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ÍNDICE

Hojas Preliminares

Portada	Pág. i
Créditos	Pág. ii
Gestión Editorial	Pág. iii
Índice	Pág. iv

Artículos de Investigación

INCIDENCE OF CREDIT RISK IN THE LIQUIDITY LEVELS OF SAVINGS AND CREDIT MUTUALS IN ECUADOR	Pág.
Daniela Rodríguez Gavilanes.....	1-9
CONTROLADOR DIFUSO EN ARDUINO UNO PARA UN ENTORNO ACADÉMICO	Pág.
Fátima Avilés Castillo, John Espinoza, Jorge Buele	10-17
SELF-MEDICATION IN URBAN AND RURAL PARISHES: A CASE STUDY IN AMBATO, ECUADOR	Pág.
Marilyn Bermeo Merino	18-25
EARLY WARNING MECHANISM TO CONTROL DELINQUENCY LEVELS	Pág.
Daniela Rodríguez Gavilanes.....	26-34
ENFERMEDAD TROFOBLÁSTICA GESTACIONAL: REPORTE DE UN CASO	Pág.
Paulina Flores Naranjo	35-45
Contraportada	Pág. 46

Incidence of credit risk in the liquidity levels of savings and credit mutuals in Ecuador

Incidencia del riesgo de crédito en los niveles de liquidez de las mutualistas de ahorro y crédito del Ecuador

Incidência de risco de crédito nos níveis de liquidez de poupança e mútuos de crédito no Equador

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Abstract

Loans within a financial institution enable its economic growth and business expansion. However, some clients cannot pay these loans, which puts the organization's monetary stability at risk. Therefore, this paper is oriented to analyze the credit risk and its impact on the liquidity levels of savings and credit mutual societies in Ecuador from 2013-2018. Savings and credit mutual societies carried out a diagnosis of default control and monitoring processes. There is a mixed approach, which begins with an interview with the managers/administrators of the head offices of the entities under study to collect direct information on these processes. On the other hand, the consolidated financial statements published by the "Superintendencia de Bancos" (SB) and the "Superintendencia de Economía Popular y Solidaria" (SEPS) were analyzed, considering the transition period. The results indicate a positive and statistically significant relationship between the variables under study and a weak negative correlation between liquidity and delinquency of the total portfolio. It is possible to prove that credit risk impacts the liquidity levels of the savings and credit mutual societies for housing in Ecuador during this period.

Keywords: *Liquidity, Non-performing loans, Credit risk, Mutual society, Credit risks.*

Resumen

Los créditos dentro de una institución financiera permiten su crecimiento económico y su expansión empresarial. Sin embargo, hay clientes que no están en condiciones de pagar dichos créditos y ponen en riesgo la estabilidad monetaria de la organización. Por ello, el presente documento está orientado a analizar el riesgo de crédito y su incidencia en los niveles de liquidez de las mutualistas de ahorro y crédito del Ecuador en el período 2013-2018. Se efectuó un diagnóstico de procesos de control y seguimiento de mora llevado a cabo por las mutualistas de ahorro y crédito. Existe un enfoque mixto, que inicia con una entrevista a los gerentes/administradores de las oficinas matriz de las entidades objeto de estudio, para recaudar información directa sobre estos procesos. Por otro lado, se analizaron los estados financieros consolidados publicados por Superintendencia de Bancos (SB) y la Superintendencia de Economía Popular y Solidaria (SEPS), considerando el periodo de transición. Los resultados indican una relación positiva y estadísticamente significativa entre las



variables de estudio y una correlación negativa débil entre liquidez y morosidad de la cartera total. Se logra comprobar que el riesgo de crédito incide en los niveles de liquidez de las mutualistas de ahorro y crédito para la vivienda del Ecuador en este periodo.

Palabras claves: *Liquidez, Morosidad, Mutualistas, Riesgos de crédito.*

Resumo

Os créditos dentro de uma instituição financeira permitem seu crescimento econômico e expansão de negócios. Entretanto, há clientes que não estão em condições de reembolsar esses empréstimos e colocar em risco a estabilidade monetária da organização. Por este motivo, este documento tem por objetivo analisar o risco de crédito e seu impacto sobre os níveis de liquidez das instituições mútuas de poupança e crédito no Equador durante o período 2013-2018. Foi feito um diagnóstico dos processos de controle e monitoramento padrão realizados pelas cooperativas mútuas de poupança e crédito. Foi utilizada uma abordagem mista, começando com uma entrevista com os gerentes/administradores das sedes das instituições em estudo, a fim de coletar informações diretas sobre esses processos. Por outro lado, foram analisadas as demonstrações financeiras consolidadas publicadas pela "Superintendência de Bancos" (SB) e pela "Superintendência de Economia Popular e Solidária" (SEPS), considerando o período de transição. Os resultados indicam uma relação positiva e estatisticamente significativa entre as variáveis em estudo e uma fraca correlação negativa entre a liquidez e a delinquência total da carteira. É possível provar que o risco de crédito tem um impacto sobre os níveis de liquidez das instituições mútuas de poupança e de crédito habitacional do Equador durante este período.

Palavras-chave: *Liquidez, Empréstimos improdutivos, Mutuais, Riscos de crédito.*

1. Introduction

The participation of the mutual societies is quite discreet within the sector since, during the last ten years, there has always been a total of 4 mutual societies. The total assets of the mutual societies amount to USD 845 million, representing only 1.9% of total assets in the sector. According to the bulletin issued by the Superintendencia de Bancos y Seguros or Superintendencia de Economía Popular y Solidaria (SEPS): the popular and solidarity economic sector is composed of 645 financial sector entities and 13,206 organizations [1].

If the collections management process is not well defined and does not have an excellent plan to recover the portfolio, the loaned capital plus the interest generated will be lost [2]. Not having good liquidity during deposit withdrawals can cause all clients to enter into a financial panic and start withdrawing their money, leaving the institution bankrupt [3]. Defaulting on payments generates problems for the credit rating of delinquent clients. It produces consequences for financial institutions, and in general, for the whole system if this behavior becomes a trend.

The risk level of each loan is written off with provisions set by SEPS. For this reason, an increase in delinquency level reflects an increase in credit risk and impacts the institutions' liquidity. Portfolio recovery in financial institutions is a frequent problem since clients are not committed to meeting their payment obligations, which affects liquidity levels. Giving money to those supposed to pay interest implies the risk of losing the capital provided to the applicant [4].

As time goes by, the relationship between loans and the economic cycles faced by a financial institution becomes evident [5], [6]. It is essential to mention that macroeconomic factors affect these institutions' portfolio groups since, initially, the lender is analyzed, but its future behavior is unknown [7]. The credit policies of each organization are significant for granting credit since they will help provide a solution in the event of nonpayment by the debtors [8]. Risk measures can be based on the delinquency rates of each country so that the inherent risks and losses can be analyzed [9].

Considering the importance of the financial sector in the Ecuadorian economy, it is essential to analyze the issue of delinquency due to its impact on the population's confidence through its intermediation activities [10]. In the article published in the Telegraph by Acosta¹, it is mentioned that as of May 2019, the delinquency rate of private banks was 3.2%, which translates into \$ 827 million of an overdue portfolio. In 2017, the private banking rate was 3.6%, i.e., 0.4 percentage points have been reduced. That amount is the balance that the bank could potentially fail to collect.

¹ <https://www.eltelegrafo.com.ec/noticias/economia/4/sin-educacion-financiera-deudas-desbordan-creditos-consumo-comerciales-ecuador>

Liquidity indicators show the level of cash available to the company; in the case of a financial institution, this is one of the main control indexes [11]. Inadequate management of the collections area causes an imbalance in deposits and placements, and this affectation can increase the level of uncollectible accounts. The present research aims to determine credit risk and its impact on the liquidity levels of savings and credit mutual societies for housing in Ecuador from 2013-2018. This is the alternative hypothesis raised and will be analyzed in this paper.

This study consists of four sections, where the introduction is section 1. The materials and methods are described in section 2, and the results in section 3. Finally, the discussion is presented in section 4.

2. Materials y methods

2.1. Type of research

Primary bibliographic and documentary research is conducted by reviewing scientific and technical documents. There is also an analysis of the public consolidated financial statements available on the SB website, economic system, balance sheets, statistical products, financial bulletins, and others. There is also a high descriptive level since the characteristics and elements of the financial system, credit risk, liquidity, and other terms are shown.

2.2. Approach

This study has a mixed approach; on the one hand, it is qualitative because of the elaboration of interviews (primary information) with the managers/administrators of the mutual societies. On the other hand, the quantitative analysis allows us to know the current situation of the four savings and credit mutual societies regarding credit control. This is done through the public financial statements available on the web portal of the Superintendency of Banks and the SEPS (secondary information). We can analyze whether the working hypothesis is fulfilled through statistical correlations with these data.

2.3. Population-sample

The population of this study has not been established by a number but by a group of companies whose data is obtained directly from the SEPS web portal. Table 1 shows the offices owned by Ecuador's savings and credit mutual societies.

Table 1. List of Mutualists nationwide.

Item	Institution	Head Office	Branches
1	Mutualista Imbabura	Ibarra	Atuntaqui y Otavalo
2	Mutualista Ambato	Ambato	-
3	Mutualista Azuay	Cuenca	Azogues
4	Mutualista Pichincha	Quito	Cuenca, Azogues, Riobamba, Ambato, Latacunga, Guayaquil, Ibarra, Loja, Quevedo, Manta y Santo Domingo

2.4. Data collection techniques and instruments

The technique to be used in this research will be the interview, which consists of a guide that will be applied to the managers of the head offices of the mutual societies. The purpose of this instrument is to measure the knowledge of how the control of delinquency and liquidity levels is carried out in mutual companies. It comprises 16 questions related to the research topic, which a group of university professors validated.

The information collection instruments include the financial statements published and available in the Superintendencia de Bancos web portal and the SEPS. This information is used to analyze the existing correlation, i.e., the degree of variations suffered by one factor due to the influence of the other.

2.5. Procedure

Based on the review of the financial information of each institution, a summary and separate calculations are made. Microsoft Excel and the statistical program Eviews are used for data processing and analysis of the information or data obtained. Excel allows grouping, filtering, and analysis of the historical data of the most relevant accounts in the financial statements, using average data for the sector analyzed. A correlation study is applied to determine the extent to which two variables correlate. Correlation attempts to establish the relationship or dependence between the two variables involved in a two-dimensional distribution. To determine whether changes in one of the variables influence changes in the other, it is concluded that the variables are correlated. With this panel data, the space and time dimensions of the pooled data are omitted, and multiple linear regression on credit risk is calculated. This is generated using EViews, which offers forecasting and statistical modeling tools through a user-friendly interface that can create graphs and charts.

3. Results

To determine the relationship between the delinquency indicator and the liquidity levels of savings and credit mutual societies for housing, correlational analysis and a panel data pooled regression are performed.

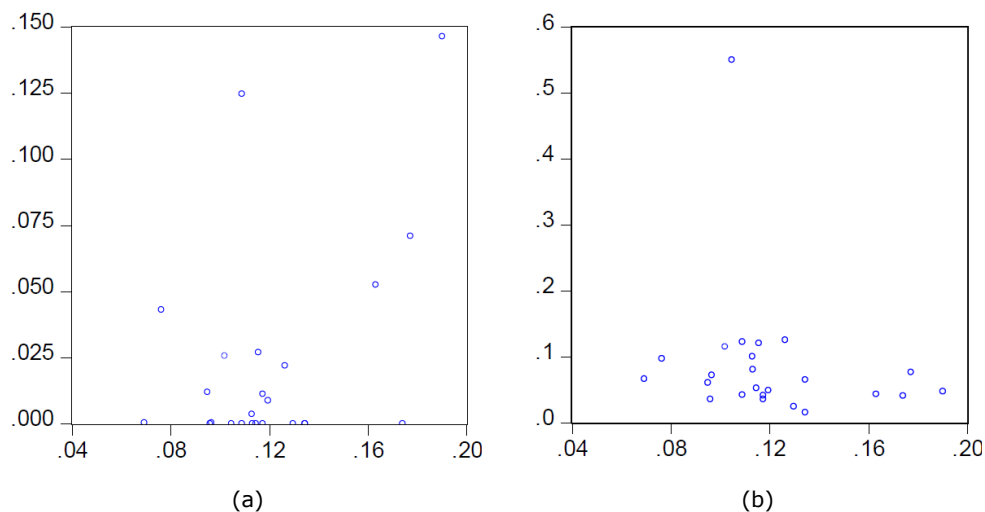
3.1. Correlaciones

Below are detailed correlation-dispersion diagrams between the liquidity indicator (Available Funds) and different proxies for the level of delinquency, tested for different portfolio segments registered by the savings and credit mutual societies for housing.

The results found that liquidity and commercial loan portfolio delinquency were not as expected since an inversely proportional relationship was considered. As shown in Figure 1 (a), this correlation is positive since the dispersion shows that delinquency depends on the institution's liquidity. While Figure 1 (b) shows a weak negative correlation, where the dispersion shows that as liquidity increases, there is a tendency for consumer loan portfolio delinquency to decrease, and other causes of dependence exist. Figure 1 (c) shows a weak negative dispersion since when liquidity grows, delinquency decreases.

Figure 1(d) shows a weak positive correlation, where the dispersion indicates that the higher the liquidity, the higher the delinquency, i.e., a linear relationship. Since if one variable is increasing, the other will also take the same direction as in this case. Figure 1 (e) shows a weak negative correlation between the variables since, with an increase in liquidity, there is a tendency for the total portfolio to decrease.

The correlation between liquidity and provisions was also analyzed and is weakly positive. The dispersion shows that the higher the liquidity, the higher the provisioning reserve, i.e., it depends on liquidity; therefore, there is a linear relationship (Figure 2(a)). Figure 2 (b) shows the weak positive correlation between liquidity and problem portfolio coverage. The dispersion indicates that the higher the liquidity, the higher the coverage, i.e., coverage depends on liquidity, so there is a linear relationship.



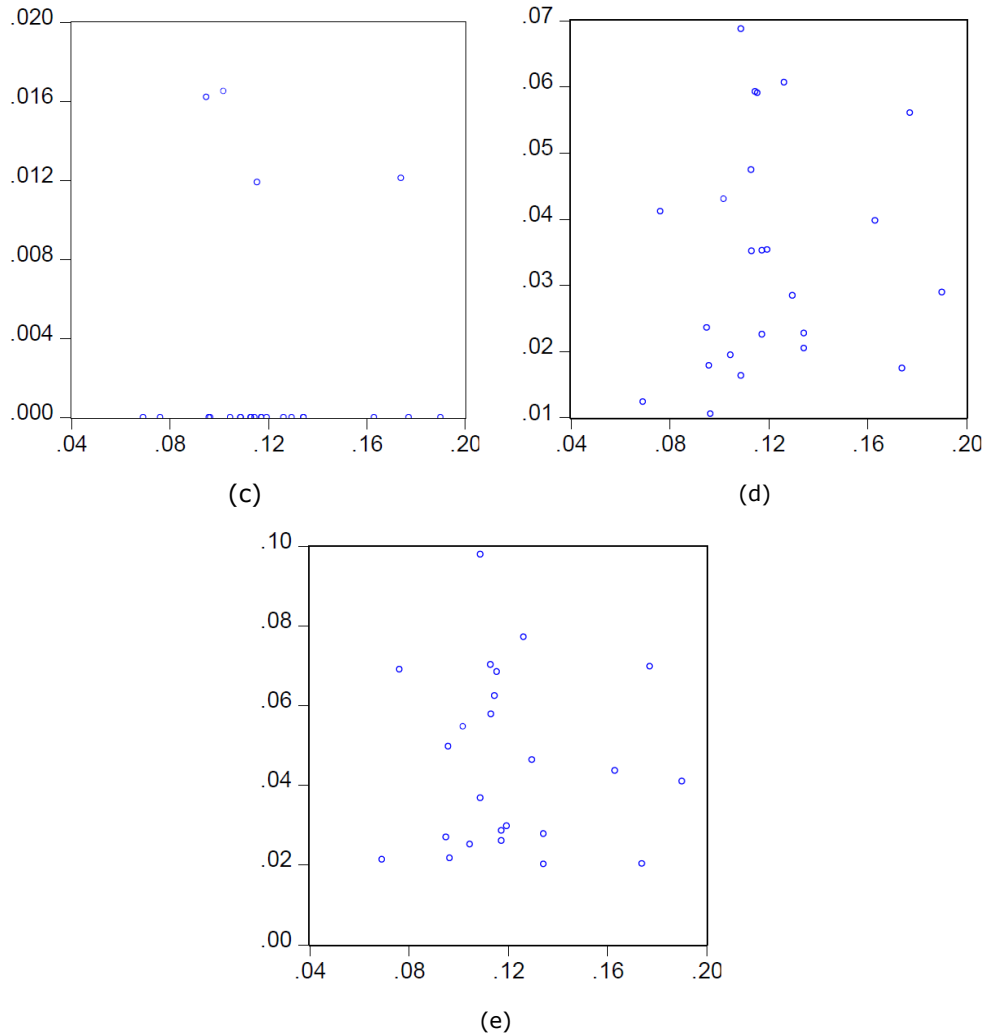


Figure 1. Correlation between liquidity (horizontal axis) and portfolio delinquency (vertical axis): (a) commercial loans (b) consumer loans (c) ordinary consumer loans (d) housing loans (e) total.

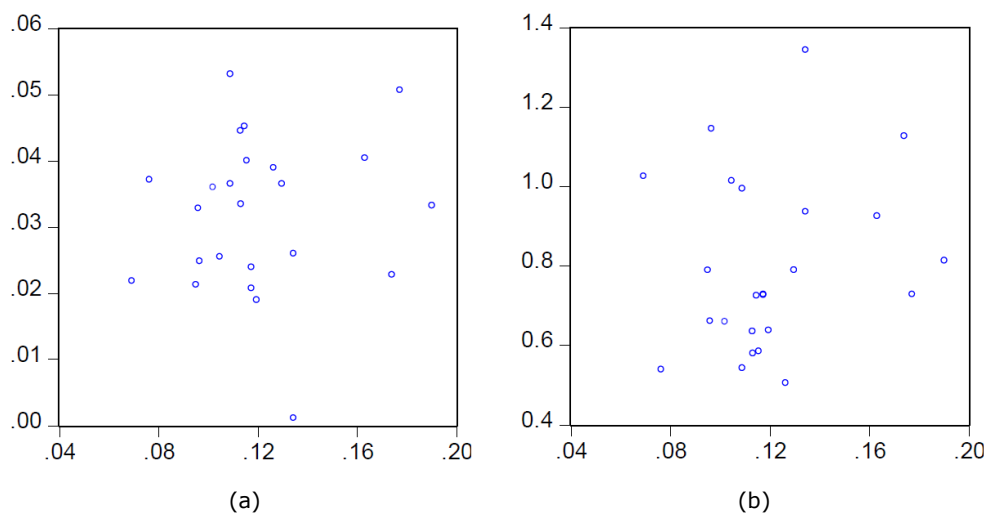


Figure 2. Correlation between liquidity (horizontal axis): (a) provisions (b) problem portfolio coverage (vertical axis).

All previous information is corroborated by the correlation matrix provided in Table 2. The correlation of liquidity with some delinquency indicators and coverage of problem portfolios and provisions was analyzed. The correlation matrix explains how each variable is related to another variable. Its diagonal will always contain the value of 1. If it has a value of 0, it indicates that it has no relationship with that variable, at least not linear; i.e., it may have a quadratic or another degree of relationship.

Table 2. Matrix of correlations of liquidity with delinquency indicators, problem portfolio coverage, and provisions.

	L	MCCC	MCCS	MCCO	MCCV	MCT	CCP	P
L	1	0.4410	-0.1935	-0.0381	0.1311	-0.0238	0.1817	0.1092
MCCC	0.4410	1	-0.0259	-0.0719	0.4526	0.4765	-0.2846	0.4679
MCCS	-0.1935	-0.0259	1	-0.0081	0.0295	0.0343	0.0137	0.0639
MCCO	-0.0381	-0.0719	-0.0081	1	0.0301	-0.0663	-0.0355	-0.0803
MCCV	0.1311	0.4526	0.0295	0.0301	1	0.8822	-0.7093	0.7247
MCT	-0.0238	0.4765	0.0343	-0.0663	0.8822	1	-0.7593	0.8538
CCP	0.1817	-0.2846	0.0137	-0.0355	-0.7093	-0.7593	1	-0.6262
P	0.1092	0.4679	0.0639	-0.0803	0.7247	0.8538	-0.6262	1

Notes: L = Liquidity, MCCC = Commercial loan portfolio delinquency, MCCS = Consumer loan portfolio delinquency, MCCO = Ordinary consumer loan portfolio delinquency, MCCV = Housing loan portfolio delinquency, MCT = Total portfolio delinquency, CCP = Problem portfolio coverage, P = Provisions.

Before performing the regression to test the hypothesis of this study, the unit root test is performed for each of the variables considered in the analysis, which helps build a better-behaved model and obtain more relevant conclusions.

3.2. Unit root test

The evaluation criteria are as follows: level 1% (-3.460300); 5% (-2.929400) and 10% (-2.638950). The stationarity tests of the series used in the regression were carried out, and it was determined that the series related to delinquency is stationary; therefore, we work with the first differences to facilitate the modeling of the data. The unit root test performed for the liquidity, total delinquency, and provisions variables is detailed below.

Table 3. Summary of unit root test results.

Variable	Statistic	Prob. **	Cross-sections	Obs
Liquidity	-3,3793	0,0004	4	20
Total portfolio delinquency	-1,1222	0,1309	4	20
Provisions	-1,5186	0,0644	4	20

Table 3 shows the unit root test for liquidity, which is analyzed and determined by the value of the t-statistic, which gave a result of -3.3793. This value is less than one of the levels described above. Therefore, it is concluded that the series is stationary and has no unit root. In the case of total portfolio delinquency, the result is -1.1222, which is greater than the levels described above, showing a unit root. In the case of provisions, the results were similar to the previous one (-1.5186), i.e., there is a unit root.

3.3. Multiple linear regression

A multiple linear regression analysis was performed to determine credit risk's impact on liquidity levels. Thus, the significance of each of these variables concerning liquidity was determined, taking "liquidity" as the dependent variable and "total portfolio delinquency" and "provisions" as independent variables. The available fund's indicator is a proxy for liquidity, while provisions and the total portfolio delinquency indicator are proxies for loan portfolio delinquency. Using EViews software, equation (1) is obtained, and the results are shown in Figure 3.

$$\text{Liquidity} = 0,4176(\text{Provisions}) - 1,2247(\text{Delinquency of the total portfolio}) + \varepsilon \quad (1)$$

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.1120	0.01796	6.2372	0.0000
D(MOROSIDAD_DE_LA_CARTERA_TOTAL)	-1.2247	0.3953	-3.0981	0.0065
PROVISIONES	0.4176	0.5131	0.8138	0.4270
R-squared	0.3650	Mean dependent var	0.1227	
Adjusted R-squared	0.2903	S.D. dependent var	0.0324	
S.E. of regression	0.0273	Akaike info criterion	-4.2263	
Sum squared resid	0.0123	Schwarz criterion	-4.0769	
Log likelihood	45.2630	Hannan-Quinn criter.	-4.1972	
F-statistic	4.8865	Durbin-Watson stat	1.3401	
Prob(F-statistic)	0.0211			

Figure 3. Multiple linear regression output in EViews.

Figure 3 shows the coefficient of determination (R²) with a value of 0.3650. This coefficient measures which part is explained in a given variant, i.e., which can be predicted by the variation of the other. It is a measure between 0 and 1, "0" meaning non-representativeness and "1" a perfect fit. The R² demonstrates a functional relationship between the analysis variables for this case study. Subsequently, the coefficients are analyzed, which indicate the variation in the number of units of the dependent variable.

As seen in Fig. 3, the coefficient of delinquency of the total portfolio yielded -1.2247; this coefficient has a probability of less than 99% confidence level. Therefore, the null hypothesis is rejected, and the alternative is accepted, and it turns out to be significant. Thus, it is evident that credit risk impacted the liquidity levels of the savings and credit mutual societies for housing in Ecuador in 2013-2018.

The Durbin-Watson coefficient represents the autocorrelation between the residuals corresponding to each observation. In the present case study, a Durbin-Watson coefficient of 1.3401 was obtained, which means that the variables are related and allow testing the hypothesis where the null hypothesis is rejected and the alternative is accepted. The t statistic represents that the parameters are statistically significant and explain the dependent variable's behavior.

3.4. Interviews

Given the length of this article, the responses obtained in the interviews are presented in [Supplementary Material 1](#).

4. Discussion

When evaluating the liquidity and delinquency of the commercial loan portfolio, a directly proportional relationship was found since the granting of loans is not the only source of funding resources [12]. More money enters the institution by providing several services as a financial institution, which generates the possibility of granting new loans that may not be repaid, increasing delinquency levels. The correlation between liquidity and total portfolio delinquency is weakly negative, at -0.0238, indicating that the relationship between the data is fragile. While with the provisions account, there is a positive correlation which shows a strong relationship of 0.1092 between the data. In all the graphs', very scattered points are identified, which shows the existence of minor errors in the measurement or recording of the data obtained from the financial statements of the control entities.

Through the interview conducted with each of the managers of the head offices of the savings and credit mutual societies for housing, it was concluded that by current legal regulations and control mechanisms, the entities had defined policies and procedures that must be fully complied with by all members of the financial institution. Mutual societies have a comprehensive risk management manual that allows the Management Committee to manage the different risks [13].

Thanks to the calculation of delinquency through statistical tools and the application of the formulas established by the Superintendency of Popular and Solidarity Economy, it was possible to determine the delinquency levels

of each of the institutions analyzed. These have been varying according to the situations in the country and the control each has had. Mutual Society Azuay is positioned with the lowest percentage of delinquency, 2.38%. A multiple linear regression analysis was carried out to determine the impact of credit risk on liquidity levels to assess the significance of each of the variables under study. Finally, it was possible to test the working hypothesis regarding the impact of credit risk on delinquency levels in these organizations.

Savings and credit mutual societies for housing must opt for the performance measurement and early warning system for delinquency. The CAMEL methodology, which weighs five criteria and 13 indicators, is recommended to implement corrective actions accordingly. External companies could also be hired to help with portfolio recovery to reduce delinquency and increase liquidity levels, thus generating greater confidence and security for members.

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Informed Consent Statement

Not applicable.

Conflicts of Interest

The author declares that they have no conflict of interest.

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Fuzzy Controller on Arduino Uno for an Academic Environment

Controlador Difuso en Arduino Uno para un Entorno Académico

Controlador Difuso no Arduino Uno para um Ambiente Acadêmico

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Abstract

Teaching and learning processes require constant updating and the incorporation of new approaches. Higher education institutions must make critical economic investments or look for lower-cost alternatives. Therefore, this paper presents the implementation of a fuzzy control algorithm on an Arduino Uno embedded board. The fuzzy controller design has five membership functions at both input and output SISO (single input/single output). As input, we have the accumulated error value, which is the difference between the desired and measured values. Simulation tests were carried out in MATLAB's Simulink block diagram environment. At the same time, the experimental tests were developed in a didactic station that mimics an industrial pressure control process. Other parameters that are part of the process curves are also obtained for better analysis. In this way, this proposal is validated, providing information for future research.

Keywords: Fuzzy Controller, Pressure Control, Arduino, Academic Station.

Resumen

Los procesos de enseñanza – aprendizaje requieren una constante actualización y la incorporación de nuevos enfoques. Para esto las instituciones de educación superior necesitan realizar importantes inversiones económicas o buscar alternativas de menor costo. Por ello en este artículo se presenta la implementación de un algoritmo de control difuso en una tarjeta embebida Arduino Uno. El diseño del controlador difuso se realiza con cinco funciones de membresía tanto a la entrada como a la salida SISO (entrada simple/salida simple). Como entrada se tiene el valor del error acumulado que es la diferencia entre el valor deseado y el valor medido. Las pruebas de simulación se efectuaron en el entorno de diagrama de bloques Simulink de MATLAB. Mientras que las pruebas experimentales se desarrollaron en una estación didáctica que imita un proceso de control de presión industrial. También se obtienen otros parámetros que son parte de las curvas de proceso para un mejor análisis. De esta manera se valida esta propuesta, ofreciendo información para futuras investigaciones.



Palabras Claves: Controlador Difuso, Control de Presión, Arduino, Estación Académica.

Resumo

Os créditos dentro de uma instituição financeira permitem seu crescimento econômico e expansão de negócios. Entretanto, há clientes que não estão em condições de reembolsar esses empréstimos e colocar em risco a estabilidade monetária da organização. Por este motivo, este documento tem como objetivo analisar o risco de crédito e seu impacto sobre os níveis de liquidez das instituições mútuas de poupança e crédito no Equador durante o período 2013-2018. Foi feito um diagnóstico dos processos de controle e monitoramento padrão realizados pelas cooperativas mútuas de poupança e crédito. Foi utilizada uma abordagem mista, começando com uma entrevista com os gerentes/administradores das sedes das instituições em estudo, a fim de coletar informações diretas sobre esses processos. Por outro lado, foram analisadas as demonstrações financeiras consolidadas publicadas pela Superintendência de Bancos (SB) e pela Superintendência de Economia Popular e Solidária (SEPS), considerando o período de transição. Os resultados indicam uma relação positiva e estatisticamente significativa entre as variáveis em estudo e uma fraca correlação negativa entre a liquidez e a delinqüência total da carteira. É possível provar que o risco de crédito tem um impacto sobre os níveis de liquidez das instituições mútuas de poupança e de crédito habitacional do Equador durante este período.

Palavras-chave: Controlador Difuso, Controle de Pressão, Arduino, Estação Académica.

1. Introducción

Las instituciones de educación superior buscan mejorar las habilidades de sus estudiantes, por lo cual invierten constantemente en la renovación de sus laboratorios [1]. Esto contribuye de manera efectiva en el proceso de formación de los estudiantes de carreras técnicas y de ingeniería. Este tipo de experimentos permiten afianzar los conocimientos teóricos por medio de la experimentación y el desarrollo de diversas prácticas. Los requerimientos del sector industrial incluyen el control de variables de nivel, presión, temperatura, flujo, etc. [2].

Existen diversos campos en los que se utilizan los controladores regulares o PID. Son configuraciones que facilitan el control de un sistema de lazo cerrado, con la finalidad de mantener una variable en un valor deseado. Éste está compuesto de tres elementos que proporcionan una acción proporcional, integral y derivativa, que justamente le otorgan su nombre. En conjunto generan una acción correctiva a partir del error que existe entre el valor medido y el deseado [3]. Con el paso del tiempo aparecieron los controladores avanzados, entre los cuales se pueden citar el MPC, adaptativo, en cascada, difuso o borroso, etc. [4]. Este último es utilizado en procesos no lineales y se basa en tres etapas que son: emborronado, reglas de membresía y desemborronado. Este controlador puede ser utilizado para diversas aplicaciones incluso en las de tipo industrial, lo cual ya se ha demostrado previamente [5].

En la industria alimenticia se ha visto su aplicación desde hace varias décadas como lo demuestra Davidson [6]. Aquí se pueden apreciar los componentes que conforman este tipo de controladores, lo cual permite comprender de mejor manera como realizar un diseño acorde con los procesos alimentarios. Este tipo de controladores permiten explorar de mejor manera la incertidumbre dentro del control de ciertos procesos. Además, incorpora más robustez, escalabilidad y es una solución de menor costo. Dentro de los entornos académicos la implementación de este tipo de herramientas aporta con mayores conocimientos para el estudiante. Dentro de su formación se puede encontrar con el control de motores mediante el control difuso, como lo muestran en [7]. También se pueden ejecutar asignaciones dedicadas en el campo de la robótica, aportando calidad, portabilidad y reducción de recursos [8]. Mientras que en [9] se puede observar un accionamiento en corriente continua usando un sistema difuso multi-cascada. En [10] se puede apreciar el control de un horno de tratamiento térmico mediante un controlador difuso Takagi-Sugeno-Kang (TSK).

Para implementar estos algoritmos en el sector manufacturero se usan PLC [5]. Dependiendo de las necesidades del usuario pueden tener costos muy elevados, por lo que las instituciones del sector público no pueden adquirirlos. La falta de renovación de equipos y las limitaciones económicas tienen una incidencia directa sobre los conocimientos de los estudiantes, por lo que se requieren cambios de manera urgente. Ante esta problemática, en el presente trabajo se implementa un controlador difuso en la tarjeta Arduino uno, para que los estudiantes realicen prácticas de control automático.

Este trabajo consta de 4 secciones, incluyendo la introducción en la sección 1. Los materiales y métodos se muestran en la sección 2. Los resultados y las conclusiones se presentan en las secciones 3 y 4 respectivamente.

2. Materiales y métodos

2.1. Tipo de investigación

Esta investigación según el objetivo es del tipo aplicada, ya que se basa en metodologías empíricas para la resolución de problemas en el campo de la educación. Los algoritmos y la información obtenida se consiguen en base a la experimentación. También es del tipo exploratoria ya que aporta información de campo que no se puede generalizar.

2.2. Enfoque

Este estudio tiene un enfoque únicamente cuantitativo, ya que se evalúan los principales parámetros de un proceso de presión, en base a la teoría de control moderno. Esta se aplica en una estación didáctica similar a una industrial, por lo que se obtienen datos numéricos que pueden ser comparados con la literatura.

2.3. Población-muestra

Este documento no tiene una población o muestra de estudio.

2.4. Técnicas e instrumentos de recopilación de datos

Los datos provenientes de la estación que simula el proceso se almacenan en un archivo con extensión .xlsx. Con esta información se pueden realizar gráficas que comparen los resultados esperados y los obtenidos.

2.5. Procedimiento

2.5.1. Estación de presión

El diseño de la planta de presión se basó en las normas ISA 5.3 e ISA 5.1, para que la nomenclatura utilizada cumpla con los parámetros internacionales. En la Fig. 1 se describen los componentes que forman parte de este sistema, donde se incluyen tuberías, tanques, válvula manual, un transmisor indicador de presión (PIT 001), un controlador (PC 001) y una válvula con posicionador (VC-1).

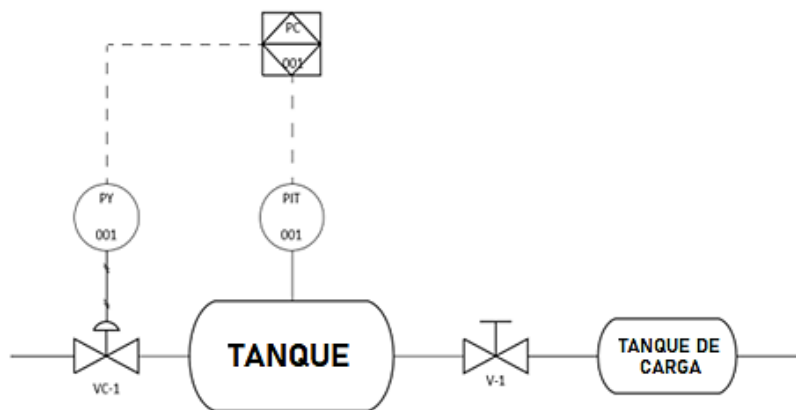


Fig. 1. Diagrama PI&D de la estación de presión.

Como controlador se utilizó la tarjeta embebida Arduino, la cual se basa en el microcontrolador ATmega328P. Un dispositivo robusto y de muy bajo costo, que es la más usada de esta familia de tarjetas. Posee 14 pines de entrada/salida, donde 6 son entradas analógicas, también posee conexión USB, alimentación externa y conexión a un sinnúmero de componentes según el proyecto que se realice. Tiene un entorno de desarrollo (IDE) propio, el cual utiliza programación estándar basado en C++ y un firmware que se ejecuta en ésta.

2.5.2. Controlador difuso tipo Mamdani

Este sistema toma decisiones y ofrece la facilidad de crear un algoritmo de control mediante el uso de variables lingüísticas. En comparación con los controles clásicos, las variables difusas pueden asumir valores entre 0 y 1, ya que se basa en reglas de tipo si - entonces. Éstas simbolizan una relación de entrada - salida que provienen de sistemas no lineales. La ventaja de este modelo es que las descripciones del sistema permiten expresar una aproximación.

Para esta aplicación se consideran el error en esta estable, el cual es la diferencia entre el valor deseado (set point SP) y el valor medido (variable de proceso PV). Una vez que se identifican estas variables de entrada y salida se definen los conjuntos de entrada y se desarrollan las 5 funciones de pertenencia que se muestran en la Tabla 1. De forma similar se forman los 5 conjuntos de salida respectivos, que se aprecian en la Fig. 2.

Tabla 1: Conjuntos difusos de entrada y salida.

	Nombre	Descripción	Intervalo
Conjuntos de entrada	ENA	Error negativo alto	-200 to -110
	ENB	Error negativo bajo	-145 to 0
	EN	Error neutral	-70 to 70
	EPB	Error positivo bajo	0 to 145
	EPA	Error positivo alto	110 to 200
Conjuntos de salida	ANA	Acción negativa alta	-5 to -2,75
	ANB	Acción negativa baja	-3.625 to 0
	AN	Acción neutral	-1.75 to 1.75
	APB	Acción positiva baja	0 to 3.625
	APA	Acción positive alta	2.75 to 5

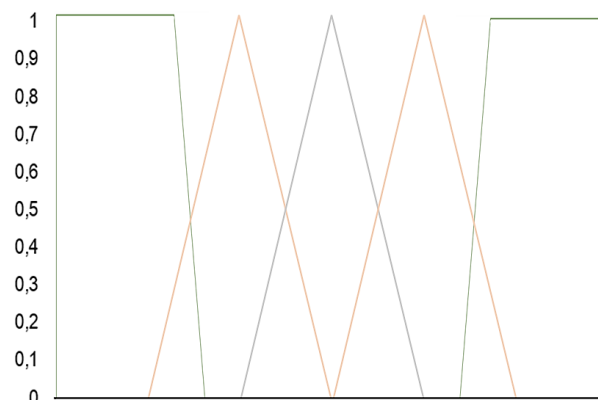


Fig. 2. Conjuntos borrosos de entrada de la variable lingüística.

Como controlador se utilizó la tarjeta embebida Arduino, la cual se basa en el microcontrolador ATmega328P. Un dispositivo robusto y de muy bajo costo, que es la más usada de esta familia de tarjetas. Posee 14 pines de entrada/salida, donde 6 son entradas analógicas, también posee conexión USB, alimentación externa y conexión a un sinnúmero de componentes según el proyecto que se realice. Tiene un entorno de desarrollo (IDE) propio, el cual utiliza programación estándar basado en C++ y un firmware que se ejecuta en ésta.

2.5.3. Comunicación OPC entre Arduino y HMI

En la Fig. 3 se detalla el diagrama de bloques, que explica la estructura de comunicación entre Arduino y el HMI.

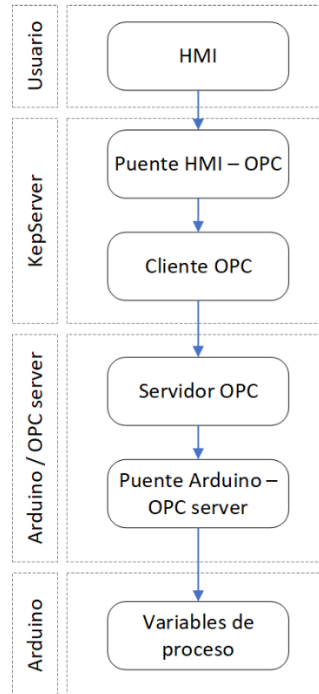


Fig. 3. Diagrama de bloques de la comunicación entre Arduino y el HMI.

Arduino ofrece la posibilidad de establecer una comunicación con el HMI mediante un servidor OPC. Para su configuración previamente se necesita descargar la librería OPC, mediante el "Gestor de Librerías" del IDE de Arduino y el programa gratuito "Arduino OPC Server". Éste está disponible enlace: <https://www.st4makers.com/download-opc-server-for-arduino>. El servidor OPC de Arduino sirve de puerta de enlace entre el IDE de Arduino y el software KepServer Ex 5 que hace las veces de cliente OPC [11].

2.5.4. Instalación y configuración de Arduino OPC Server 1.9

Antes de iniciar con la instalación del servidor OPC de Arduino es indispensable instalar los componentes principales de OPC, los cuales están disponibles en: <https://opcfoundation.org/developertools/developer-kits-classic/core-components>. Para acceder a la descarga es necesario crear un usuario y contraseña con fines de verificación de la página. A continuación, seguir estos pasos:

- Descomprima y ejecute el archivo ArduinoOPCServer.exe. Luego de ejecutarse el archivo generará dos archivos nuevos.
- Los archivos que se crean sirven para registrar el servidor en el sistema operativo, luego configurar el servidor dirigiéndose a la pestaña "Configuration". Ahí seleccionar el puerto serial, la velocidad de comunicación y el intervalo de lectura.
- Salvar la configuración y ejecutar como administrador el archivo "register", para registrar en el sistema operativo los cambios que se realizaron en la comunicación. Estos pasos se realizan una sola vez o cuando los parámetros de comunicación sean cambiados.
- Ejecutar el IDE de Arduino y seleccione la pestaña "Programa", en esta opción elija "Incluir Librería" y luego "Gestionar Librerías". En la ventana que se despliega dirigirse a la barra de búsqueda y escribir OPC para localizar la librería necesaria; seleccionar la última versión e instalar.

2.5.5. Configuración del cliente OPC en el software KEPServerEx 5

En el software KEPServerEx 5 se configura el canal y dispositivo que permita enviar los valores de las variables de proceso del control realizado en Arduino y así visualizarlas en LabVIEW.

- a) Creación del Canal del cliente OPC
 - Crear un nuevo canal y darle un nombre para identificarlo fácilmente.

- Seleccionar el controlador del dispositivo. En este caso el controlador a elegir es OPC DA Client, dar clic en siguiente hasta llegar a la ventana de selección del servidor OPC.
 - En la ventana del wizard de ayuda seleccionar el servidor OPC con el cual va a conectarse, como se trata de una comunicación local se despliega la pestaña Local Machine y escoger ArduinoOPCServer.1.
 - Avanzar en las ventanas de ayuda del wizard (no es necesario modificar los parámetros) hasta finalizar la creación del canal.
- b) Creación del Dispositivo OPC y los tags de comunicación
- Crear un nuevo dispositivo en el canal que se creó anteriormente.
 - Clic en siguiente hasta llegar a la ventana de importar ítems, cabe mencionar que en las ventanas anteriores no es necesario modificar ningún parámetro para obtener una buena comunicación.
 - Importar los ítems que deben estar previamente compilados y cargados a la tarjeta Arduino para ser reconocidos por el software. Añadir uno a uno los tags que representan a las variables de proceso.
 - Verificar que la calidad de comunicación sea buena [11].

3. Resultados

3.1. Simulación

En la Fig. 4 se presenta la simulación de la respuesta del controlador en la estación mencionada. Se realiza en el software Simulink, donde se aprecia que la variable de procesos sigue a la señal de control establecida, como se esperaba.

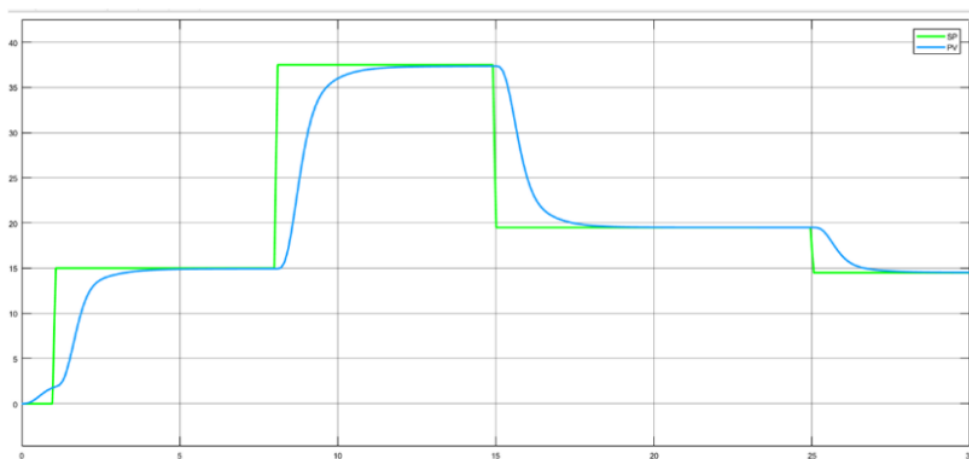


Fig. 4. Resultados de simulación del controlador.

3.2. Pruebas experimentales

A continuación, se presenta el análisis de las curvas de respuesta que producen las variables del proceso, al implementar el algoritmo de control difuso. Este experimento inicia con el SP en 0 PSI y posteriormente va incrementado 60, 40, 20, 100 y 40 PSI cada 15 segundos respectivamente. En el eje vertical se presentan los valores de presión, mientras que en el eje horizontal está el tiempo. Como se puede observar en la Fig. 5 el valor del PV sigue al SP con poco sobreimpulso negativo en el cambio de 100 a 20.

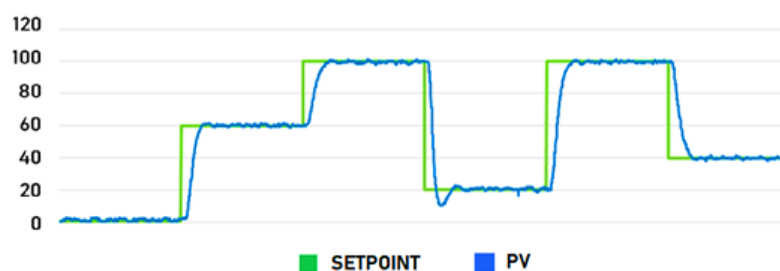


Fig. 5. Curvas de respuesta de la señal ante distintos cambios de SP.

En la tabla se describen los valores característicos temporales y de sobreoscilación del sistema ante la excitación de un escalón unitario, como producto del cambio del valor del SP de 0 a 80 PSI. El rango de variación del SP es igual a 80 PSI, por lo que, el tiempo de asentamiento (T_s) se determina cuando la curva de respuesta alcanza un rango igual o menor al 5% alrededor del SP. En este caso el rango será $80 \pm 5\%$, es decir entre 76 y 84 PSI. El tiempo de subida (T_r) se determina desde que la curva de respuesta está al 10% hasta que alcanza el 90%, es decir desde 8 hasta 72 PSI. El tiempo muerto (T_m) es el intervalo desde que se cambia la consigna y el controlador reacciona, mientras que el porcentaje de sobreimpulso ($\%M$) es la cantidad de variación de la PV con respecto al SP, cuando éste varía.

Tabla 2: Resumen de los valores temporales y de sobreoscilación del sistema.

T_m	T_r	T_s	$\%M$
3.16 s	7.64 s	12.6 s	4.21%

4. Discusión

El sector industrial necesita de profesionales que estén capacitados, en este caso particular que los ingenieros dominen la teoría de control. En esta aplicación se desarrolló un controlador de bajo costo que puede ser usado por los estudiantes de una institución de educación superior para reforzar su aprendizaje teórico. Con este prototipo los alumnos pueden variar los conjuntos de entrada y de salida y ver la respuesta del sistema tanto en simulación como su implementación real. Para comprobar su correcto funcionamiento de diseño un algoritmo de control con cinco funciones de membresía que ofrece muy buenos resultados.

De igual manera se comprueba que tarjetas de muy bajo costo pueden ser usadas para el control de elementos semi-industriales. La tarjeta Arduino Uno es la más económica de su familia, sin embargo, tiene buenas prestaciones, lo cual ya ha sido comprobado en otras aplicaciones como [12], [13]. Dentro del algoritmo desarrollado se tuvieron tiempos bajos de respuesta y un porcentaje reducido de sobreimpulso. En la Fig. 5 al realizar una reducción brusca del valor de SP de 100 a 20 PSI se percibe un sobreimpulso negativo considerable. Un resultado que dado el alto rango de variación de la consigna y las limitadas características técnicas de esta tarjeta son justificados, sin reducir su validez.

Como principal limitación se tienen las características propias de la tarjeta, pero que para esta aplicación son suficientes. También se destaca la necesidad de un acondicionamiento de señales a la entrada y salida de las señales, lo cual con un PLC no sería necesario. Finalmente, el uso de una estación de uso estudiantil, podría tener un comportamiento distinto a un proceso real a pesar de la existencia de elementos industriales como válvulas, tuberías y tanques.

Como trabajo futuro se motiva a otros investigadores a seguir probando la validez de este tipo de tarjetas embebidas en otros procesos. También se podría comparar con el desempeño de un PLC, lo cual daría mayor información sobre su uso en las industrias.

Financiamiento

Esta investigación ha sido financiada en su totalidad por los autores.

Declaración de la Junta de Revisión Institucional

No aplica.

Declaración de Consentimiento Informado

No aplica.

Conflictos de Interés

Los autores declaran no tener un conflicto de interés.

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Self-medication in urban and rural parishes: A case study in Ambato, Ecuador

Automedicación en parroquias urbanas y rurales: Un caso de estudio en Ambato, Ecuador

Automedicação em paróquias urbanas e rurais: um estudo de caso em Ambato, Equador

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Abstract

Self-medication is a global phenomenon and a potential factor in developing antibiotic resistance in human pathogens. To determine the prevalence of self-medication with non-steroidal anti-inflammatory drugs (NSAIDs) in the urban and rural population of Ambato in the period March-July 2020; a descriptive and cross-sectional study was conducted where participants went without prescription to community pharmacies in Santa Rosa and Izamba (rural area) and San Francisco and La Matriz (urban area) of Ambato. They were invited to answer a survey where sociodemographic aspects and general information (medications, causes, diseases) were evaluated. A sample of 760 people, primarily women (56.7%), with 29.6% living in rural areas, was used. The results showed that 45.7% of the subjects were self-medicating; of these, 65.4% belonged to the urban sector. In addition, factors predisposing to this practice were identified, such that most of them had a secondary or higher level of education. Likewise, the media had a direct influence, among which family (40.9%), the internet (27.7%), and advertisements (16.7%) stood out. In comparison, lack of time (34.3%) and proximity to community pharmacies (32%) were the main reasons for self-medication.

Keywords: Self-medication, Medical prescription, Biochemistry, Pharmacy, NSAIDs.

Resumen

La automedicación es un fenómeno global y un factor potencial en el desarrollo de resistencia a antibióticos en patógenos humanos. Con el fin de determinar la prevalencia de la automedicación con antiinflamatorios no esteroideos (AINEs) en la población urbana y rural del Cantón Ambato en el período marzo-julio 2020. Se realizó un estudio descriptivo y de corte transversal donde los participantes acudieron sin receta médica a farmacias comunitarias de Santa Rosa e Izamba (zona rural) y de San Francisco y la Matriz (zona urbana) del cantón Ambato. Fueron invitadas a responder una encuesta donde se evaluaron aspectos sociodemográficos e información general (medicamentos, causas, enfermedades). Se utilizó una muestra de 760 personas, en su mayoría mujeres (56.7%), donde el 29.6% radicaba en la zona rural. Los resultados determinaron que el 45.7% de sujetos se automedicaban y de estos, el 65.4% pertenecían al sector urbano. Además, se identificaron los factores que predisponen a esta práctica, de modo que, la mayor parte tenían un nivel de instrucción de secundaria y superior. Asimismo, los medios de comunicación influían directamente, entre los



que sobresalían la familia (40,9%), internet (27,7%) y propagandas (16,7%), en tanto que, la falta de tiempo (34,3%) y cercanía de las farmacias comunitarias (32%) fueron las principales razones para la automedicación.

Palabras claves: Automedicación, Prescripción médica, Bioquímica, Farmacia, AINEs.

Resumo

A automedicação é um fenômeno global e um fator potencial no desenvolvimento da resistência aos antibióticos em patógenos humanos. A fim de determinar a prevalência de automedicação com anti-inflamatórios não esteroides (AINEs) na população urbana e rural de Ambato no período de março a julho de 2020. Foi realizado um estudo descritivo, transversal, em que os participantes visitaram farmácias comunitárias em Santa Rosa e Izamba (zona rural) e San Francisco e La Matriz (zona urbana) do cantão de Ambato sem receita médica. Eles foram convidados a responder a uma pesquisa que avaliou aspectos sociodemográficos e informações gerais (medicamentos, causas, doenças). Foi utilizada uma amostra de 760 pessoas, a maioria mulheres (56,7%), 29,6% das quais viviam em áreas rurais. Os resultados mostraram que 45,7% dos sujeitos eram automedicantes e destes, 65,4% eram do setor urbano. Além disso, foram identificados fatores predisponentes a esta prática, de tal forma que a maioria deles tinha um nível de ensino secundário ou superior. Além disso, a mídia teve uma influência direta, sendo a família (40,9%), a Internet (27,7%) e a publicidade (16,7%) as principais razões para a automedicação, enquanto a falta de tempo (34,3%) e a proximidade de farmácias comunitárias (32%) foram as principais razões para a automedicação.

Palavras-chave: Automedicação, Prescrição médica, Bioquímica, Farmácia, AINEs.

1. Introduction

According to the World Health Organization (WHO), *self-medication* is defined as the use of one or more drugs available in pharmacies, on one's initiative and without a prescription, to take care of oneself autonomously, which grew in the 1960s and 1980s, being a common phenomenon in the entire population worldwide, occupying almost 69%, since its acquisition was easy and fast [1], [2]. Self-medication has a potential danger in the face of irresponsible and inappropriate use of medications by aggravating and lengthening infectious diseases causing drug dependence, and resulting, as a result, in increased morbidity and mortality [3]. Economic, political, and cultural factors have stimulated the increase of self-medication in the world; unfortunately, the pharmaceutical industries, through misleading advertising, make the use of medication synonymous with health due to its greater availability in the market [4].

A study on European and Latin American populations observed a high prevalence of self-medication, evidenced by 98.1%, due to short time and lack of money [5]. On the other hand, in the state of Hidalgo in Mexico City, the prevalence of self-medication is 87.61%, mentioning headache as the primary symptom that leads to this practice [6]. While in Cartagena - Colombia, its prevalence was 89.7%, showing that the primary influence comes from the family being the everyday use of NSAIDs (ibuprofen, ketorolac) in 95.1% [7]. In the United States, 40% of drugs consumed are NSAIDs, while in Latin American countries, their use is equal to or higher; for example, in Brazil, 36% of NSAID drug sales correspond to self-medication. According to Albarrán, a study conducted in Chile found that 55% of the people surveyed in a rural area self-medicated with NSAIDs and were unaware of their use [8]. In Ecuador, the pharmaceutical budget has increased by 53% in the last four years, given the high morbidity rate in the country; therefore, 69% of the pharmaceutical products acquired are imported, and 9% of the total medicines are generic (Ortiz-prado et al., 2016). Of the total number of registered drugs, 1739 (12.7%) are considered over-the-counter, and 11539 (84.3%) are dispensed under medical prescription [9].

Self-medication is a fundamental problem at the social level; in developed and developing countries, it is present in the acquisition of medicines without prescription, administering medication under the concept of colleagues, friends, and others, in addition to consuming leftover drugs stored at home or sharing them with family members [10]. In addition, self-medication makes the patient more independent in making decisions about minor health problems. However, it also generates numerous setbacks and risks for the patient; the prevalence of over-the-counter medications varies according to geographic location and population demographics [10], [11]. Several studies showed that it affects between 35% and 79% of elderly patients, increasing hospitalizations and public health spending; one of the primary drugs used in self-medication is NSAIDs [12]. The manifestations of self-medication with NSAIDs are a potential risk, widespread worldwide, with around 60%. This increase in frequency can be attributed to the free sale of NSAIDs in underdeveloped and developing countries, over-saturation of health services, and unemployment [13].

The relevance of this problem lies in the negative impact on quality of life, morbidity, mortality, and on the personal economy, given that its prevalence reaches up to 65% due to different factors, regardless of disease,

age, gender, social stratum, and educational level (Zavala et al., 2018). The cost of medical care for patients with resistant diseases is much more expensive than for patients with illnesses considered as usual due to the longer duration of the disease, additional tests needed, and the use of much more expensive drugs [14].

2. Methodology

2.1. Type of research

The type of research used was field research since data was collected through a survey directed to the inhabitants of Ambato's urban and rural parishes. In addition, it was descriptive research since it refers to events or occurrences, leaving aside explanations. On the other hand, it is not experimental since the variables were not manipulated; instead, the phenomenon was described as it occurs in its nature. It is cross-sectional since the data was collected in an established period (March - June 2020).

2.2. Population-sample

The population consisted of all those who visited community pharmacies in urban parishes (San Francisco and La Matriz) and rural parishes (Santa Rosa and Izamba) in Ambato. It should be mentioned that the population was selected according to population density. In addition, the following inclusion criteria were considered: individuals between 15 and 70 years of age, who could read and interpret the survey, who attended community pharmacies during the period March-July 2020, who gave their consent for the application of the survey; and exclusion: individuals with ages outside the study range (15 to 70 years), any physical or psychological limitation that prevented self-completion of the questionnaire, individuals who did not give informed consent for the survey.

The sample for the present investigation was established using the formula for the finite model in (1). The rural population was 26566 (Santa Rosa 15003-Izamba 11563), and the urban population was 47330 (San Francisco 21680- La Matriz 25650).

$$n = \frac{z^2 * p * q * N}{e^2 (N-1) + z^2 * p * q} \quad (1)$$

According to the calculations made, the present investigation was carried out with a sample of 760 individuals (378 in rural areas and 382 in urban areas) belonging to Ambato from urban parishes (San Francisco and La Matriz) and rural parishes (Santa Rosa and Izamba), so that this number is necessary for a confidence level of 95% according to the formula for finite samples.

2.3. Procedure

The research was conducted in three phases: Phase I: Preparation, structuring, and validation of the survey; Phase II: Application of the survey and delivery of the triptych with information on self-medication and irrational use of NSAIDs; Phase III: Analysis, Correlation, and Interpretation of the data.

The survey was applied to Ambato's urban and rural population, who visited community pharmacies without a prescription from March-July 2020. This instrument consisted of 11 closed questions; the first section corresponds to demographic information (age, education, and gender) and general information (medications, causes, diseases) in the next section. It was validated by six health professionals, biochemists, and pharmacists. In addition, a health education campaign was carried out for the participants to inform them of the advantages and disadvantages of self-medication.

2.4. Data collection

At the end of the survey, the data collected were tabulated in a spreadsheet and subsequently analyzed using SPSS v25 statistical software for descriptive statistical analysis.

3. Results

A total of 760 individuals were surveyed, and of these, 382 (50.3%) were participants from urban parishes, while 378 (49.7%) belonged to rural areas. On the other hand, of the total number of respondents, 56.7% were female, 29.6% were concentrated in rural parishes, while 43.3% were male, with a higher frequency of 23.2% in urban areas. In terms of age, there was a higher percentage of young adults between 19-35 years (53.8%), followed by 36-59 years (40.1%); there was a more significant number in the urban parishes with

a difference of 5.9% about the rural zone. The educational level of the individuals was also identified (Table 1).

These results were obtained because the study period included months in which the country was isolated during the SARS-COVID-19 (coronavirus) pandemic. There was a higher number of infections in the urban area, which implies a higher frequency of patients who go to community pharmacies in search of treatment [15, pp. 16–18].

Table 1: The educational level of individuals surveyed in urban and rural parishes of Ambato.

INSTRUCTION LEVEL	PARISHES		Total
	Urban Parishes N (%)	Rural Parishes N (%)	
No education	0 (0)	15 (2)	15 (2)
Primary	10 (1.3)	98 (12.9)	108 (14.2)
Secondary	145 (19.1)	207 (27.2)	352 (46.3)
Higher	227 (29.9)	58 (7.6)	285 (37.5)
Total	382 (50.3)	378 (49.7)	760 (100)

It was found that 347 of 760 persons surveyed were self-medicated, which corresponds to 45.7%. Three factors associated with self-medication with NSAIDs were identified: self-medication with educational level, self-medication with the media, self-medication, and reasons for its incidence. At the same time, hypotheses were put forward that will be tested to generate more confidence in the research, which will be presented below.

Table 2 shows the correlation of self-medication with the level of education, showing that 65.4% of self-medicated individuals (65.4%) belonged to urban areas, while 34.6% belonged to rural parishes. There was a higher prevalence in secondary and higher education (53.3% and 31.4%, respectively).

Table 2: Prevalence of self-medication in Ambato's urban and rural parishes regarding the education level.

INSTRUCTION LEVEL	PARISHES		Total
	Urban Parishes N (%)	Rural Parishes N (%)	
Primary	10 (2.9)	43 (12.4)	53 (15.3)
Secondary	118 (34)	67 (19.3)	185 (53.3)
Higher	99 (28.5)	10 (2.9)	109 (31.4)
Total	227 (65.4)	120 (34.6)	347 (100)

In addition, it was possible to deduce that individuals in rural areas treated their pathologies with home remedies and went to community pharmacies only when the clinical condition worsened since, having a lower level of education, it is challenging to identify pathology and, even more so, to know or acquire medicines.

The first hypothesis, on whether the level of education affects self-medication, obtained a significance of less than 0.05% ($p < 0.05$), so it was decided to accept the hypothesis, showing a clear difference in self-medication between parishes, which in turn was demonstrated in Table 2 since there is a higher percentage of individuals with secondary and higher education who perform this practice in the urban area.

In addition, it was found that a higher percentage of individuals from urban parishes preferred to self-medicate (65.4%), due to the lack of time to go to a medical appointment because of their workload, in addition to the proximity of community pharmacies to their homes, the high cost of private consultations, over-saturation of the health system and continuous medical care.

Once the prevalence of self-medication among the respondents had been established, the factors that directly influenced this practice were identified. Table 3 shows the communication they used to obtain medication information before acquiring it in community pharmacies. It is noted that 40.9% went to their family to find out what pharmacological treatment could be administered for their ailments or pathologies, with a considerable number of cases in urban parishes (28.8%). Following this, 27.7% used the internet as a source of consultation. Of these, the majority were concentrated in urban areas (19.3%), which could be explained by the fact that rural parishes have less availability of this service.

Table 3: Means of communication used to obtain information on medicines in urban and rural parishes of Ambato.

MEANS OF COMMUNICATION	PARISHES		Total
	Urban Parishes N (%)	Urban Parishes N (%)	
Advertising (tv, radio, newspaper)	30 (8.6)	28 (8.1)	58 (16.7)
Family	100 (28.8)	42 (12.1)	142 (40.9)
Internet	67 (19.3)	29 (8.4)	96 (27.7)
Other (information from health professionals, healers)	30 (8.6)	21 (6.1)	51 (14.7)
Total	227 (65.4)	120 (34.6)	347 (100)

Finally, it was found that 16.7% of people who self-medicated preferred to use television, radio, or newspaper advertisements to find out what medications they could acquire to improve their pathological conditions. Information on medicines is available in these media through ads. This phenomenon is widespread in Latin America since, in developed countries, it has been seen that the population prefers professional advice for a correct diagnosis and management of medicines [16, p. 6]. As for the section on other means of communication, these refer to the search for information on drugs in sources other than those mentioned, such as traditional medicine, visits to healers, other health professionals, or people who say they know what medication a patient should take for any ailment, showing that 8.6% of people from urban parishes opted for this response, while 6.1% were from rural sectors.

On the other hand, Table 4 shows the results of the reasons why individuals self-medicate, where 34.3% answered that they lacked or did not have enough time to go to a doctor's office, with these values prevailing in both urban and rural parishes (17.3% and 17%, respectively).

Table 4: Reasons for self-medication in urban and rural parish respondents.

REASONS	PARISHES		Total
	Urban Parishes N (%)	Urban Parishes N (%)	
Proximity to the pharmacy	79 (22.8)	32 (9.2)	111 (32)
Lack of time	60 (17.3)	59 (17)	119 (34.3)
Lack of money to go to a private practice	29 (8.4)	10 (2.9)	39 (11.2)
The medical center is overcrowded	10 (2.9)	9 (2.6)	19 (5.5)
Continuous medication	49 (14.1)	10 (2.9)	59 (17)
Total	227 (65.4)	120 (34.6)	347 (100)

In addition to these results, 32% of people justified self-medication by indicating that their residence was close to a community pharmacy. The percentage was higher in urban parishes (22.8% of the total cases) because many community pharmacies are concentrated in the urban center of Ambato [17].

On the other hand, the last two reasons selected were the lack of money to go to a private consultation and the oversaturation of medical centers in 11.2% and 5.5%, respectively, with a higher prevalence in urban parishes (8.4% and 2.9%). The study period included months in which the country was in isolation due to SARS-CoV2, so there was a significant reduction in economic income, mainly in the urban area. In addition, the health system collapsed, and users preferred to self-medicate rather than expose themselves to possible contagion [18, p. 12].

Thus, these reasons directly influence self-medication, especially the one related to the lack of time people have to visit a doctor since there is a higher percentage of individuals who mentioned self-medication for this reason (34.3%).

4. Discussion

Self-medication is a widespread habit in the world population, and pain is the most frequent symptom for which this practice is adopted. For symptomatic treatment, over-the-counter NSAIDs are used in oral and topical preparations. Misuse can worsen the clinical picture and complicate the evolution of diseases if a physician does not control them. Among Ecuador's most commonly used drugs are Ibuprofen, Naproxen, and Diclofenac, among others [19].

The research determined that 347 of 760 persons surveyed were self-medicated, representing 45.7%. This percentage is similar to that obtained by Gonzalez and collaborators in their article on "Self-medication with NSAIDs by users of two primary care offices", where 42% of the sample self-medicated, emphasizing that these values are considered, which is why the pharmacist needs to offer health education in the event of signs of this practice, avoiding the appearance of adverse effects derived from self-medication. Furthermore, in the same research, the authors recommend that people who suffer from chronic pain or who have a history of chronic or duodenal ulcers should not self-medicate with non-steroidal anti-inflammatory drugs [20, p. 57].

The results showed that 37.5% of individuals had higher education, of which 29.9% belonged to urban parishes, which was to be expected since it has been seen that the urban population has more academic preparation than the rural population. It is essential to mention that, during the study period, it was concluded that people with secondary and higher education in both areas were the ones who generally went to community pharmacies because they understood the instructions given by the pharmacist more easily. In a study conducted in Colombia at the Catholic University of Manizales, Álvarez and collaborators demonstrated that the level of education directly influences self-medication, so it could be thought that individuals with low education (primary) are those who go to community pharmacies for medication. However, it is indicated that this does not always happen because people with higher education self-medicate before a greater availability of information [21, p. 95]. Similarly, it is mentioned that there is a more significant number of therapeutic noncompliance and medication errors associated with the self-medication of these patients since they believe they know the basic information on the use of medications, which leads to making erroneous decisions regarding their pharmacological treatment [22, p. 56].

The research by Tobón and collaborators in Colombia indicated that 49% of those surveyed preferred to consult their relatives or neighbors about medications. Similar to that obtained in this research. However, it is mentioned that people in the family circle have insufficient knowledge since they do not have the necessary experience or studies to attend health consultations and aspects related to pharmaco-safety [23, p. 125]. The studies corroborate this by Menéndez and Chávez, which detail the media's influence on self-medication. It is considered that advertisements on radio, internet, television, or newspapers refer mainly to male and female esthetics, i.e., dendritic, soaps, antiseptics, and rarely refer to drugs such as analgesics, NSAIDs, and antiemetics, among others. The population is based on the criteria that their relatives or acquaintances have about the experience with a drug to treat a disease, so this is the factor that most influences the decision to self-medicate, as observed in this research [16, p. 12], [22, p. 58].

5. Conclusions

The research identified the factors predisposing to self-medication with NSAIDs in patients attending Ambato's urban and rural community pharmacies. In this way, most of them had a secondary and higher education level, leading to determining that it is associated with the incidence of self-medication. Most of them came from urban parishes (34% and 28.5%, respectively), which is indisputable since in the rural areas, most of the population is engaged in agriculture or livestock farming, so few people are academically prepared, with 12.4% having only a primary school level.

It is increasingly common to resort to self-medication through the media. 40.9% of the people choose to use medicines without a medical prescription due to the influence of their family, 27.7% through the Internet, and 16.7% due to the effect of advertisements. The health education provided to the participants was enriching, thus encouraging new awareness campaigns and avoiding this lousy practice. Social networks offer large amounts of information, and people often resort to this advice, which is counterproductive for their pathologies.

Meanwhile, lack of time (34.3%) and proximity to community pharmacies (32%) were other reasons people self-medicated. This mainly happens in urban areas with more community pharmacies nearby. It is convenient and essential to mention that all the effects derived from self-medication of NSAIDs, such as gastric ulcer and dyspepsia, cannot always be avoided by the pharmacist and have no health justification. Other anti-inflammatory drugs do not require a prescription and are similar to those, so they are easily purchased in community pharmacies without restriction. At the same time, it is more profitable to dispense those that do not require a prescription and are sold over the counter.

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Institutional Review Board Statement

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Conflicts of Interest

The author declares that they have no conflict of interest.

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Early warning mechanism to control delinquency levels

Mecanismo de alerta temprana para controlar los niveles de morosidad

Mecanismo de alerta precoce para controlar os níveis de inadimplência

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Abstract

The growth of financial institutions depends to a great extent on the granting of loans to their customers. This contract establishes the values and terms in which the capital must be repaid together with interest and commissions. Delinquency related to loans originated when there was inadequate analysis and control of the policies established in each institution. Therefore, this document proposes an early warning mechanism to control delinquency levels. It also offers the measurement of the performance of these financial institutions through the CAMEL methodology. This will allow senior management to take prompt decisions and corrective actions to avoid decreased liquidity levels. A heat map is also defined to enable timely detection of risk and thus place greater emphasis on those that are necessary. Finally, the conclusions and recommendations are presented as a basis for future research, encouraging readers to deepen or replicate the work.

Keywords: *Liquidity, CAMEL Methodology, Non-Performing Loans, Mutuals.*

Resumen

El crecimiento de las entidades financieras depende en gran manera del otorgamiento de créditos para sus clientes. En este contrato se establecen los valores y plazos en los que el capital se deberá devolver junto a los intereses y comisiones. La morosidad relacionada con los créditos se origina cuando no se realiza un adecuado análisis y control de las políticas establecidas en cada institución. Por ello en este documento se propone un mecanismo de alerta temprana para el control de los niveles de morosidad. También así como la medición del desempeño de estas instituciones financieras a través de la metodología CAMEL. Esto le permitirá a la alta dirección tomar decisiones prontas y acciones correctivas para evitar una disminución en los niveles de liquidez. También se define un mapa de calor que permita detectar oportunamente el riesgo y así poner mayor énfasis en los que son necesarios. Finalmente se exponen las conclusiones y recomendaciones como una base para futuras investigaciones, que incentiven a los lectores a profundizar o replicar el trabajo elaborado.

Palabras claves: *Liquidez, Metodología CAMEL, Morosidad, Mutualistas.*



Resumo

O crescimento das instituições financeiras depende, em grande parte, da concessão de empréstimos a seus clientes. Este contrato estabelece os valores e os termos em que o capital deve ser reembolsado juntamente com os juros e comissões. A inadimplência relacionada ao crédito surge quando não há uma análise e um controle adequados das políticas estabelecidas em cada instituição. Portanto, este documento propõe um mecanismo de alerta precoce para controlar os níveis de delinquência. Também é proposto medir o desempenho dessas instituições financeiras através da metodologia CAMEL. Isto permitirá que a alta administração tome decisões antecipadas e ações corretivas para evitar um declínio nos níveis de liquidez. Um mapa de calor também é definido para permitir a detecção oportuna de riscos e assim dar maior ênfase aos riscos que são necessários. Finalmente, as conclusões e recomendações são apresentadas como base para pesquisas futuras, o que incentivará os leitores a explorar ou replicar ainda mais o trabalho.

Palavras-chave: *Liquidez, Metodologia CAMEL, NPLs, Mutuais.*

1. Introduction

Latin American countries face a problem of delinquency because financial institutions risk non-payment by debtors. A quantitative and qualitative study should be carried out at the beginning of a credit application to minimize this risk [1]. The debt factor generated by overdue payments strongly impacts liquidity levels, which, if not controlled in time, could lead to a crisis in the financial institution [2], [3].

According to what is mentioned by the Latin American Federation of Banks (FELABAN) (2018), there are ten countries with delinquency indicators and values in the total portfolio and non-performing portfolios with a high level in 2018. Colombia stands out as having the highest hand compared to the other countries in the region by registering a portfolio quality index of 4.81%. In addition to Colombia, the top five nations with a high level of delinquency in Latin America are Uruguay (4.03%), Brazil (3.28%), Paraguay (2.84%), and Peru (2.64%). It can be seen from Figure 1 that from 2003 to 2014, the trend at the regional level was to decrease liquidity indicators. It is essential to maintain control of risk levels by analyzing all internal and external factors that impact the increase in delinquency levels and affect liquidity [4], [5].

In Ecuador, the financial system is considered one of the most critical factors within the economy. It allows savings to be channeled towards investment, which is why it has become the fundamental pillar for wealth generation. Economic entities have relied on financial institutions to obtain working capital, productive expansion, and infrastructure [6]. In 2002 there were 17 banks, which increased at a rate of 2.15% per year until 23 banks were in service in December 2016, which shows relative stability of the financial sector. Banks currently accumulate 70.7% of the total assets of the private financial sector, with an amount equivalent to US\$35,599 million. For their part, financial companies have remained between 5 and 6 companies, the amounts in assets managed here represent 3.59%, and finally cooperatives with a piece of 6,641.59 million dollars which means 14.86.

At least annually, the Board of Directors should review and approve strategies, policies, and practices related to liquidity management, ensuring that senior management effectively manages credit risk [7]. For all relevant on- and off-balance sheet business activities, financial institutions should include liquidity costs, benefits, and risks in internal pricing, performance measurement, and new product approval processes [8]. To match the risk-taking incentives of the different business lines with the liquidity risk exposures that their activities cause to the institution as a whole [9], [10]

Financial institutions worldwide have portfolio recovery problems because there are no valid credit-granting policies [11]. There is no good management in the collections area, which generates delinquency levels that, if not controlled in time, can cause damage to liquidity levels. Although there are risks involved in this type of operation, all possible solutions should be analyzed to help improve the collections process [12]. Delinquency affects all countries and is a frequent problem with the easy granting of credits without efficient applicants' control. This project will analyze the public consolidated financial statements available on the web portal of the Superintendency of Banks and thus propose a tool to control delinquency. On the social level, adequate control when granting loans will help mutuals present financial statements with lower levels of non-performing loans to the control entity. This is a proxy measure that will help to obtain data on delinquency and liquidity and will also help to detect these high levels in time.

The materials and methods are described in section 2, and the results in section 3. Finally, the discussion is presented in section 4.

2. Materials y methods

2.1. Type of research

This research is bibliographic because it requires the review of primary and secondary documents to define the financial situation of these institutions. It is also field research because it is necessary to meet the needs of the actors in person. Finally, it is non-experimental research where a methodology is applied, but no experimental tests are performed.

2.2. Approach

This study has a mixed approach since it analyzes the satisfaction of the methodology developed using a questionnaire. On the other hand, this tool is used to improve the processes for detecting late payments, thus adding a quantitative approach.

2.3. Population-sample

The four mutual societies in Ecuador were chosen as participants in this study, and their employees used this tool to evaluate users. Indirectly, there is also an impact on end clients, who have increased confidence due to the sound levels of liquidity.

2.4. Data collection techniques and instruments

A questionnaire is used as a data collection instrument to determine the degree of user satisfaction with the tool presented. On the other hand, a usability test is also carried out to identify the degree of conformity with this developed application in percentage terms.

2.5. Procedure

The CAMEL Method is used worldwide to analyze the operational performance of financial institutions considering six fundamental components: (i) C: Capital Adequacy, (ii) A: Asset Quality, (iii) M: Management, (iv) E: Earnings and (v) L: Liquidity.

The indicators calculated are the capitalization factor (FK), intermediation factor (FI), net capitalization index, and the coverage of non-performing assets. Also considered are the percentage of non-performing assets, credit quality, credit coverage, net financial margin absorption, operating efficiency, and administrative management. Return on assets (ROA), return on equity (ROE), liquidity ratio, adjusted liquidity ratio, and immediate liquidity ratio. The rating scale performs quantitative analyses of profitability, asset quality, liquidity and funding, asset/liability management, and capital. The qualitative analysis evaluates the industry, business, financial, and management risks. Finally, a traffic light is made depending on the level of liquidity, and the entity is rated according to the levels obtained.

3. Results

3.1. Developed System

3.1.1. System description

It consists of 13 Excel spreadsheets, through which we seek to analyze and detect promptly the risk caused by the delinquency levels in the savings and credit mutuals for housing in Ecuador. Fig. 1 shows the front page of the system.



Fig. 1. Front page of the system.

3.1.2. Table of contents

Fig. 2 shows the details of each tab contained in the arrears control system. In this way, the user has the facility to visualize the content using hyperlinks that facilitate access to each tab.



Fig. 2. Table of contents window.

3.1.3. Statement of financial position

Fig. 3 contains the statement of financial position (in thousands of dollars) obtained from the Superintendencia de Economía Popular y Solidaria (SEPS) web portal with data on the financial situation of savings and credit mutuels for 2018.

ÍNDICE		ESTADO FINANCIERO MUTUALISTAS DE AHORRO Y CRÉDITO PARA LA VIVIENDA PERIODO DEL 01 DE ENERO 2018 AL 31 DE DICIEMBRE 2018 EN DÓLARES			
COD CONTABLE	NOMBRE DE LA CUENTA	AMBATO	AZUAY	IMBABURA	PICHINCHA
1	ACTIVO	\$ 27.744.569,00	\$ 186.117.705,24	\$ 53.464.045,64	\$ 714.859.681,94
11	FONDOS DISPONIBLES	\$ 1.341.751,49	\$ 10.276.095,11	\$ 4.118.743,64	\$ 40.989.613,37
1101	Caja	\$ 96.974,40	\$ 2.500.636,76	\$ 663.623,66	\$ 3.698.810,88
110105	Efectivo	\$ 96.474,40	\$ 2.500.286,76	\$ 662.973,66	\$ 3.689.450,88
110110	Caja chica	\$ 500,00	\$ 350,00	\$ 650,00	\$ 9.360,00
1102	Depósitos para encaje	\$ 649.269,98	\$ 3.623.662,01	\$ 1.716.264,58	\$ 15.893.351,20
110205	Banco Central del Ecuador	\$ 649.269,98	\$ 3.623.662,01	\$ 1.716.264,58	\$ 15.893.351,20
110210	Banco Ban Ecuador	\$ 0,00	\$ 0,00	\$ 0,00	\$ 0,00
110215	Otras entidades financieras	\$ 0,00	\$ 0,00	\$ 0,00	\$ 0,00

Fig. 3. Statement of financial position window.

3.1.4. Income Statement

Fig. 4 contains the statement of results (in thousands of dollars), which is also obtained from the SEPS web platform.

ÍNDICE		ESTADO DE RESULTADOS MUTUALISTAS DE AHORRO Y CRÉDITO PARA LA VIVIENDA PERIODO DEL 01 DE ENERO 2018 AL 31 DE DICIEMBRE 2018 EN DÓLARES			
COD CONTABLE	NOMBRE DE LA CUENTA	AMBATO	AZUAY	IMBABURA	PICHINCHA
5	Ingresos	\$ 3.153.501,44	\$ 18.135.323,07	\$ 5.931.937,43	\$ 81.638.860,52
51	Intereses y descuentos ganados	\$ 2.905.244,55	\$ 16.594.939,86	\$ 5.117.832,28	\$ 60.618.307,60
(-) 41	Intereses causados	\$ 1.520.714,08	\$ 6.945.727,30	\$ 2.765.375,14	\$ 28.844.520,28
	MARGEN NETO DE INTERESES	\$ 1.384.530,47	\$ 9.649.212,56	\$ 2.352.457,14	\$ 31.773.787,32
(+) 52	Comisiones ganadas	-	-	\$ 517,32	\$ 1.463.005,66
(+) 54	Ingresos por servicios	\$ 66.006,29	\$ 331.140,10	\$ 377.187,40	\$ 3.932.082,84
(-) 42	Comisiones causadas	\$ 8.079,00	\$ 126.779,40	\$ 6.925,35	\$ 320.455,84
(+) 53	Utilidades financieras	\$ 21.203,38	\$ 75.252,37	-	\$ 2.967.839,59
(-) 43	Pérdidas financieras	\$ 0,00	\$ 53.855,78	-	\$ 6.174.265,41
	MARGEN BRUTO FINANCIERO	\$ 1.463.661,14	\$ 9.874.969,85	\$ 2.723.236,51	\$ 33.641.994,16
(-) 44	Provisiones	\$ 373.065,60	\$ 828.959,06	\$ 436.709,85	\$ 6.127.181,37
	MARGEN NETO FINANCIERO	\$ 1.090.595,54	\$ 9.046.010,79	\$ 2.286.526,66	\$ 27.514.812,79

Fig. 4. Results status window.

3.1.5. Portfolio Composition

The entire loan portfolio composition is presented (Fig. 5) to obtain the total non-performing portfolio and the gross portfolio for the year 2018 of the mutual societies. These calculations will be used in the development of the indicators.

COMPOSICIÓN DE LA CARTERA		AMBATO	AZUAY	IMBABURA	PICHINCHA
COD CONTABLE	NOMBRE DE LA CUENTA				
14	CARTERA DE CRÉDITOS	\$ 18.507.776,57	\$ 143.156.306,58	\$ 40.099.758,37	\$ 382.305.742,79
1401	Cartera de créditos comercial prioritario por vencer	\$ 0,00	\$ 4.529.480,69	\$ 407.729,78	\$ 65.131.826,67
140105	De 1 a 30 días	\$ 0,00	\$ 26.719,99	\$ 11.871,33	\$ 8.340.488,67
140110	De 31 a 90 días	\$ 0,00	\$ 53.571,88	\$ 25.187,53	\$ 16.496.216,07
140115	De 91 a 180 días	\$ 0,00	\$ 81.212,72	\$ 29.670,40	\$ 9.159.789,30
140120	De 181 a 360 días	\$ 0,00	\$ 169.149,95	\$ 52.951,98	\$ 6.745.019,54
140125	De más de 360 días	\$ 0,00	\$ 4.198.826,15	\$ 288.048,54	\$ 24.390.313,09
1402	Cartera de créditos de consumo prioritario por vencer	\$ 5.132.293,45	\$ 16.162.512,15	\$ 18.493.203,40	\$ 74.112.275,29
140205	De 1 a 30 días	\$ 131.308,14	\$ 2.143.807,87	\$ 900.240,76	\$ 15.889.097,78
140210	De 31 a 90 días	\$ 227.240,14	\$ 1.032.543,26	\$ 1.104.902,54	\$ 9.385.705,40
140215	De 91 a 180 días	\$ 296.184,55	\$ 1.247.704,14	\$ 1.491.408,17	\$ 7.888.146,97
140220	De 181 a 360 días	\$ 547.119,85	\$ 1.895.351,90	\$ 2.686.617,51	\$ 11.440.421,07

Fig. 5. Portfolio composition window.

3.1.6. Breakdown of assets and liabilities

As shown in Fig. 6, from the statement of financial position tab, the values of the accounts comprising liquid assets, demandable liabilities, gross unproductive assets, provisions, liabilities with cost, productive assets, and short-term deposits are obtained. These values are used to calculate the various indicators.

COMPOSICIÓN DE LA CARTERA		AMBATO	AZUAY	IMBABURA	PICHINCHA
COD CONTABLE	NOMBRE DE LA CUENTA				
14	CARTERA DE CRÉDITOS	\$ 18.507.776,57	\$ 143.156.306,58	\$ 40.099.758,37	\$ 382.305.742,79
1401	Cartera de créditos comercial prioritario por vencer	\$ 0,00	\$ 4.529.480,69	\$ 407.729,78	\$ 65.131.826,67
140105	De 1 a 30 días	\$ 0,00	\$ 26.719,99	\$ 11.871,33	\$ 8.340.488,67
140110	De 31 a 90 días	\$ 0,00	\$ 53.571,88	\$ 25.187,53	\$ 16.496.216,07
140115	De 91 a 180 días	\$ 0,00	\$ 81.212,72	\$ 29.670,40	\$ 9.159.789,30
140120	De 181 a 360 días	\$ 0,00	\$ 169.149,95	\$ 52.951,98	\$ 6.745.019,54
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140215	De 91 a 180 días	\$ 296.184,55	\$ 1.247.704,14	\$ 1.491.408,17	\$ 7.888.146,97
140220	De 181 a 360 días	\$ 547.119,85	\$ 1.895.351,90	\$ 2.686.617,51	\$ 11.440.421,07

Fig. 6. Assets and liabilities breakdown.

3.1.7. Indicator calculations

It indicates the criterion, the indicator, the type of indicator with its respective formula, the weighting per criterion, and the optimum. This can be established according to the degree of importance of each indicator, as shown in Figure 7.

	Porcentaje de activos improductivos	Cuantitativo	$\frac{\text{Activos improductivos netos}}{\text{Total de los activos}}$		
Calidad de crédito				4%	
	Calidad de crédito		$\frac{\text{Cartera vencida}}{\text{Cartera bruta}}$	16%	7%
	Cobertura crediticia		$\frac{\text{Provisiones}}{\text{Cartera vencida}}$		5%
Gestión Operativa	Grado de absorción del margen financiero neto		$\frac{\text{Gastos Operativos}}{\text{Margen financiero neto}}$		6%
	Eficiencia Operativa		$\frac{\text{Gastos Operativos}}{\text{Total Activo}}$	18%	7%
	Manejo Administrativo		$\frac{\text{Activos productivos}}{\text{Pasivos con costo}}$		5%

Fig. 7. Methodology for calculating indicators.

3.1.8. Indicator Results

This window shows the indicators considered most important for measuring each criterion based on the CAMEL methodology, as shown in Fig. 8. This process was developed using the formulas established by the SEPS and has a traffic light. The red color indicates weakness; yellow indicates a regular state concerning the average; green indicates an optimal degree of the indicator.

ÍNDICE			AMBATO	AZUAY	IMBABURA	PICHINCHA
Suficiencia de Capital	Indice de capitalización neta		5,80%	9,72%	6,68%	5,05%
	Cobertura patrimonial de activos improductivos		28,28%	57,37%	38,23%	20,08%
Calidad de crédito	Porcentaje de activos improductivos		26,94%	21,57%	22,65%	37,87%
	Calidad de crédito		0,78%	0,28%	0,92%	1,93%
	Cobertura crediticia		579,36%	766,14%	360,00%	186,07%
Gestión Operativa	Grado de absorción del margen financiero neto		109,16%	76,09%	92,61%	124,66%
	Eficiencia Operativa		4,29%	3,70%	3,96%	4,80%
	Manejo Administrativo		91,05%	99,12%	97,30%	77,77%
Rentabilidad	ROA		-0,16%	1,09%	0,51%	0,30%
	ROE		-1,94%	9,69%	5,70%	3,86%
Liquidez	Indice de liquidez		15,86%	16,35%	15,78%	7,01%
	Liquidez ajustada		15,42%	16,35%	16,56%	7,46%
	Liquidez inmediata		11,47%	9,51%	19,02%	10,20%

Fig. 8. Indicator results window.

3.1.9. Qualification

It is scored by indicator and criterion, using the weighting table above. This results in a numerical value that makes it possible to determine the range in which the mutual societies are found, as shown in Fig. 9.

ÍNDICE			MUTUALISTA	PONDERACION	CALIFICACION POR CRITERIO	CALIFICACION METODOLOGÍA CAMEL
Suficiencia de Capital	Indice de capitalización neta			8,00%		17,33%
	Cobertura patrimonial de activos improductivos			9,33%		
Calidad de crédito	Porcentaje de activos improductivos			2,67%		
	Calidad de crédito			4,67%		12,33%
	Cobertura de crédito			5,00%		
Gestión Operativa	Grado de absorción del margen financiero		AMBATO	2,00%		
	Eficiencia Operativa			7,00%		71,33%
	Manejo Administrativo			3,33%		
Rentabilidad	ROA			2,00%		
	ROE			1,33%		3,33%
Liquidez	Indice de liquidez			10,00%		
	Liquidez ajustada			8,00%		26,00%
	Liquidez inmediata			8,00%		

Fig. 9. Ambato mutual society rating.

3.1.10. Weighting

A weighting is established according to the traffic light system, where red has a value of 1 point, yellow equals 2 points, and the green represents 3 points. Fig. 10 shows the values obtained by each mutual society.

CRITERIO	INDICADOR	AMBATO	AZUAY	IMBABURA	PICHINCHA
Suficiencia de Capital	Índice de capitalización neta	2	3	2	2
	Cobertura patrimonial de activos improductivos	2	3	3	2
Calidad de crédito	Porcentaje de activos improductivos	2	2	2	1
	Calidad de crédito	2	3	2	1
	Cobertura crediticia	3	3	2	1
Gestión Operativa	Grado de absorción del margen financiero neto	1	2	2	1
	Eficiencia Operativa	3	2	2	3
	Manejo Administrativo	2	3	3	2
Rentabilidad	ROA	1	3	3	2
	ROE	1	3	3	2
Liquidez	Índice de liquidez	3	3	3	2
	Liquidez ajustada	3	3	3	2
	Liquidez inmediata	2	2	3	2

Fig. 10. Weighting of mutual society ratings.

3.1.11. Ranking and Heat Map.

Fig. 11 shows the rating of each mutual society depending on the established limits. Considering the five indicators (credit quality, credit coverage, and liquidity and their proxies), the levels of delinquency and liquidity are analyzed. An early warning system is used to avoid risks, as shown in Fig. 12.

CALIFICACION	LIMITE INFERIOR	LIMITE SUPERIOR
AAA	>=85%	100%
AA	>=70%	<85%
A	>=60%	<70%
BBB	>=50%	<60%
BB	>=45%	<50%
B	>=40%	<45%
C		<40%

	CALIFICACION
AMBATO	71,33%
AZUAY	90,33%
IMBABURA	86,33%
PICHINCHA	61,67%

Fig. 11. Ranking of mutual societies.

INDICADOR	MUTUALISTA					PROMEDIO
	AMBATO	AZUAY	IMBABURA	PICHINCHA		
Calidad de crédito	0,78%	0,28%	0,92%	1,93%	0,98%	
Cobertura crediticia	579,36%	766,14%	360,00%	186,07%	472,89%	
Liquidez	15,86%	16,35%	15,78%	7,01%	13,75%	
Liquidez ajustada	15,42%	16,35%	16,56%	7,46%	13,95%	
Liquidez inmediata	11,47%	9,51%	19,02%	10,20%	12,55%	

ÍNDICE

Fig. 12. Heat map of the mutual societies.

4. Discussion

Financial institutions must manage their resources sufficiently to make them available immediately in case of possible liquidity risk. Each organization must have alert mechanisms that help detect and analyze its liquidity and how much it is affected by the lack of payment of loans granted. This affects delinquency levels and therefore causes a decrease in liquidity levels.

Not only is there a risk in granting loans, but also in the financial crises that may occur. For example, in 1999, Ecuador was hit by a banking crisis due to previous events that were not detected in time. This event demonstrates the need and importance of creating mechanisms or tools that allow early warning of these events so that senior management and different executives can analyze, make the best decisions, and be prepared to face this type of event. The United States Federal Reserve (FED) developed the CAMEL rating system used in this research.

The proposal developed will be used as a support tool since it is based on a financial evaluation system that has been validated for over five decades. It will be easier to know the performance behavior of savings and credit mutual societies, given the need to provide them with financial instruments to make timely and early decisions and obtain early warnings of delinquency levels through a heat map. Public information supplied by SEPS was used, including financial statements such as balance sheets and profit and loss statements. The various indicators of the CAMEL method were also included, which will be linked to the information provided in the financial statements through hyperlinks. This offers incredible speed in the calculation since it is generated automatically. The indicators to be applied are divided into five areas: capital adequacy, asset quality, administrative management, profitability, and liquidity risk.

A tool was generated to help senior management of savings and credit mutual societies to analyze their performance. Given the object of the study, special attention was given to accounts related to the loan portfolio. In addition, it will help detect high delinquency levels in time and apply corrective measures to avoid a decrease in liquidity levels, analyzing the components and indicators of the CAMEL methodology. A heat map helps to detect risk timely through credit quality, credit coverage, and liquidity indicators to make decisions that benefit financial institutions, improving their strategies and generating greater confidence and security for their members.

The main limitation of this study is that the tool is still in the testing phase since the methodology may not be adapted to all institutions. Therefore, it is proposed as future work to carry out more tests in other financial institutions and to be able to carry out a current and future analysis to determine if there was an improvement in the processes.

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Informed Consent Statement

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Conflicts of Interest

The author declares that they have no conflict of interest.

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Gestational Trophoblastic Disease: A Case Report

Enfermedad Trofoblástica Gestacional: Reporte de un Caso

Doença trofoblástica gestacional: relato de caso

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Abstract

The gestational trophoblastic disease is caused by the highly abnormal development of placental trophoblastic tissue, consisting of benign and malignant disorders. The hydatidiform mole has the highest incidence. In its development, several factors intervene, among which age, previous molar pregnancy, and habits influence a significant percentage. The hydatidiform mole constitutes excessive trophoblastic proliferation in addition to abnormal embryonic development, being complete or partial and differentiated genetically by its diploid and triploid karyotype, respectively. The present study aimed to present the presentation of gestational trophoblastic disease and the importance of its detection, treatment, and follow-up to prevent possible complications. The diagnosis is based on a multifactorial approach that constitutes clinical features, quantitative determination of beta human chorionic gonadotropin, and abdominal or transvaginal ultrasound. It is confirmed through anatomopathological and immunohistochemical study, cytogenetic techniques, and DNA analysis, which has allowed the identification and differentiation of complete and partial molar pregnancy. Treatment is based on spiral curettage after mechanical cervical dilatation and under ultrasound guidance; in patients with good parity, hysterectomy is the best option. Surveillance and follow-up are crucial to avoid gestational trophoblastic neoplasia after a molar pregnancy.

Keywords: Gestational trophoblastic disease, Placental trophoblastic tissue, Hydatidiform mole, Human chorionic beta gonadotropin.

Resumen

La enfermedad trofoblástica gestacional se da por un desarrollo altamente anormal del tejido trofoblástico placentario, constituido por trastornos benignos y malignos. La mola hidatiforme es la de mayor incidencia, en su desarrollo intervienen varios factores dentro de los cuales la edad, embarazo molar previo y los hábitos influyen en un gran porcentaje. La mola hidatiforme constituye la proliferación trofoblástica excesiva además del desarrollo embrionario anormal, siendo completa o parcial diferenciándose genéticamente por su cariotipo diploide y triploide respectivamente. El objetivo del presente estudio fue dar a conocer la presentación de la enfermedad trofoblástica gestacional y la importancia de su detección, tratamiento y seguimiento, para prevenir posibles complicaciones. El diagnóstico se basa en un enfoque multifactorial que constituye las características clínicas, la determinación cuantitativa de beta gonadotropina coriónica humana, ecografía abdominal o transvaginal. Se llega a confirmar a través del estudio anatomopatológico e inmunohistoquímica, técnicas citogenéticas y el análisis de ADN, que ha permitido identificar y diferenciar el embarazo molar completo y parcial. El tratamiento se basa en el legrado espirativo previa dilatación cervical mecánica y bajo guía ecográfica, en pacientes con paridad satisfecha la histerectomía es la mejor opción. Es muy importante la vigilancia



y el seguimiento para evitar que se llegue a un neoplasia trofoblástica gestacional después de un embarazo molar.

Palabras claves: *Enfermedad trofoblástica gestacional, Tejido trofoblástica placentario, Mola hidatiforme, Beta gonadotropina coriónica humana.*

Resumo

A doença trofoblástica gestacional é um desenvolvimento altamente anormal do tecido trofoblástico placentário, consistindo em desordens benignas e malignas. A molécula hidatidiforme tem a maior incidência, e seu desenvolvimento é influenciado por vários fatores, entre os quais a idade, a gravidez molar anterior e os hábitos desempenham um papel importante. A toupeira hidatidiforme constitui uma proliferação trofoblástica excessiva, além do desenvolvimento embrionário anormal, sendo completa ou parcial e diferenciada geneticamente por seu cariótipo diplóide e triploide, respectivamente. O objetivo do presente estudo foi aumentar a conscientização da apresentação da doença trofoblástica gestacional e da importância de sua detecção, tratamento e acompanhamento, a fim de evitar possíveis complicações. O diagnóstico é baseado em uma abordagem multifatorial que consiste em características clínicas, determinação quantitativa da gonadotropina coriônica beta-humana, ultrassom abdominal ou transvaginal. É confirmado através de estudo anatomopatológico e imunohistoquímico, técnicas citogenéticas e análise de DNA, o que permitiu identificar e diferenciar a gravidez molar completa e parcial. O tratamento é baseado na curetagem espiral após dilatação cervical mecânica sob orientação de ultra-som, e a histerectomia é a melhor opção em pacientes com paridade satisfatória. A vigilância e o acompanhamento são muito importantes para evitar a neoplasia trofoblástica gestacional após uma gravidez molar.

Palavras-chave: *Doença trofoblástica gestacional, tecido trofoblástico placentário, toupeira Hydatidiform, gonadotropina coriônica humana Beta.*

1. Introducción

La enfermedad trofoblástica gestacional (ETG), se entiende como la hiperproliferación de células trofoblásticas; este proceso resulta de la mutación del genoma paterno, que en ocasiones puede contribuir la parte materna; esta enfermedad incluye la mola hidatiforme completa, la mola parcial e invasiva y los tumores trofoblásticos gestacionales o epiteloideos, coriocarcinoma y tumores del lecho placentario [1]. Los embarazos molares pueden desarrollar niveles elevados de hormona gonadotropina coriónica humana (hCG) después de su evacuación, con una posibilidad de progresión al coriocarcinoma [2].

El embarazo molar es más común en algunas partes de Asia, con tasas de incidencia reportadas de hasta uno a dos pacientes por 1000 embarazos, mientras que en Europa y América del Norte, llega a ser inferior a 1 por 1000 embarazos. La incidencia del coriocarcinoma no se puede estimar ya que es raro. Las tasas de prevalencia tanto de la mola hidatiforme como del coriocarcinoma ha disminuido en los últimos 30 años, posiblemente se encuentre en relación con el adelanto de la economía y una mejor dieta, así como una disminución en las cifras de natalidad [2]. La mola hidatiforme se relaciona con la gametogénesis o fertilización anormal, tiene mayor peligro de padecer mola hidatiforme completa pacientes mayores de 35 años y menores de 21 años, y 7.5 veces mayor para las mujeres mayores de 40 años [3]. El riesgo de que nuevamente aparezca en mujeres que hayan presentado un embarazo molar es de aproximadamente el 1% [4], [5].

Los embarazos molares se caracterizan por diferentes grados de proliferación trofoblástica y además de edema vesicular de la placenta asociado o no con la presencia del embrión. Se han descrito dos síndromes de mola hidatiforme que comprende la completa y parcial. En la mola hidatiforme completa se da un acrecentamiento de las vellosidades en desaparición de feto o de embrión, el trofoblasto se encuentra hiperplásico con varios grados de atipia y vellosidades y los capilares se encuentran ausentes, alrededor del 90% son 46XX y se originan de la duplicación de los cromosomas de un espermatozoide haploide poco tiempo detrás de la fertilización. Mientras que la mola hidatiforme parcial muestran vellosidades coriónicas con edema focal, acompañado de tejido fetal o embrionario que presenta cariotipo triploide 69XXY por la fecundación de un óvulo por dos espermatozoides, la misma es menos frecuente [5].

Se presenta un caso de paciente femenino de 42 años de edad, con edad gestacional de 12.4 semanas que ingresa por presentar sangrado vaginal, al examen físico se evidencia altura de fondo uterino de 17cm que tras estudio ecográfico se demuestra la presencia de masa heterogénea central con espacios anecoicos, que corresponden a vellosidades coriónicas hidrópicas por lo cual se realiza histerectomía total evidenciando la presencia de mola hidatiforme completa que se confirma a través de estudio histopatológico y se realiza el seguimiento por la consulta externa por medio de exámenes de laboratorio e imagen [6].

Este trabajo se encuentra dividido por capítulos, en el primero consta de la introducción, donde se enfocan los conceptos básicos de la Enfermedad trofoblástica gestacional, el segundo capítulo son los procedimientos metodológicos que se siguieron, aquí se define las diversas estrategias utilizadas en el estudio, con un orden específico, detallando la clínica, diagnóstico, tratamiento y los procedimientos realizados en la paciente. Previo a lo cual se tuvo una entrevista con la paciente indicando el estudio que se va a realizar la misma que acepto.

2. Procedimientos metodológicos

Se toman los datos desde el ingreso del paciente, hasta el alta definitiva indicando la evolución, tratamiento dependiendo del tipo de sintomatología presentada, se toman los datos más significativos diariamente. De la evolución diaria se saca los datos relevantes que se hace constar en el informe caso clínico en estudio. Conforme a la sintomatología se solicitan exámenes correspondientes y se detalla, la conducta a seguir y su seguimiento por consulta externa.

Se buscó un paciente con sintomatología de aparición brusca, para efectuar un listado de signos y síntomas con un diagnóstico diferencial que nos llevó a un diagnóstico definitivo. Para obtener los resultados y conclusiones.

2.1. Anamnesis y motivo de consulta

Paciente de 42 años, sexo femenino, mestiza, viuda, católica, instrucción básica superior, ocupación costurera, nacida en Penipe y residente en Riobamba. El motivo fue un sangrado vaginal.

2.2. Enfermedad actual

Paciente refiere que hace 12 horas como fecha aparente y 9 horas como fecha real de forma súbita y sin causa, presenta sangrado vaginal en moderada cantidad de color rojo oscuro acompañado de dolor abdominal tipo cólico localizado en hipogastrio con irradiación dorsolumbar de leve intensidad, que se ha ido incrementando con el tiempo, hasta el momento que asiste a emergencia del Hospital Provincial General Docente Riobamba.

2.3. Antecedentes patológicos personales

Como antecedentes clínicos se tuvo hipertensión arterial hace tres años en tratamiento con losartán 50mg vía oral cada día. No tiene alergias y no refiere antecedentes quirúrgicos. Tampoco posee antecedentes traumáticos.

2.4. Antecedentes patológicos familiares

Abuela materna fallecida con hipertensión arterial.

2.5. Antecedentes gineco-obstétricos

- Gestas: 4
- Partos: 4
- Abortos: 0
- Cesáreas: 0
- Hijos vivos: 4
- Menarquia: 12 años.
- Ciclos Menstruales: Irregulares cada 45 días aproximadamente.
- Características físicas de la menstruación: color rojo oscuro sin coágulos
- Número de parejas sexuales: 2
- Fecha de última menstruación: 5/11/2018
- GESTA ACTUAL
- Edad gestacional: 12.4 semanas
- Edad probable de parto: 12/08/2019
- Controles: 1
- Ecografías: 0

2.6. Hábitos fisiológicos

- Alimentario: 3 a 4 veces al día.
- Miccional: 4 veces al día.
- Defecatorio: 2 vez al día.
- Sueño: 7- 8 horas diarias.
- Alcohol, tabaco y drogas: No refiere.

2.7. Historia social

Paciente vive en casa arrendada de cemento, la cual consta de 2 dormitorios, cocina, baño y todos los servicios básicos.

2.8. Revisión del estado actual de aparato y sistemas

2.8.1. Constitucional

- Variaciones de peso: pertinente negativo.
- Anorexia: pertinente negativo.
- Astenia: pertinente negativo.
- Fiebre: pertinente negativo.
- Irritabilidad: pertinente negativo refiere.

2.8.2. Piel

- Antecedentes de lesiones cutáneas: pertinente negativo.
- Contusiones: pertinente negativo.
- Trastornos hemorrágicos: pertinente negativo.

2.8.3. Cabeza

- Cefalea: pertinente negativo
- Pérdida de conocimiento: pertinente negativo.
- Traumatismos: pertinente negativo.

2.8.4. Ojos

- Visión: pertinente negativo.
- Fotofobia: pertinente negativo.
- Diplopía: pertinente negativo.
- Escotomas: pertinente negativo.

2.8.5. Oídos

- Audición: pertinente negativo.
- Vértigo: pertinente negativo.
- Tinnitus: pertinente negativo.

2.8.6. Respiratorio superior

- Problemas de Senos paranasales: pertinente negativo.
- Epistaxis: pertinente negativo.
- Obstrucción: pertinente negativo.

2.8.7. Respiratorio inferior

- Tos: pertinente negativo.
- Disnea: pertinente negativo.
- Estertores: pertinente negativo.
- Hemoptisis: pertinente negativo.

2.8.8. Linfático

- Aumento de tamaño de nódulos: pertinente negativo.

2.8.9. Cardiovascular

- Dolor torácico: pertinente negativo.
- Palpitaciones: pertinente negativo.
- Edema: pertinente negativo.

2.8.10. Gastrointestinal

- Dolor Abdominal: pertinente positivo, dolor de moderada intensidad en hipogastrio.
- Disfagia: pertinente negativo.
- Odinofagia: pertinente negativo.
- Vómitos: pertinente negativo.
- Hematemesis: pertinente negativo.

2.8.11. Genitourinario

- Poliuria: pertinente negativo.
- Disuria: pertinente negativo.
- Hematuria: pertinente negativo.
- Sangrado vaginal: pertinente positivo, en moderada cantidad color rojo oscuro.

2.8.12. Articulaciones musculo-esqueléticas

- Dolor: pertinente negativo.

2.9. Examen físico

2.9.1. Signos vitales

- Tensión arterial: 128/70mmhg.
- Temperatura axilar: 36.8 °C.
- Pulso: 90 pulsaciones por minuto.
- Frecuencia cardiaca: 90 latidos por minuto.
- Frecuencia respiratoria: 20 respiraciones por minuto.
- Saturación de oxígeno: 96 % al aire ambiente.

2.9.2. Medidas antropométricas

- Peso: 60 Kg
- Talla: 147cm.
- IMC: 27,7 Kg/m².

2.9.3. Estado general

Piel y anexos:

- Piel: rosada, caliente, elasticidad conservada, no se evidencia lesiones, higiene regular.
- Pelo: Cabello de cantidad y distribución de acuerdo al sexo.
- Uñas: Llenado capilar < 2 segundos.
- Cabeza: A la inspección se observa normocefálica, simétrica, no se evidencia lesiones en cuero cabelludo.
- Ojos: Conjuntivas rosadas y húmedas, pupilas isocóricas, normoreactivas a la luz y acomodación.
- Nariz: Fosas nasales sin lesiones evidentes, tabique nasal sin desviaciones, senos paranasales y nasales no dolorosos a la digito presión.
- Oídos: Pabellones auriculares de implantación normal, forma y tamaño normal, sin signos de lesiones. Conductos auditivos externos permeables, sin signos de lesión, perforación, inflamación y cicatrización.
- Boca: Mucosas orales rosadas, húmedas y brillantes. Encías húmedas y rosadas. Lengua rosada, húmeda, movilidad conservada y no se evidencia lesiones.
- Cuello: Cuello simétrico, movilidad conservada, no se palpa adenopatías.

Campos pulmonares:

- Inspección: Simétrico, expansibilidad conservada.
- Palpación: Expansibilidad pulmonar y frémito conservada.
- Percusión: claridad pulmonar conservada.
- Auscultación: Murmullo vesicular conservado sin ruidos sobreañadidos.

Corazón:

- Inspección: Ápex no visible
- Palpación: Ápex no palpable.
- Auscultación: R1-R2 rítmicos no soplos.

Abdomen:

- Abdomen globoso, fondo uterino discordante respecto a amenorrea (aparenta mayor edad gestacional), altura de fondo uterino de 17cm, doloroso a la palpación superficial y profunda a nivel de hipogastrio de moderada intensidad, bordes bien definidos, móvil, blando, actividad uterina ausente, no se ausculta frecuencia cardiaca fetal.

Región Inguino-genital:

- Tacto vaginal: Útero en anteversoflexión aumentado de tamaño, cérvix posterior orificio cervical externo entreabierto, de consistencia blanda, fondo de saco de Douglas libre, se evidencia sangrado rojo rutilante en moderada cantidad.

Extremidades superiores e inferiores:

- Extremidades simétricas, de longitud normal, tono y fuerza conservada, pulsos distales presentes y conservados, llenado capilar menor a 2 segundos.

Sistema neurológico:

- Consciente, escala de Glasgow puntuación de 15/15, estado lucido. Pares craneales sin alteración, fuerza muscular 5/5 y resistencia activa.

2.9.4. Impresión diagnóstica

- Embarazo de 12.4 semanas por fecha de última menstruación.
- Amenaza de aborto.
- Hipertensión arterial crónica.
- Madre añosa.
- Embarazo de alto riesgo obstétrico.
- Sobrepeso.

3. Hallazgos

3.1. Evolución del paciente en hospitalización

Día del ingreso

NOTA DE INGRESO: Paciente de 42 años, gestas 4, partos 4, abortos 0, cesáreas 0, hijos vivos 4, que ingresa al servicio de ginecología y obstetricia por presentar sangrado vaginal de 12 horas de evolución en moderada cantidad de color rojo oscuro acompañado de dolor abdominal tipo cólico localizado en hipogastrio de leve intensidad, al examen físico el abdomen se encuentra globoso, altura de fondo uterino de 17cm, doloroso a la palpación superficial y profunda a nivel de hipogastrio de moderada intensidad, actividad uterina ausente, no se ausculta frecuencia cardíaca fetal; al tacto vaginal: el cérvix se encuentra posterior orificio cervical externo entreabierto, blando, se evidencia sangrado rojo rutilante en moderada cantidad y fondo de saco de Douglas libre. Con presunción diagnóstica de embarazo de 12.4 semanas por fecha de última menstruación y amenaza de aborto. Se inicia tratamiento a base de dieta blanda más líquidos medidas generales, valoración de score mama según puntuación, analgesia (paracetamol 1 gramo vía oral por razones necesarias), antihipertensivo (nifedipina 30mg vía oral cada día), calcio 500mg vía oral cada 8 horas, ácido acetilsalicílico 100mg vía oral cada día y vitaminas prenatales. Se indica además exámenes de laboratorio (biometría hemática, química sanguínea, TP, TTP, plaquetas, VIH, VDRL, tipificación sanguínea, elemental y microscópico de orina), exámenes de imagen (Ecografía obstétrica) y valoración por cardiología.

Día 2 de hospitalización

Paciente con signos vitales dentro de parámetros normales, SCORE MAMA 0 puntos; refiere dolor abdominal tipo cólico de leve intensidad localizado en hipogastrio, al examen físico abdomen globoso doloroso a la palpación a nivel de hipogastrio de leve intensidad con irradiación hacia región lumbar, actividad uterina ausente y no se ausculta frecuencia cardíaca fetal. A nivel de región genital no se evidencia sangrado vaginal se continua con indicaciones médicas. Se recibe exámenes de laboratorio que se encuentra dentro de parámetros normales. Además se realiza rastreo ecográfico transvaginal en el cual se evidencia útero en anteversoflexión con presencia de formaciones vesiculares en el endometrio, con dimensiones de 8,57 x 8,64mm; a descartar enfermedad trofoblástica gestacional. Se recomienda realizar BHCG cuantitativa y nueva ecografía. En la Tabla 1 se presentan los resultados de sus exámenes de sangre.

Día 3 de hospitalización

Paciente con signos vitales dentro de parámetros normales SCORE MAMA 0 puntos; al momento se encuentra con evolución estacionaria presentando dolor abdominal tipo cólico de leve intensidad localizado en hipogastrio, al examen físico abdomen globoso con altura uterina de 17cm, doloroso a la palpación a nivel de hipogastrio de leve intensidad, actividad uterina ausente y no se ausculta frecuencia cardíaca fetal; a nivel de región genital no se evidencia sangrado vaginal.

Se recibe resultados de exámenes de laboratorio realizados que indican β -hCG >200.000 mUI/ml. Se realiza ecografía transvaginal: El estudio demuestra útero de contornos regulares notablemente incrementado de tamaño, mide 12x7.9x10cm, con volumen de 549cc, miometrio de textura homogénea sin imágenes de nódulos y masas. La cavidad endometrial muestra masa heterogénea central con espacios anecoicos, que corresponden a vellosidades coriónicas hidrópicas (patrón en tormenta de nieve). Embrión y líquido amniótico ausente. Ovario izquierdo de localización anatómica y tamaño normal, muestra contornos regulares, bien definidos, tiene un volumen de 6,1cc. Ovario derecho no se logra visualizar por interposición de masas intestinales y tamaño del útero. Espacio de Douglas libre. Cérvix de tamaño y morfología habitual. Conclusión: Hallazgos compatibles con enfermedad trofoblástica gestacional.

Se continúa con las mismas indicaciones médicas, además se solicita exámenes de laboratorio BHCG cuantitativa, TGO, TGP, bilirrubina total, indirecta y directa, LDH, fosfatasa alcalina, inmunología, radiografía estándar de Tórax y la realización de electrocardiograma además de valoración por cardiología para programación de intervención quirúrgica.

Tabla 1: Resultados de los exámenes de sangre.

Parámetro	Valor	Unidad
Biometría hemática		
Glóbulos Blancos	6.90	10 ³ /UL
Neutrófilos %	67.7	%
Glóbulos Rojos	4.29	10 ⁶ /UL
Hemoglobina	14.2	g/dL
Hematocrito	40.5	%
Contaje de Plaquetas	231	10 ³ /UL
Grupo sanguíneo		
Grupo	A	
Factor	RH positivo	
Perfil de coagulación		
TTP	24.80	Seg
TP	12.7	Seg
TP%	76.40	%
INR	1.14	
Química sanguínea		
Glucosa	78.3	mg/dl
Creatinina	0.66	mg/dl
Ácido úrico en suero	3.10	mg/dl
Bun	7.4	mg/dl
Serología		
VIH	No reactiva	
Sífilis prueba rápida	Negativa	
Elemental y microscópico de orina		
Ph	6.0	
Proteínas	Negativo	
Nitritos	Negativo	
Bacterias	+	
Gota fresca gram	Bacilos gram negativos 1-2 xc	

Día 4 de hospitalización

Paciente con signos vitales dentro de parámetros normales SCORE MAMA 0 puntos, al momento asintomática, se recibe exámenes de laboratorio que indica BHCG cuantitativa que se mantiene >200.000 resto de exámenes dentro de parámetros normales. Se realiza electrocardiograma que indica ritmo sinusal normal.

Radiografía estándar de Tórax: Partes blandas y estructuras óseas visibles sin alteraciones evidentes, campos pulmonares libres de infiltrados sin signos evidentes de lesión pleuropulmonar activa, ángulos costo y cardiopulmonares libres, silueta cardiaca de tamaño normal, tronco de la pulmonar y botón aórtico de calibre normal. La paciente es valorada por cardiología que indica riesgo cardiológico GOLDMAN II/IV. Con dichos resultados se programa resolución quirúrgica, histerectomía abdominal total por ser una paciente de 42 años más paridad satisfecha con diagnóstico de mola hidatiforme.

Se indica protocolo prequirúrgico: Dieta blanda más líquidos hasta las 22 horas luego NPO, medidas generales, SCORE MAMA según puntuación, preparar campo operatorio, marcar sitio quirúrgico, colocar sonda vesical antes de bajar a quirófano, colocar vendaje en miembros inferiores, asepsia vaginal y enema evacuatorio a las 22 horas, canalizar vía intravenosa a las 6 am, solución salina 0.9% intravenoso pasar a 42 gotas minuto, cefazolina 2 gramos intravenoso antes de procedimiento, enoxaparina 40mg subcutáneo antes del procedimiento, pasar parte operatorio comunicar a anestesiología, comunicar a jefe de servicio, firmar autorizaciones, indicaciones de cardiología.

Día 5 de hospitalización

Paciente con SCORE MAMA de 0 puntos. Se administra protocolo y baja a centro quirúrgico.

NOTA POSTQUIRÚRGICA: Bajo anestesia general se realiza histerectomía total mas salpingectomía total bilateral por mola hidatiforme completa, además se observa trompas uterinas con quiste de Morgagni con sangrado aproximado de 80 mililitros, no hay complicaciones en procedimiento quirúrgico. Se indica nada por vía oral, medidas generales, control de signos vitales y sangrado cada 15 minutos por 2 horas y después cada 6 horas, mantener sonda vesical y retirar al siguiente día, mantener vendaje de miembros inferiores hasta deambulacion de paciente, hidratación (dextrosa en solución salina 1000ml más 10ml electrosol potasio pasar 2500ml intravenoso a 35 gotas por minuto), cefazolina 1 gramo intravenoso cada 6 horas, ketorolaco 30 mg intravenoso cada 6 horas, paracetamol 1 gramo intravenoso cada 6 horas, histopatológico de útero y trompas uterinas.

Día 6 de hospitalización

Paciente postquirúrgico inmediato, hemodinámicamente estable, en buen estado general con evolución favorable refiere leve dolor a nivel de herida quirúrgica que cede con analgesia, se decide su alta al día 7 de hospitalización con antibioticoterapia (cefalexina 500mg vía oral cada 6 horas por 5 días), analgesia (ibuprofeno 400 mg vía oral cada 8 horas por 3 días), y valoración por consulta externa en 15 días con resultado de

BHCG cuantitativa e histopatológico. Con diagnósticos de Enfermedad trofoblástica gestacional e Hipertensión Arterial.

3.2. Seguimiento por consulta externa

Se realiza controles por consulta externa con evolución favorable Diecinueve días después se realiza control post-cirugía. El paciente acude a control por consulta externa con histerectomía abdominal hace 3 semanas al momento asintomático, en buenas condiciones generales con reporte de β hCG de 365 mUI/ml. Resultado de Histopatológico indica lo descrito en la Tabla 2.

Tabla 2: Resultados de los exámenes de sangre.

Servicio	Ginecología
Diagnóstico clínico	Mola Hidatiforme
Operación practicada	Histerectomía + Salpingectomía
Origen y naturaleza de la muestra	Útero y trompas
Se recibe útero con trompas uterinas bilaterales, pesa 500 gr, el cuerpo uterino mide 10 x 9,5 x 8 cm, está cubierto por serosa parda, lisa. El cuello mide 3,5 cm de diámetro a nivel de su base, está cubierto por mucosa exocervical blanquecina, lisa, en canal endocervical es permeable, se comunica con la cavidad uterina central dilatada que mide 8 x 7 cm, ocupada por el tejido de aspecto vesicular membranoso y coágulos hemáticos, en conjunto hacen un volumen de 50 cc. A los cortes sucesivos, el espesor del endometrio es de 0,8 cm, y del miometrio de hasta 2 cm, de aspecto fibromuscular.	
La trompa uterina derecha mide 8 x 0,7 cm, está cubierta por serosa gris, lisa, con un quiste de contenido líquido, claro que mide 0,8 cm de diámetro, localizado a nivel de las fimbrias.	
La trompa uterina izquierda mide 5 x 0,8 cm, está cubierta por serosa gris, lisa, con un quiste de contenido claro, que mide 1,4 cm de diámetro, localizado a nivel de las fimbrias. Se procesa partes representativas:	
A) Cérvix	1 caseta.
B) Endo/miometrio	1 caseta.
C) Tejido vesicular	1 caseta.
D) Trompa uterina derecha	1 caseta.
E) Trompa uterina izquierda	1 caseta.
Diagnóstico	
Cérvix	Cervicitis aguda
Endometrio	Mola Hidatiforme completa
Trompas uterinas	Quistes simples paratubáricos bilateral

Un mes posterior el paciente acude a control no refiere sintomatología al examen físico herida quirúrgica infraumbilical sin signos de infección. Resultado de exámenes de laboratorio indican β hCG 115 mUI/ml. se programa controles mensuales para evaluar evolución, los mismos que indican que cifras de β hCG han disminuido llegando a un valor de < 1.01 mUI/ml en su último control. En la Tabla 3 se describen los resultados del laboratorio clínico y en la Tabla 4 se muestran los valores de referencia de BHCG durante la gestación. La Tabla 5 presenta el listado de signos y síntomas.

Tabla 3: Resultados del laboratorio clínico.

BHCG	Valor
03/02/2019	> 200.000 mUI/ml
22/02/2019	365 mUI/ml
25/03/2019	115 mUI/ml
22/04/2019	42 mUI/ml
15/05/2019	20 mUI/ml
18/06/2019	< 1.01 mUI/ml

Tabla 4: Valores de referencia de BHCG en el embarazo.

Sistema de gestación	Valor
1 - 2 Semanas	16-156
2 - 3 Semanas	101- 4870
3 - 4 Semanas	1110- 31500
4 - 5 Semanas	2560-82300
5 - 6 Semanas	23100-151000
6 -7 Semanas	27300-233000
7-11 Semanas	20900-291000
11 -16 Semanas	6140-103000
16 - 21 Semanas	4720-80100
21 -39 Semanas	2700-78100

Tabla 5: Listado de signos y síntomas.

Signo	Síntoma
Sangrado vaginal	Dolor abdominal
Altura uterina mayor a la edad gestacional	-

3.3. Diagnóstico diferencial por signos y síntomas

Al identificar signos y síntomas en cuanto a las hemorragias de la primera mitad del embarazo se ha identificado que enfermedad trofoblástica gestacional presenta sangrado vaginal profuso, dolor abdominal, cuello uterino abierto y tamaño uterino mayor a la edad gestacional por lo que se descarta el resto de patologías. La Tabla 6 lo muestra de mejor manera.

Tabla 6: Diagnóstico diferencial por síntomas y signos.

Patología	Amenaza de aborto	Aborto completo	Aborto incompleto	Aborto inevitable	Embarazo ectópico	Enfermedad trofoblástica gestacional
Sangrado vaginal profuso			x	x		x
Dolor abdominal	x	x	x	x	x	x
Cuello uterino abierto			x	x	x	x
Tamaño uterino mayor a la edad gestacional						x
Total	1	1	3	3	2	4

3.4. Diagnóstico diferencial de mola hidatiforme

Esto se muestra en la Tabla 7.

Tabla 7: Diagnóstico diferencial de mola hidatiforme.

Mola hidatiforme	Completa	Parcial
Ausencia de tejido fetal	x	
Ausencia de amnios, eritrocitos fetales	x	
Edema vellosos difuso	x	
Proliferación trofoblástica	x	x
Quiste de la teca luteínica	x	
Total	5	1

3.5. Diagnóstico definitivo

La paciente tiene mola hidatiforme completa, hipertensión arterial crónica y cervicitis aguda quística.

4. Discusión

Mola Hidatiforme es el tipo más común de ETG, que se determina por la degeneración hidrópica, desaparición de vascularización en las vellosidades coriales, edema del estroma vellositario y por la proliferación del epitelio trofoblástico [7]. Teniendo mola hidatiforme completa y parcial siendo la más común mola hidatiforme completa, que está relacionada con la gametogénesis y la fertilización anormal, no tiene feto o embrión y es de origen paterno [7], [8].

En la mola completa la imagen típica de "copos de nieve" o "panal de abejas" se manifiesta por la cavidad ocupada por ecos disminuidos en amplitud, que corresponden al tejido trofoblástico proliferado [9]. Dentro de los estudios de laboratorio la determinación cuantitativa de la subunidad beta de hCG con valores elevados [10], el estudio histopatológico tiene una apariencia típica de una masa voluminosa de estructuras de vellosidad coriónica anormales se lo utiliza como el método confirmatorio [11].

El legrado aspirativo previa dilatación cervical mecánica y bajo guía ecográfica es el método de preferencia. Pero en este caso la histerectomía con preservación anexial puede ser una opción en pacientes que presenten deseo genésico cumplido ya que presenta un mínimo riesgo de secuelas malignas posterior a la evacuación en comparación con lo que es el legrado aspirativo [12]. El seguimiento inmediatamente de la evacuación uterina de la mola hidatiforme se lleva a cabo mediante la medición de la hCG sérica por exámenes semanales hasta tres niveles normales consecutivos y luego exámenes mensuales durante seis meses [13]. Un nivel de hCG normal se considera menor de 5 UI/L [13].

Al ser una patología poco común y con pocos estudios en el Ecuador, se tomó el presente caso clínico para su estudio y seguimiento. Considerando la clínica de la paciente y los factores de riesgo fue hospitalizada en el servicio de ginecología y obstetricia en donde se realizó estudios de laboratorio e imagen dando una presunción diagnóstica de enfermedad trofoblástica gestacional, misma que fue intervenida quirúrgicamente por la edad de 42 años y la paridad satisfecha; por lo cual se procedió a la histerectomía total con el estudio histopatológico para confirmar el diagnóstico. El seguimiento por consulta externa fue de mucha importancia evidenciando una evolución favorable con valores de β -hCG a los 5 meses de $< 1.01\text{mUI/ml}$ y sin evidencia de progresión a la malignidad.

5. Conclusión

Dentro de la enfermedad trofoblástica gestacional la mola hidatiforme es el tipo más común ya que se origina la degeneración hidrópica de la placenta con desaparición de vascularización en las vellosidades coriales, además del edema del estroma vellositario. El diagnóstico es multidisciplinario usando la ecografía en la cual se evidencia la imagen de la cavidad con ecos de baja amplitud que corresponden al tejido trofoblástico proliferado, además se utiliza la determinación cuantitativa de beta gonadotropina coriónica humana observando valores elevados, la patología se confirma por el estudios histopatológicos La histerectomía con preservación anexial puede ser una opción en pacientes que presenten deseo genésico cumplido ya que presenta un menor peligro de secuelas malignas postmola comparada con lo que es el legrado aspirativo. El seguimiento detrás de la evacuación uterina de la mola hidatiforme se dio mediante la medición de la hCG sérica por exámenes semanales hasta tres niveles normales consecutivos y luego exámenes mensuales durante 6 meses y cada 2 meses por 1 año.

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Esta investigación ha sido financiada en su totalidad por el autor.

Declaración de la Junta de Revisión Institucional

No aplica.

Declaración de Consentimiento Informado

Este consentimiento ha sido firmado por el participante y el autor de esta investigación.

Conflictos de Interés

El autor declara no tener un conflicto de interés.

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