability to mobilize knowledge, skills, and attitudes to solve problem situations in a variety of contexts. Assessment was conducted using a second structured observation instrument organized around four dimensions: autonomous problem solving, communication of mathematical information, validation of procedures and results, and efficient use of techniques. As with the previous instrument, a four-level ordinal achievement scale was applied. The aggregated scores were used to determine an overall level of mathematical competency development for each classroom group.

Data collection was carried out through direct observation of teaching practices and students' performance during academic activities conducted in face-to-face and/or virtual settings. This process was complemented by the review of learning evidence produced during the study period. Each teacher and the corresponding group of students were observed on a single assessment occasion in order to obtain descriptive information regarding the variables under investigation.

The instruments were developed based on regulatory frameworks and pedagogical criteria established by

the Mexican Ministry of Education for basic education. However, no formal psychometric validation procedures or statistical reliability estimates were performed. This limitation should be acknowledged when interpreting the study findings.

Data analysis was conducted using descriptive statistics. Frequencies, percentages, and overall achievement levels were calculated for each variable to characterize teacher performance and the development of mathematical competencies within the study population. Subsequently, a descriptive comparison of the levels achieved in both variables was performed to identify patterns of observed correspondence across the analyzed cases.

Owing to the small teacher sample size, the ordinal nature of the measurement scales, and the non-probability sampling method employed, no inferential statistical analyses were conducted. Consequently, the findings should be interpreted as context-specific descriptive evidence rather than as conclusive statistical associations.

RESULTS AND DISCUSSION

The analysis of the data provided a descriptive characterization of teacher performance levels and the development of mathematical competencies among sixth-grade primary school students from School District 095. The findings related to teacher performance indicated that most of the teachers evaluated achieved achievement levels classified as good, according to the criteria established in the observation instrument. Overall, the pedagogical

practices observed demonstrated an acceptable degree of compliance with the curricular standards considered in the evaluation process. A summary of the results obtained is presented in Figure 1.

To determine overall achievement levels, an aggregation procedure was applied to the scores obtained across the different indicators assessed. The score ranges used for classifying these levels are presented in Figure 2. Based on this classification, the overall level of teacher performance was situated within the good category. In contrast, the analysis of mathematical competency development revealed that the predominant achievement level was basic, indicating that students demonstrated partial progress in the competencies evaluated without consistently reaching the higher proficiency levels established for their grade.

A comparison of the two variables revealed differences in the overall achievement levels attained. Whereas teacher performance was primarily concentrated in the good category, the development of mathematical competencies was predominantly classified at the basic level. Nevertheless, correspondence between the levels achieved in both variables was observed in eight of the thirteen cases analyzed. A summary of these findings is presented in Figure 3.

To further examine variations across cases, a comparison was conducted between the performance level attained by each teacher and the corresponding level of mathematical competency development demonstrated by their respective student group. Figure 4 illustrates the agreements and discrepancies identified between the two variables.

The descriptive analysis showed that correspondence between teacher performance and students' mathematical competencies was more frequently observed in cases where teachers achieved performance levels classified as good or excellent. At the same time, several cases were identified in which teacher performance levels exceeded the levels of mathematical competency development attained by students. This finding highlights differences between the assessment of observed pedagogical practices and the learning outcomes demonstrated by students.

Regarding the dimensions that comprised teacher performance, lesson planning obtained the highest achievement levels, whereas assessment practices received the lowest scores. In particular, indicators related to self-assessment, peer assessment, and feedback provision emerged as areas requiring further strengthening when compared with the other components evaluated..

Levels: 1 = insufficient 2 = elementary 3 = good 4 = excellent

DOMAIN	CONTENT / SCORE BY RATER	TEACHER PERFORMANCE LEVELS IN THE CLASSROOM												TOTAL	
		RATER 1	RATER 2	RATER 3	RATER 4	RATER 5	RATER 6	RATER 7	RATER 8	RATER 9	RATER 10	RATER 11	RATER 12	Reference Score	Rubric Average
Planning	I Content	3	4	3	3	3	4	3	2	4	4	4	4	44	42.5
	II Purpose Selection	3	3	2	3	3	4	3	2	4	4	4	4	42	
	III Design of didactic strategies	4	3	2	4	2	4	3	2	4	4	4	4	43	
	IV Evaluation mechanisms	3	3	2	3	3	4	3	1	4	4	4	4	41	
Classroom Environment Management	V Interpersonal relationships	2	4	2	2	2	2	3	3	2	2	3	2	31	32.5
	VI Group management	3	3	2	3	2	2	4	3	2	2	3	3	34	
Curriculum Management	VII Knowledge of the curriculum	3	3	2	3	2	2	3	2	3	3	3	3	35	32.3
	VIII Relationships between subjects	3	3	2	3	2	2	3	2	3	2	2	2	31	
	IX Connections between subjects – contexts	3	3	2	3	2	2	3	2	3	2	2	2	31	
Instructional Management	X Curriculum presentation	2	3	2	2	2	3	3	2	2	3	3	2	31	35.25
	XI Differentiated instruction	2	2	2	2	4	3	2	2	2	2	2	2	29	
Resources and Classroom Processes	XII Group organization	3	3	2	3	2	2	3	2	3	2	3	2	33	35.0
	XIII Student learning relationship	3	3	2	3	2	3	3	2	3	2	3	3	35	
	XIV Didactic resources	3	2	2	3	2	3	2	2	3	2	4	4	34	
	XV Spatial resources	4	3	2	4	2	3	2	2	4	2	4	2	36	
	XVI Time management	4	3	2	4	3	4	2	1	3	3	4	3	39	
	XVII Indicators	4	3	2	4	3	3	4	2	3	3	2	2	38	
	XVIII Explanations	4	3	2	4	3	3	4	2	3	3	2	3	39	
	XIX Questions	4	3	3	4	3	2	4	2	3	3	4	4	43	
	XX Guided activities	2	3	2	2	3	3	3	2	2	2	2	2	31	
Assessment	XXI Independent activities	2	3	2	2	4	3	2	0	2	2	4	4	32	30.5
	XXII Self-assessment	2	3	0	2	3	2	2	0	2	3	3	3	27	
	XXIII Peer assessment	3	3	2	3	3	2	2	0	2	2	3	2	30	
	XXIV Teacher assessment of students	2	3	2	2	3	2	2	2	2	2	3	3	31	
Total score per rater		74	74	50	74	65	70	72	43	71	65	78	72	66	
Overall performance level of each teacher		3	3	2	3	3	3	3	2	3	3	4	3	3	

Total number of items: 25

Level achieved according to the score obtained

Ranges:

Level 1 = insufficient: 0 – 25 points Level 2 = elementary: 26 – 50 points

Level 3 = good: 51 – 75 points Level 4 = excellent: 76 – 100 points

Figure 1. Summary of teacher performance assessment results

Teacher Performance

Teachers	TEACHER 1	TEACHER 2	TEACHER 3	TEACHER 4	TEACHER 5	TEACHER 6	TEACHER 7	TEACHER 8	TEACHER 10	TEACHER 11	TEACHER 12	TEACHER 13	FINAL RESULT	
													Average Total Score	Achievement Level
Achievement level in teacher performance	3	3	2	3	3	3	2	2	3	4	3	3	38	3: Good

Students' Mathematical Competencies

Teachers	TEACHER 1	TEACHER 2	TEACHER 3	TEACHER 4	TEACHER 5	TEACHER 7	TEACHER 8	TEACHER 9	TEACHER 10	TEACHER 11	TEACHER 12	TEACHER 13	FINAL RESULT	
													Total Score	Achievement Level
Average achievement level in students' mathematical competencies	2	3	2	3	3	2	3	1	3	4	3	1	33	2: Elementary

Scoring Ranges:

Level 1 = insufficient: 0 – 25 points

Level 2 = elementary: 26 – 38 points

Level 3 = good: 27 – 39 points

Level 4 = excellent: 40 – 52 points

Figure 2. Achievement Levels

Teacher Performance

Teachers	TEACHER 1	TEACHER 2	TEACHER 3	TEACHER 4	TEACHER 5	TEACHER 6	TEACHER 7	TEACHER 8	TEACHER 9	TEACHER 10	TEACHER 12	TEACHER 13	FINAL RESULT	
													Average Total Score	Achievement Level
Achievement level in teacher performance	3	3	2	3	3	3	3	2	3	4	3	3	38	3: Good

Students' Mathematical Competencies

Teachers	TEACHER 1	TEACHER 2	TEACHER 3	TEACHER 4	TEACHER 6	TEACHER 7	TEACHER 8	TEACHER 9	TEACHER 10	TEACHER 11	TEACHER 12	TEACHER 13	FINAL RESULT	
													Total Score	Achievement Level
Average achievement level in students' mathematical competencies	2	3	2	3	3	2	3	1	3	4	3	1	33	2: Elementary

Scoring Ranges:

Level 1 = insufficient: 0 – 25 points

Level 2 = elementary: 26 – 38 points

Level 3 = good: 27 – 39 points

Level 4 = excellent: 40 – 52 points

Figure 3. Final summary of teacher performance and mathematical competency development results

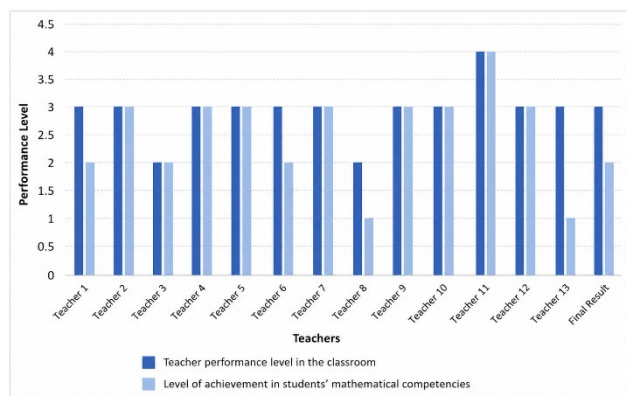


Figure 4. *Variations across individual cases*

The results indicate that teacher performance was predominantly concentrated at a good achievement level, whereas the development of mathematical competencies was largely classified as basic. This finding is consistent with the specialized literature, which recognizes the importance of pedagogical practices in learning processes while emphasizing that academic achievement is also shaped by multiple factors associated with the school, family, and sociocultural context (Hattie, 2017; Muijs et al., 2014).

The correspondence observed between teacher performance levels and the development of mathematical competencies in most of the cases analyzed represents a relevant finding within the context under study. Although the descriptive nature of the research design precludes the establishment of conclusive statistical associations, the results suggest that groups taught by teachers who attained higher performance levels tended to demonstrate more favorable levels of mathematical competency development. This trend is consistent with previous research highlighting the influence of pedagogical

content knowledge, instructional planning, and teacher mediation on mathematics learning outcomes (Hill et al., 2005; Blömeke et al., 2016).

Nevertheless, the findings also reveal a gap between the overall level of teacher performance and the level of mathematical competencies achieved by students. While teaching practices were generally rated as good, the development of mathematical competencies remained within the basic category. This discrepancy may indicate that the implementation of practices aligned with curricular standards does not, by itself, guarantee the consolidation of complex learning outcomes, particularly when additional factors related to student characteristics, institutional conditions, and pedagogical support processes are involved.

Another noteworthy aspect concerns the differentiated performance across the dimensions of teacher evaluation. Lesson planning received the most favorable ratings, whereas assessment practices obtained the lowest scores. These results are consistent with studies reporting persistent challenges in the incorporation of formative assessment strategies, self-assessment, and peer assessment within basic education settings (Shavelson, 2018; Sanmartí, 2008).

Because the development of mathematical competencies requires processes of reflection, argumentation, and validation of procedures, the weaknesses identified in assessment practices may limit students' progression toward higher levels of achievement.

Furthermore, the variability observed among teachers and classroom groups reinforces the view of mathematics learning as a multidimensional and complex phenomenon. The presence of cases in which relatively high levels of teacher performance were accompanied by lower levels of student mathematical competencies suggests the possible influence of factors not examined in the present study, such as students' socioeconomic conditions, the availability of educational resources, family involvement, and characteristics of the school environment.

CONCLUSIONS

This study described the levels of teacher performance and mathematical competency development among sixth-grade primary school students enrolled in School District 095, providing context-specific empirical evidence through an observational and descriptive approach. The findings revealed that teacher performance was predominantly concentrated at a good achievement level, whereas mathematical competency development was largely situated within the basic category, highlighting opportunities for improvement in the teaching and learning of mathematics.

The results also identified a pattern of correspondence between teacher performance levels and students' mathematical competency development in most of the cases analyzed. However, given the methodological characteristics of the study, this correspondence should be interpreted solely as a

context-specific descriptive trend rather than as evidence of a statistically validated association.

The findings suggest that efforts to strengthen teacher performance should address not only lesson planning and mastery of curricular content but also the consolidation of formative assessment practices aimed at promoting reflection, continuous feedback, and self-regulated learning. In this regard, the results help identify specific areas that may benefit from targeted professional development, instructional support, and ongoing teacher training initiatives.

Finally, it is important to acknowledge that limitations related to the sample size, the non-probability sampling strategy, the absence of formal instrument validation and reliability procedures, and the exclusive use of descriptive statistics constrain the scope of the conclusions. Nevertheless, the evidence generated provides a valuable reference for future research seeking to advance the study of teacher performance and mathematics learning through more robust methodological designs, larger samples, psychometrically validated instruments, and statistical analyses capable of examining the nature of the relationship between these variables with greater precision.

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Musculoskeletal disease as an extrahepatic manifestation associated with the hepatitis C virus: state of the art

Enfermedad musculoesquelética como manifestación extrahepática asociada al virus de la hepatitis C: estado del arte

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Abstract

Chronic hepatitis C virus infection is recognized as a systemic disease with multiple extrahepatic manifestations that can precede liver damage. Among these, musculoskeletal disease stands out due to its frequency and the functional impact it has on patients. The objective of this narrative review was to analyze the current state of knowledge regarding musculoskeletal disease as an extrahepatic manifestation associated with the hepatitis C virus, considering its pathophysiological mechanisms, clinical scenarios, and therapeutic approaches. A narrative review of scientific literature published between 2019 and 2024 in specialized health sciences databases was conducted. The evidence shows that musculoskeletal manifestations associated with the virus present a broad spectrum, including arthralgia, myalgia, and various patterns of inflammatory arthritis, with complex immunological bases. Furthermore, treatment with direct-acting antivirals not only allows for viral eradication but is also associated with clinical improvement of these manifestations. Timely recognition of musculoskeletal involvement is essential for early diagnosis and comprehensive management of the infection.

Keywords: hepatitis C virus; extrahepatic disease; musculoskeletal disease; HCV-associated arthritis; direct-acting antivirals

Resumen

La infección crónica por el virus de la hepatitis C se reconoce como una enfermedad sistémica con múltiples manifestaciones extrahepáticas que pueden preceder al daño hepático. Entre ellas, la enfermedad musculoesquelética destaca por su frecuencia y por el impacto funcional que genera en los pacientes. El objetivo de esta revisión narrativa fue analizar el estado actual del conocimiento sobre la enfermedad musculoesquelética como manifestación extrahepática asociada al virus de la hepatitis C, considerando sus mecanismos fisiopatológicos, escenarios clínicos y abordajes terapéuticos. Se realizó una revisión narrativa de literatura científica publicada entre 2019 y 2024 en bases de datos especializadas en ciencias de la salud. La evidencia muestra que las manifestaciones musculoesqueléticas asociadas al virus presentan un espectro amplio, que incluye artralgias, mialgias y distintos patrones de artritis inflamatoria, con bases inmunológicas complejas. Asimismo, se identifica que el tratamiento con antivirales de acción directa no solo permite la erradicación viral, sino que se asocia con mejoría clínica de estas manifestaciones. El reconocimiento oportuno de la afectación musculoesquelética es fundamental para un diagnóstico temprano y un manejo integral de la infección.

Palabras clave: virus de la hepatitis C; enfermedad extrahepática; enfermedad musculoesquelética; artritis asociada a VHC; antivirales de acción directa

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Fecha de recepción: 17/junio/2025 | **Fecha de aceptación:** 05/abril/2026 | **Fecha de publicación:** 14/agosto/2026

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INTRODUCTION

Chronic infection with hepatitis C virus (HCV) remains a major global public health concern because of its high prevalence, frequently asymptomatic course, and capacity to induce multisystem organ damage. According to the World Health Organization, more than 50 million people are living with chronic HCV infection worldwide, with a heterogeneous distribution and a substantial disease burden in low- and middle-income regions where barriers to early diagnosis and universal access to antiviral therapy persist (World Health Organization, 2023). Despite significant therapeutic advances achieved over the past decade, hepatitis C continues to pose important challenges to healthcare systems, particularly because of the prevalence and complexity of its extrahepatic manifestations.

Hepatitis C virus is characterized not only by its hepatotropic nature and its central role in the development of chronic hepatitis, cirrhosis, and hepatocellular carcinoma, but also by its ability to induce extrahepatic disease in a significant proportion of infected individuals. It has been estimated that 40% to 70% of patients with chronic HCV infection develop at least one extrahepatic manifestation, highlighting the systemic nature of the disease and the persistent interaction between the virus and the host immune system (Cacoub et al., 2016). These manifestations encompass metabolic, endocrine, renal, neurological, dermatological, and musculoskeletal disorders, which may precede the diagnosis of liver disease and, in some cases,

represent the primary reason for seeking medical attention.

Within this clinical spectrum, HCV-associated musculoskeletal disease is of particular relevance because of its frequency and the considerable functional impairment it may cause. Musculoskeletal manifestations range from nonspecific arthralgia and myalgia to chronic inflammatory arthritis that can closely resemble primary rheumatic diseases, especially rheumatoid arthritis (Johnson & Lee, 2022). This clinical and serological overlap poses a significant diagnostic challenge, potentially leading to delayed recognition of the underlying viral infection and the inappropriate initiation of immunomodulatory therapies in the presence of active viral replication.

The pathophysiology of HCV-related musculoskeletal disease is complex and multifactorial. Persistent viral infection promotes chronic immune activation characterized by polyclonal B-cell stimulation, sustained autoantibody production, and the formation of immune complexes that may deposit in multiple tissues, including articular structures (Argyropoulou et al., 2020). Concurrently, molecular mimicry, loss of immunological tolerance, and activation of both innate and adaptive inflammatory pathways have been implicated in the development of synovial inflammation and joint damage (Kim & Park, 2023; Nguyen & Tran, 2022). This immunological milieu accounts for the high prevalence of rheumatoid factor, cryoglobulins, and other autoantibodies

observed in patients with HCV infection and rheumatologic manifestations.

The introduction of direct-acting antiviral agents has dramatically transformed the management of HCV infection and its extrahepatic complications. These therapies achieve sustained viral eradication rates exceeding 90%, with favorable safety profiles and excellent tolerability, thereby substantially altering the natural history of liver disease and improving a wide range of systemic manifestations (Cooke et al., 2024). Available evidence suggests that viral clearance is associated with a significant reduction in articular inflammatory activity and improved functional outcomes in patients with HCV-associated musculoskeletal disease (Johnson & Lee, 2022).

In this context, a comprehensive evaluation of the available scientific evidence regarding musculoskeletal disease as an extrahepatic manifestation of HCV infection is warranted. A thorough understanding of the underlying pathophysiological mechanisms, the diverse clinical presentations, and the impact of antiviral therapy is essential not only for optimizing patient management but also for strengthening early detection strategies that facilitate timely diagnosis of HCV infection. Therefore, the aim of this narrative review is to synthesize the current state of knowledge regarding the relationship between hepatitis C virus infection and musculoskeletal disease, emphasizing its clinical, diagnostic, and therapeutic relevance within a comprehensive patient-centered approach.

METHODS, TECHNIQUES AND INSTRUMENTS

The present study was conducted as a narrative review of the scientific literature aimed at comprehensively analyzing musculoskeletal disease as an extrahepatic manifestation associated with chronic hepatitis C virus (HCV) infection. This methodological approach was considered appropriate given the complex, multidimensional, and heterogeneous nature of the phenomenon under investigation, which encompasses pathophysiological, immunological, clinical, and therapeutic dimensions that have been explored through diverse research designs and conceptual frameworks.

The narrative review approach enabled the integration of evidence derived from observational studies, scholarly reviews, immunopathological investigations, and clinical consensus documents, providing a broad and contextualized perspective on the current state of knowledge. Unlike systematic reviews or meta-analyses, the purpose of this review was not to quantify effects or compare specific interventions but rather to identify relevant pathophysiological patterns, recurring clinical scenarios, and emerging therapeutic strategies, while also highlighting knowledge gaps that may guide future research.

A structured literature search was performed using the PubMed, SciELO, and LILACS databases, selected for their extensive coverage of health sciences, internal medicine, rheumatology, infectious

diseases, and medical education. Controlled vocabulary and keywords in both English and Spanish were combined using Boolean operators. Search terms included hepatitis C virus, extrahepatic manifestations, musculoskeletal disease, arthritis, rheumatic manifestations, and direct-acting antivirals. The search strategy was adapted to the specific characteristics of each database to maximize both sensitivity and relevance of the retrieved records.

Studies published between 2019 and 2024 and available in full text were eligible for inclusion if they explicitly addressed the relationship between HCV infection and musculoskeletal manifestations from a clinical, pathophysiological, or therapeutic perspective. Original research articles employing quantitative, qualitative, or mixed-methods designs, as well as narrative reviews, systematic reviews, meta-analyses, and normative documents issued by international organizations, were considered. Editorials, letters to the editor, anecdotal reports, and publications lacking a clearly described methodology or not directly relevant to the objectives of the review were excluded.

The literature selection process was conducted in two stages. First, titles and abstracts were screened to identify potentially relevant studies. Subsequently, the full texts of preselected articles were reviewed to verify compliance with the predefined inclusion criteria. Reference management was performed manually to avoid duplication and ensure consistency in citation practices.

Data extracted from the selected studies were organized through a thematic narrative synthesis structured around key analytical domains, including the epidemiology of HCV-related extrahepatic disease, the immunopathogenic mechanisms underlying musculoskeletal involvement, the principal clinical presentations reported in the literature, and the impact of direct-acting antiviral therapy on the course of rheumatologic manifestations. This approach facilitated a critical integration of the available evidence, highlighting areas of convergence, divergence, and emerging trends across the scientific literature.

Because this study consisted exclusively of a review of previously published literature, it did not involve direct participation of human subjects or the handling of personal data and therefore did not require approval from a research ethics committee. Nevertheless, the review was conducted in accordance with the principles of scientific integrity, methodological transparency, and appropriate acknowledgment of sources, consistent with international standards for academic publication.

RESULTS AND DISCUSSION

The review of the scientific literature identified musculoskeletal disease as one of the most frequent and clinically significant extrahepatic manifestations associated with chronic hepatitis C virus (HCV) infection. The studies analyzed consistently reported that rheumatologic manifestations may occur at various stages of infection, including prior to the diagnosis of liver disease, thereby reinforcing their

value as potential early clinical indicators of previously unrecognized HCV infection (Cacoub et al., 2016; Nguyen & Tran, 2022).

From a clinical perspective, HCV-associated musculoskeletal manifestations encompass a broad spectrum that includes nonspecific arthralgia and myalgia, oligoarticular reactive arthritis, and symmetric polyarthritis with features that overlap considerably with rheumatoid arthritis. Several studies have reported that these clinical entities may be difficult to distinguish serologically, as a substantial proportion of patients exhibit positive rheumatoid factor and other autoantibodies despite the absence of true rheumatoid arthritis (Su et al., 2014; Johnson & Lee, 2022). This diagnostic overlap represents a major clinical challenge because failure to recognize the underlying viral etiology may lead to the inappropriate use of immunosuppressive therapies.

The reviewed evidence demonstrated that the pathophysiology of HCV-related musculoskeletal involvement is complex and multifactorial. Chronic infection induces persistent immune activation characterized by polyclonal B-cell stimulation, sustained autoantibody production, and the formation of immune complexes containing cryoglobulins, IgG and IgM immunoglobulins, and complement components. These immune complexes may deposit within articular and vascular tissues, triggering inflammatory cascades that perpetuate tissue injury (Argyropoulou et al., 2020; Chen & Zhao, 2024). In addition, molecular mimicry and loss

of immunological tolerance have been implicated in disease pathogenesis, whereby viral antigens share structural similarities with joint components, promoting cross-reactive autoimmune responses (Kim & Park, 2023; Lee & Kim, 2023).

Recent literature has further highlighted the contribution of innate inflammatory mechanisms to HCV-associated arthritis. In particular, activation of the NLRP3 inflammasome has been proposed as a relevant driver of chronic inflammation through the induction of proinflammatory cytokines, including interleukin-1 β and interleukin-18, which contribute to the amplification and maintenance of joint inflammation (Wan et al., 2024). This emerging pathophysiological framework provides a more integrated understanding of articular damage by linking persistent viral infection to sustained activation of both innate and adaptive immune responses.

Regarding treatment, the studies reviewed indicated that the introduction of direct-acting antiviral agents (DAAs) has substantially altered the clinical course of HCV-associated musculoskeletal manifestations. Viral eradication achieved with these therapies was consistently associated with reduced articular inflammatory activity and significant improvements in pain and physical function, thereby decreasing the need for prolonged immunosuppressive treatment in many patients (Johnson & Lee, 2022; Cooke et al., 2024). These findings have led contemporary clinical guidelines and recent reviews to recommend antiviral therapy as the primary therapeutic strategy for

patients presenting with rheumatologic manifestations related to HCV infection.

Nevertheless, the available evidence also suggested that a subset of patients continues to experience articular symptoms despite successful viral eradication, indicating that certain autoimmune mechanisms may persist independently of active viral replication. In such cases, a combined therapeutic approach may be required, incorporating nonsteroidal anti-inflammatory drugs, low-dose corticosteroids, or, in selected patients, immunomodulatory agents, with careful monitoring to minimize the risk of hepatic toxicity or potential viral reactivation (Martínez & Hernández, 2022; Nardone et al., 2024). From a public health and medical education perspective, the evidence synthesized in this review underscores the importance of recognizing musculoskeletal manifestations as a valuable diagnostic opportunity for HCV detection.

Several authors have emphasized that the identification of atypical arthritis or inflammatory joint disease with an unusual clinical course in patients without a known diagnosis of hepatitis C should prompt HCV screening, in accordance with international recommendations advocating at least one lifetime screening test and continued surveillance among individuals at increased risk (World Health Organization, 2023; Cooke et al., 2024).

CONCLUSIONS

Hepatitis C virus (HCV)-associated musculoskeletal disease should be recognized as an integral component of the extrahepatic spectrum of infection rather than as a secondary or incidental complication. Its recognition expands the traditional clinical perspective focused primarily on hepatic injury and underscores the need to view HCV as a systemic pathogen capable of inducing sustained multisystem involvement through complex immunological mechanisms that extend beyond the articular domain. Such a comprehensive understanding is essential for contemporary clinical practice and is consistent with current scientific evidence.

The management of musculoskeletal manifestations related to HCV infection requires a conceptual shift in both diagnostic and therapeutic approaches. Recognizing these manifestations as potential indicators of underlying viral infection can strengthen strategies aimed at early diagnosis and reduce treatment delays that contribute to increased morbidity and mortality.

In this regard, the clinical evaluation of patients presenting with atypical rheumatologic conditions or inflammatory musculoskeletal disorders with an unusual clinical course represents a strategic opportunity to improve HCV detection rates and optimize the benefits of antiviral therapy.

Ultimately, the management of HCV infection and its extrahepatic manifestations should be grounded in an interdisciplinary approach that integrates hepatology, rheumatology, and primary care, with particular emphasis on the continuous education of healthcare professionals and the implementation of population-based screening strategies. Consolidating this framework not only contributes to improving patients' quality of life but also strengthens ongoing efforts to eliminate hepatitis C as a major public health concern, in alignment with international goals aimed at reducing new infections and preventing long-term systemic complications.

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Normal Distribution

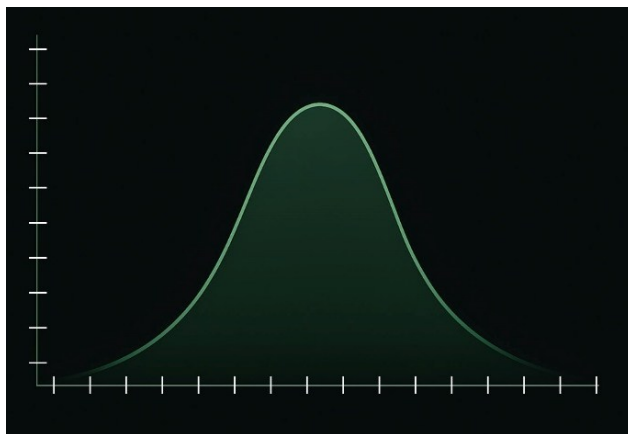
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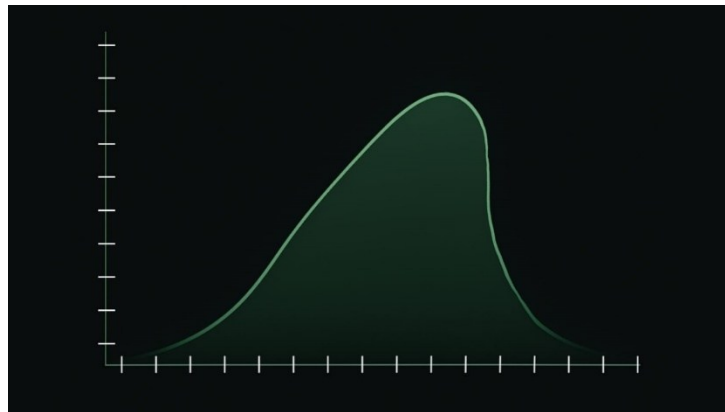
INTRODUCTION

The normal distribution is a widely used theoretical model that describes how the numerical values of a variable are distributed within a dataset. It is commonly referred to as the bell-shaped curve because the graph of its probability density function resembles the shape of a bell.



Theoretically, it is assumed that data derived from any random variable, which by definition are always numerical and measured on either an interval or ratio scale, can generally be approximated by a normal distribution. However, this assumption is not always met in practice. Therefore, data transformation procedures and, in some cases, modifications to the measurement scale are recommended to achieve an approximately normal distribution, particularly because this assumption is required for the application of parametric statistical methods.

For example, if serum creatinine levels were measured in a group of individuals between 40 and 50 years of age, the resulting data distribution might be skewed, as creatinine values tend to increase with age. This pattern would produce an asymmetric distribution curve with a positive skew, characterized by a longer tail extending to the right.



To solve this drawback, we could implement, for example, a statistical procedure known as a log transformation, which would make it possible to normalize the data or reduce skewness.

The normal distribution is a model defined by a mathematical algorithm, which is calculated from a formula:

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} \exp\left[-\frac{1}{2\sigma^2} (x - \mu)^2\right]$$

Where:

$f(x)$ = Function of the variable x

σ = Population standard deviation

σ^2 = Population variance

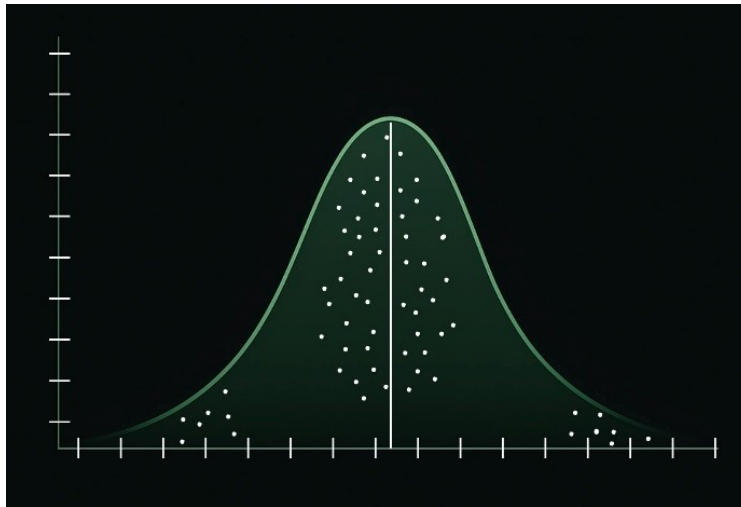
π = 3.1416

e = Base of the natural logarithm= 2.7182

μ = Population mean of the random variable X

This type of distribution, also known as the Gaussian distribution or bell curve, is one of the most important and widely used probability distributions in mathematics, statistics, and numerous scientific disciplines.

It is characterized by its symmetrical shape, in which most observations are concentrated around the mean. This property also reflects the fact that the probability of observing atypical or extreme values (outliers) decreases exponentially as the distance from the mean increases.



The German mathematician Carl Friedrich Gauss, from whom the term Gaussian curve or Gaussian distribution derives, introduced this model through his work and observations in fields such as astronomy, physics, and mathematics. Its development was particularly influenced by his studies of the method of least squares, number theory, and the distribution of prime numbers.



It is important to emphasize that this model enables statistical inference and, more importantly, that data interpretation depends on the context of the problem under investigation, as it describes the behavior of a numerical random variable under specific natural or experimental conditions.

In the analysis and interpretation of a normal distribution curve, the mean and variance are key parameters that determine the shape and location of the distribution.

- The mean defines the central point around which values are distributed, thereby determining the symmetry of the curve.
- The variance influences the dispersion of the data, thereby determining the width of the curve.

The standard deviation also plays a fundamental role in determining the shape of the distribution. A larger standard deviation and variance result in a wider and flatter curve, indicating that the values are more dispersed. Conversely, smaller values imply that the data are more tightly clustered around the mean, producing a narrower and more peaked distribution. The width of the curve refers to its visual appearance, specifically how broad or narrow it appears.

Variability refers to the degree of dispersion of values around the mean. It is worth noting that variance is more commonly used because its mathematical properties facilitate:

- Modeling of random processes
- Comparisons of variability
- Risk analysis
- Multivariate distributions

In fact, in the formula of the normal distribution, the variance appears in the denominator of the exponent.

Applications of the Normal Distribution

- Analysis of data exhibiting a symmetric and unimodal distribution.
- Inferential statistical procedures, particularly hypothesis testing.
- Construction and interpretation of confidence intervals.

Limitations

- Assumption of normally distributed data, which is not always realistic.
- Sensitivity to outliers, which can affect accuracy.

Other important concepts are the probability density function (PDF) and the area under the curve, which, although related, are not exactly the same.

The PDF specifically describes the probability that a random variable takes a particular value. It is a mathematical function that assigns a probability to each possible value of a variable.

The PDF has several properties, among which the following are particularly noteworthy:

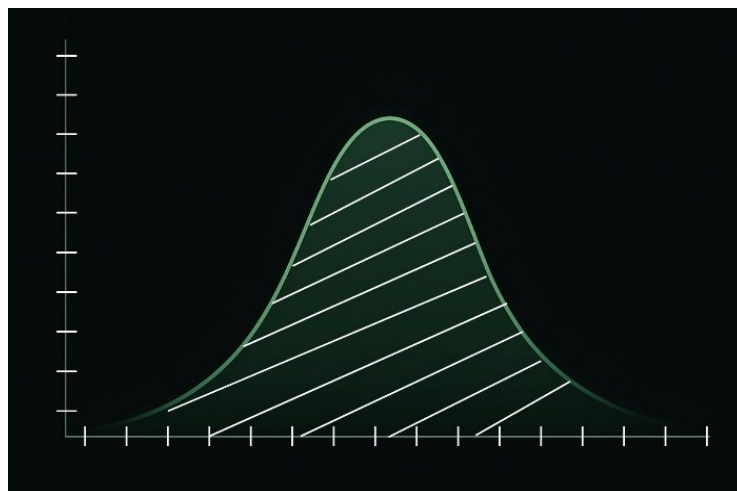
- Non-negativity: the function is non-negative for all values of x .
- Integral equal to 1: the integral of the function over all possible values of x is equal to 1.

Examples of Interpretation

- Maximum density: The highest point of the PDF indicates the most probable value of the random variable.
- Distribution tails: The tails of the distribution indicate the probability of extreme values.
- Symmetry: The symmetry of the PDF indicates whether the distribution is symmetric or asymmetric.

On the other hand, the area under the probability density function (PDF) curve represents the cumulative probability that the variable assumes a value within a specific interval:

- The total area under the curve is equal to 1, representing the total probability.



In other words, the probability density function (PDF) represents the height of the curve at each point, whereas the area under the curve corresponds to the integral of the PDF over a specified interval.

A normally distributed random variable with population mean (μ) and population standard deviation (σ) is commonly denoted as $N(\mu, \sigma)$.

Example

If the fasting blood glucose levels of a group of individuals have an arithmetic mean of 110 mg/dL and a standard deviation of 10 mg/dL, and the data follow a normal distribution, this can be expressed as $N(110, 10)$.

The normal distribution is fundamental across many fields and is particularly useful when:

- The data exhibit a central tendency, meaning that most values cluster around a mean (the center of the distribution).
- Statistical models are required to make inferences about large populations based on sample data.
- A large number of observations are available. According to the Central Limit Theorem, if sufficiently large random samples are drawn from any distribution with a finite mean and variance, the distribution of the sample means will tend toward a normal distribution.

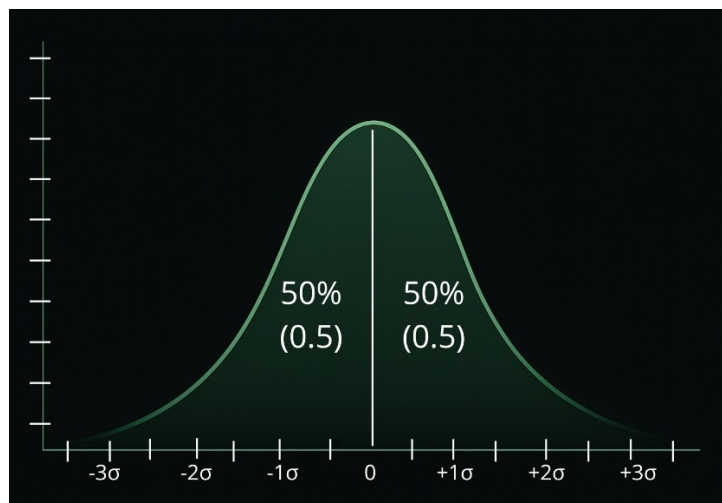
Examples of use

- Human height: In a given population, individuals' heights typically follow a normal distribution, with most people having heights close to the population mean and relatively few exhibiting extremely tall or short statures.
- Standardized academic test scores: The results of many standardized examinations tend to approximate a normal distribution. Most students achieve scores near the average, whereas exceptionally high or low scores occur less frequently.

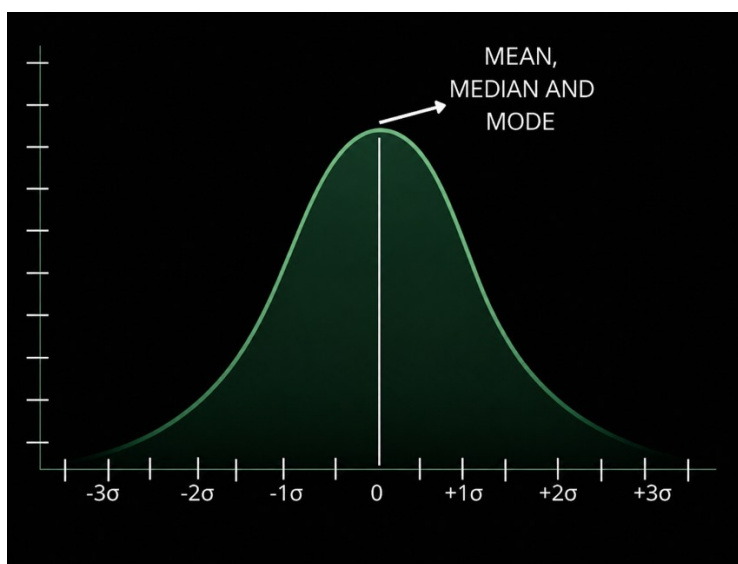
The normal curve, given its importance, has been studied extensively, and several of its properties are particularly useful for probability calculations.

To interpret the area under the Gaussian curve, the following should be considered:

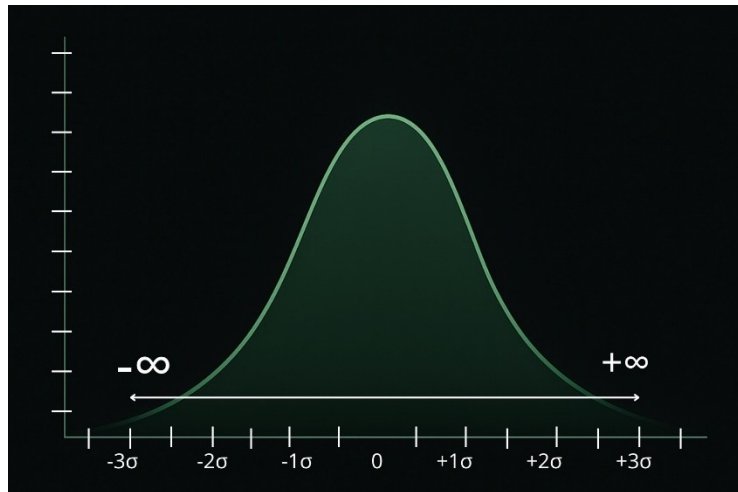
- The area under the curve is the same on both sides of the mean (50%, or 0.5 when expressed as a decimal), such that the right side is essentially a mirror image of the left side.



- A distinctive characteristic of the normal distribution is that the mean, median, and mode are equal. This property makes it a symmetric distribution, meaning that all three measures have the same value and are represented at the peak of the curve.

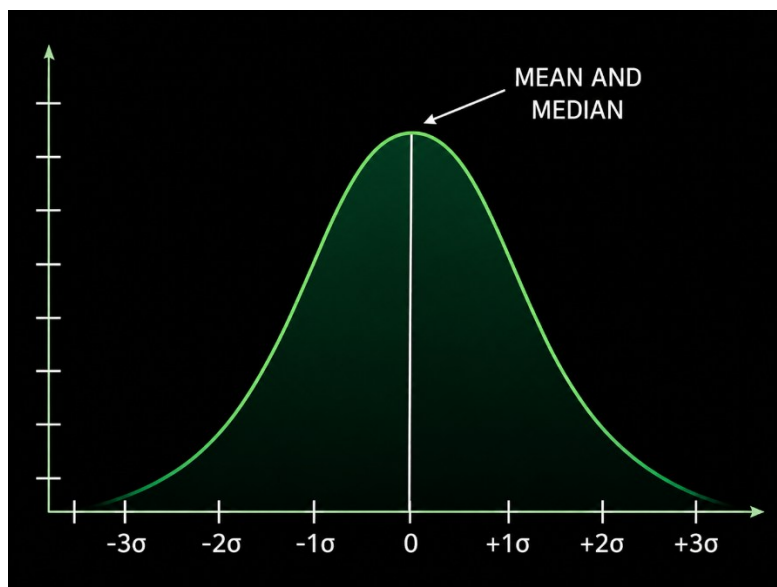


- The area between the curve and the x-axis represents the probability that the random variable assumes any value between $-\infty$ and $+\infty$; this probability is equal to 1.

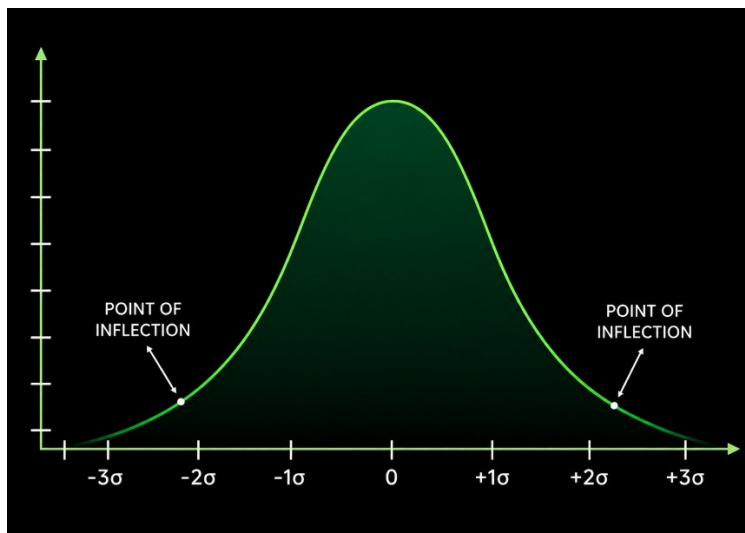


- Values located more than three standard deviations (σ) from the arithmetic mean have a substantially lower probability of occurrence.

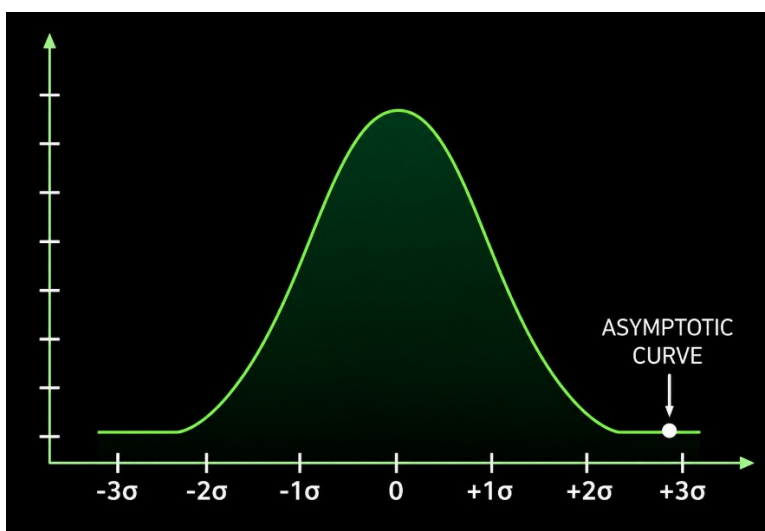
Any value located far from the mean is possible, although its probability of occurrence is low.



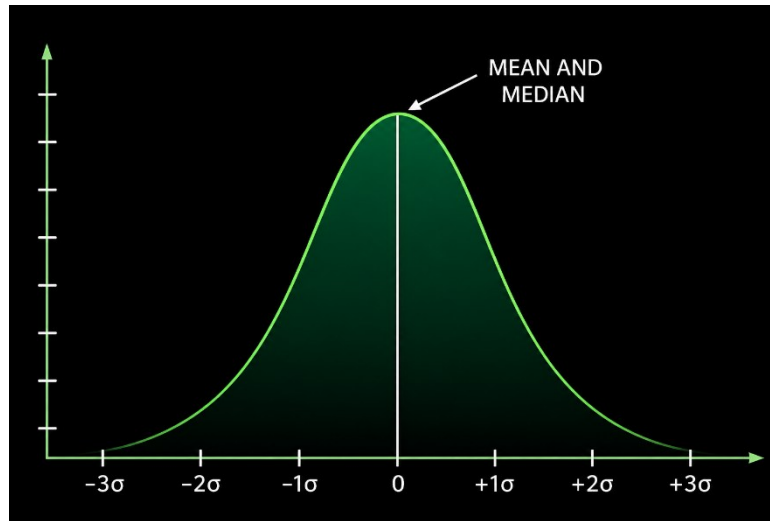
- The inflection points, where the curve changes from concave to convex, occur at values of X equal to $(\mu - \sigma)$ and $(\mu + \sigma)$.



- The tails of the distribution are asymptotic; that is, they approach but never actually intersect the horizontal axis (also known as the x-axis or axis of abscissas).



- The median divides the data into two equal parts in terms of the number of observations. However, when the data follow a normal distribution and the mean and median coincide, the arithmetic mean also divides the data into two equal halves with respect to the number of observations.



Z SCORES

Also known as standard scores, Z scores are standardized measures used to calculate the probability that a given score occurs within a normal distribution. They are expressed in terms of standard deviations from the mean. Z scores are also useful for comparing two scores that belong to different normal distributions.

To further understand the interpretation of the normal distribution, the concept of the area under the curve, and Z scores, it is first necessary to consider the concept of the standard deviation, which is a measure of dispersion for numerical variables and serves as the basis for calculating Z values.

Standard Deviation or Measure

- First, it should be pointed out that it is a measure of variability whose function is to assess the dispersion of data with respect to its mean, which makes it possible to measure how much individual values deviate from the mean of a dataset.
- Second, it identifies atypical values (outliers).
- Finally, it allows the comparison of the dispersion of different datasets and the calculation of confidence intervals.

The formula is:

$$\sigma = \sqrt{\frac{\sum (x - \mu)^2}{N}}$$

Where:

σ = Standard deviation

x = Individual values

μ = Population mean

N = Number of observations

Σ = Summation symbol (sum of values)

This measure of variability is particularly useful because it enables comparisons across variables expressed in different units of measurement.

Example: Comparison of ages Between two groups.

Suppose we have two groups of students:

Group A

- Ages: 18, 19, 20, 21, 22

- Mean: 20 years

- Standard deviation: 1.41 years

Group B

- Ages: 18, 22, 25, 28, 30

- Mean: 24.6 years

- Standard deviation: 4.76 years

Analysis

Although the mean age of Group B is higher, the key aspect is the comparison of the standard deviations. The standard deviation of Group A is low (1.41 years), indicating that the ages are clustered closely around the mean (20 years). In contrast, the standard deviation of Group B is high (4.76 years), indicating that the ages are more widely dispersed and farther from the mean (24.6 years).

Conclusion

Standard deviation enables the comparison of data variability between groups. In this example, Group A exhibits greater homogeneity in ages, whereas Group B shows greater diversity. Thus, standard deviation provides information beyond that offered by a measure of central tendency such as the mean alone. This can be useful in a variety of applications, including the planning of educational programs, preventive health initiatives, and the identification of health-related conditions within populations, to mention only a few examples.

In summary

- A high standard deviation indicates that the data are widely dispersed and far from the mean.
- A low standard deviation indicates that the data are clustered close to the mean and exhibit little variability.

It is important to note that raw numerical scores are frequently transformed into other types of scores that facilitate more meaningful comparisons and more intuitive interpretations.

One method of transforming data is through the use of Z scores, also known as standard scores or z-values.

This approach is considered a method of standardizing data within a normal distribution, allowing the determination of how many standard deviations a particular value lies from the mean of the dataset.

Interpretation of the Z Score

$Z = 0$ the value is exactly at the mean.

$Z > 0$ the value is above the mean.

$Z < 0$ the value is below the mean.

Formula for calculating a z Score:

$$z = \frac{x - \mu}{\sigma}$$

Where:

x = individual value

μ = mean of the dataset

σ = population standard deviation

The greater the absolute value of the z-score, the farther the value is from the mean.

Example:

Suppose we are analyzing examination scores..

- The mean is $\mu=70$
- The standard deviation is $\sigma=10$

We want to determine the z-score of a student who obtained $X=85$

Applying the formula:

$$z = \frac{x - \mu}{\sigma} = \frac{85 - 70}{10} = \frac{15}{10} = 1.5$$

Interpretation of the result

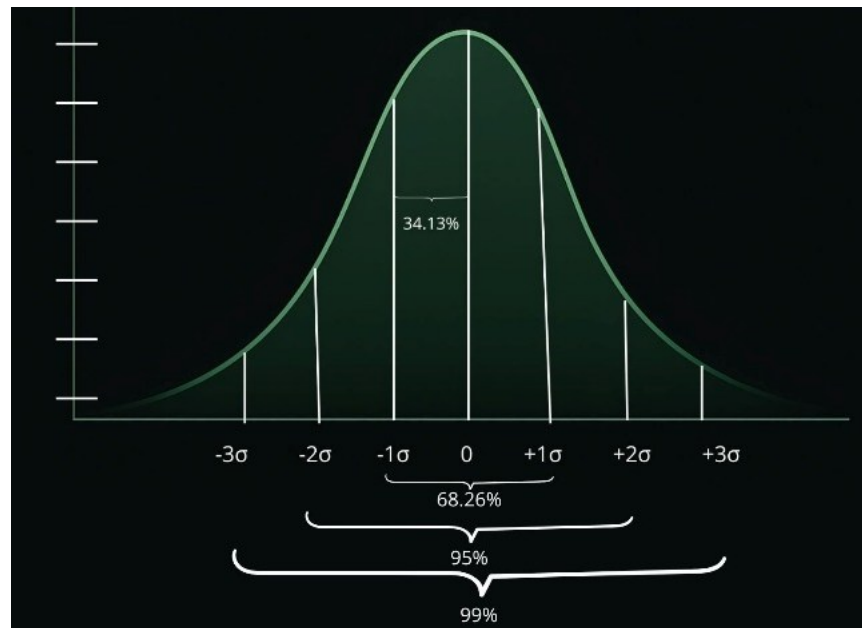
The student who scored 85 points is 1.5 standard deviations above the mean, indicating performance that is notably higher than the average. A z-score is obtained by subtracting the mean from an individual value and dividing the result by the standard deviation.

This procedure is particularly useful for identifying outliers and determining how many standard deviations a given value lies above or below the arithmetic mean within a distribution. When the distribution is strictly normal, the z-score distribution has a mean of 0 and a standard deviation of 1.

Additional considerations:

- The area under the curve represents 100% of the data; one-half of the area corresponds to 50% on each side of the distribution.
- In proportional terms, the total area under the curve is equal to 1.

When a set of numerically expressed values measured on an interval scale follows a normal distribution, their representation as Z scores is as follows:



- Within one standard deviation to the right and left of the mean, 68.26% of all observations are contained (therefore, each side of the curve contains 34.13%).
- Within two standard deviations to the right and left of the mean, 95.44% of all observations are contained (each side of the curve contains 47.72%). In practice, this value is commonly rounded to 95%.
- Within three standard deviations to the right and left of the mean, 99.74% of all observations are contained (each side of the curve contains 49.87%), that is, only 2.15% more than that contained within two standard deviations. In practice, this value is commonly rounded to 99%.

For greater precision, it should be noted that, in practice, 95% of the data fall between -1.96 and +1.96 standard deviations, 99% fall between -2.58 and +2.58 standard deviations, and 99.9% fall between -3.90 and +3.90 standard deviations. This clarification is fundamental for inferential statistical procedures.

In summary, z-scores represent a statistical measure that indicates how many standard deviations a value lies from the mean of a dataset. This tool is useful for comparing observations from different distributions and for assessing their relative position with respect to the mean.

Example A:

Suppose we have a set of examination scores obtained by university students, and we wish to calculate the Z score for a particular student. (For this example, assume that the standard deviation is not initially available)

Scores of 10 students: 70, 85, 90, 60, 75, 80, 95, 55, 85, 100

Step 1: Calculate the mean (average)

The mean (μ) is calculated by summing all values and dividing the result by the total number of observations:

$$\mu = \frac{70 + 85 + 90 + 60 + 75 + 80 + 95 + 55 + 85 + 100}{10} = \frac{835}{10} = 83.5$$

Step 2: Calculate the standard deviation (σ)

The standard deviation was calculated using the following formula:

$$\sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{n}}$$

Where X_i represents the values in the dataset, μ is the mean, and N is the total number of observations. For this dataset, the calculation would be as follows:

$$\begin{aligned} \sigma &= \sqrt{\frac{(70 - 83.5)^2 + (85 - 83.5)^2 + (90 - 83.5)^2 + \dots + (100 - 83.5)^2}{10}} = \frac{\sqrt{4402.5}}{10} \\ &= \sqrt{440.25} \approx 20.98 \end{aligned}$$

Step 3: Calculate the Z score for a specific score

The Z score is calculated using the following formula:

$$z = \frac{x - \mu}{\sigma}$$

Where X is the student's score. If a student obtained a score of 95 points, then:

$$z = \frac{95 - 83.5}{20.98} \approx \frac{11.5}{20.98} \approx 0.55$$

Interpretation

A z-score of 0.55 means that the raw score of 95 points is 0.55 standard deviations above the mean (a value within one standard deviation). In other words, the student has a score that is slightly above the class average (the score lies between the mean and one standard deviation above it).

APPLICATION IN MEDICINE

Example B:

Child Growth

Z scores allow the comparison of a child's weight, height, and body mass index (BMI) with the expected reference values for children of the same age and sex.

A 5-year-old child weighs 20 kg.

The mean weight for children of the same age is 18 kg, with a standard deviation of 2 kg (in this case, the standard deviation is available).

The Z score is calculated as follows:

$$z = \frac{x - \mu}{\sigma} = \frac{20 - 18}{2} = \frac{2}{2} = 1.0$$

Interpretation

A $Z = 1.0$ means that, in terms of weight, the child is 1 standard deviation above the mean, which suggests that the child's weight is above average, but within the normal range.

If Z were greater than +2 or less than -2, it would indicate significant overweight or underweight.

Example C:

Bone Densitometry

In studies of bone mineral density (BMD), such as dual-energy X-ray absorptiometry (DXA), the Z score is used to compare a patient's bone density with that of individuals of the same age and sex.

A 60-year-old woman has a BMD of 0.85 g/cm².

The mean BMD for her age group is 1.0 g/cm², with a standard deviation of 0.1 g/cm².

Z Score:

$$z = \frac{0.85 - 1.0}{0.1} = \frac{-0.15}{0.1} = -1.5$$

Interpretation

A Z = -1.5 suggests that her bone density is 1.5 standard deviations below the mean, that is, lower than average, which could indicate osteopenia; even lower values would suggest osteoporosis.

Example D:

Laboratory tests and clinical values

Z scores can also be used to analyze biomarkers in laboratory tests, such as glucose and cholesterol levels, or in the analysis of vital signs such as blood pressure, comparing them with population reference values.

A patient has a systolic blood pressure of 140 mmHg.

The population mean is 120 mmHg with a standard deviation of 10 mmHg.

Z Score:

$$z = \frac{140 - 120}{10} = \frac{20}{10} = 2.0$$

Interpretation

A $Z = 2.0$ indicates that the patient's blood pressure is 2 standard deviations above the mean, higher than the average, which could suggest systolic arterial hypertension.

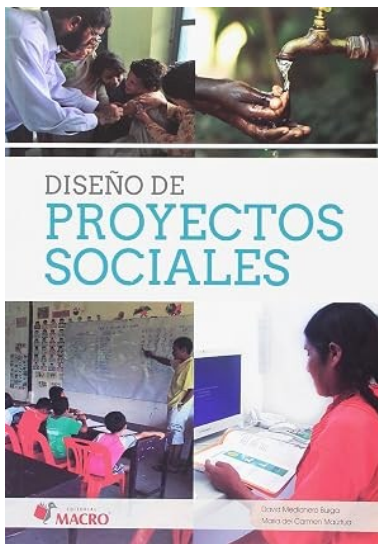
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Social project design

Editorial Macro. ISBN 978-6123043742

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The book *Social Project Design*, by David Medianero Burga and María del Carmen Maúrtua, serves as a methodological guide for the formulation and evaluation of social projects aimed at reducing poverty. Its distinguishing feature lies in its emphasis on linking such projects to economic competitiveness through sustainable productive initiatives that effectively increase the income of target populations. The central objective is to consistently integrate three dimensions that are often addressed separately in practice:

- Qualitative analysis (problem identification, stakeholder analysis, objectives, and logical framework);
- Quantitative analysis (costs, benefits, budgeting, and cash flow); and
- Formal requirements established by funding agencies (SNIP and APCI formats, business plans, and related documentation).

El ofrecimiento del libro es directo ya The book offers a clear value proposition, asserting that by following its methodology, it is possible to develop coherent, realistic, financially viable, and evaluable projects using the same technical language employed by evaluators in public institutions and international organizations. The content is organized into three major sections, complemented by an annex presenting a complete model of a productive development promotion project.

One of the key concepts addressed in the work is the principle of autonomy, which recognizes individuals' right to make informed decisions regarding matters that affect them. In this context, autonomy is associated with informed decision-making as an essential process of communication and participation. The first section presents the conceptual framework, defining what constitutes a project and distinguishing it from routine administrative management. A project is described

as a set of interconnected activities designed to achieve specific development objectives within clearly established timeframes and budgetary constraints.

The text further clarifies the concept of a social project, examines its different modalities, and approaches evaluation not merely as a technical requirement but as a meaningful exercise in value assessment. Strategic business analysis is adapted to the social sector in order to design projects that not only attract support but also demonstrate market viability. Finally, the authors outline the general project design methodology and the instruments employed throughout the process, including design procedures, analytical tools, key guiding questions, and the role of social projects within public policy and government action.

The second section functions as the practical component of the book. It presents a case study that applies the methodology through ten sequential steps, each supported by theoretical foundations, analytical tools, and practical implementation examples. These steps range from defining the central problem and conducting problem and alternative analyses to project description, market assessment, implementation planning, and financing strategies, culminating in project feasibility assessment. The section concludes with a complete productive development promotion project model, illustrating how project identification, formulation, and evaluation stages should be structured.

The third section focuses on project writing and presentation. It provides general guidelines for effective writing and offers recommendations aimed at achieving clarity, logical organization, and coherence. Various project formats are presented, including generic project proposals, business plans, and other commonly required structures.

In conclusion, the book proposes an integrated methodology for the formulation of social projects aimed at combating poverty through technically sound design, economic consistency, and compatibility with financing and international cooperation systems. The text is specifically intended to support the development of projects capable of securing funding, being effectively implemented, and undergoing rigorous evaluation. It successfully bridges social objectives with the practical realities of available resources, market dynamics, and public policy frameworks.



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