

ANALYSIS OF PRIMARY CAREGIVERS' KNOWLEDGE CONCERNING THE CARIOGENIC RISK ASSOCIATED WITH THE USE OF PEDIATRIC LIQUID MEDICATIONS

Análisis del conocimiento de los cuidadores principales sobre el riesgo cariogénico implicado en la ingesta de medicamentos líquidos pediátricos

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ABSTRACT

Introduction: Pediatric liquid medications (PLM) are frequently administered to children, yet their usage may contribute to the onset of dental caries. Despite its prevalence, there is a notable scarcity of scientific research regarding caregivers' knowledge of this potential cariogenic risk.

Objective: This study aims to assess the knowledge of the main caregivers of children aged 5 to 12 years concerning the cariogenic potential associated with the use of PLM.

Materials and Methods: A cross-sectional analytical observational study involving 152 primary caregivers of children aged 5 to 12 was conducted. Data were collected on caregivers' perceptions of the cariogenic risk associated with PLMs and their consumption habits. The study also assessed oral hygiene routines and evaluated the level of information provided by healthcare professionals.

Results: Research findings indicated a significant lack of awareness among primary caregivers regarding the cariogenic risks of PLMs, with 78.95% being unaware of these risks and 47.37% unaware of the sugars present in such medications. Additionally, a high rate of PLM consumption was observed, with 63% of caregivers using them in the last year. The study underscored a notable absence of guidance from healthcare professionals, as 91.45% of the caregivers stated that they had not received instructions on tooth brushing after the administration of the PLM.

Conclusions: The study highlights a significant lack of awareness among primary caregivers regarding the cariogenic risks associated with the ingestion of pediatric liquid medications. This deficit in information and preventive measures presents a substantial obstacle to children's oral health. To address this issue, it is crucial for healthcare professionals to offer comprehensive guidance and promote preventive measures.

Keywords: Dental Caries; Knowledge; Caregivers; Child; Pharmaceutical Preparations; Oral hygiene.

RESUMEN

Introducción: La administración de medicamentos líquidos pediátricos (MLP) es una práctica común en la población infantil y puede estar vinculada al desarrollo de lesiones de caries dental. Sin embargo, la evidencia científica que aborda el conocimiento de los cuidadores acerca de este riesgo cariogénico es escasa.

Objetivo: Este estudio busca determinar el conocimiento de los cuidadores principales de niños de 5 a 12 años sobre el potencial cariogénico asociado al consumo de MLP.

Materiales y Métodos: Se llevó a cabo un estudio observacional analítico transversal que incluyó a 152 cuidadores principales de niños en el rango de edad de 5 a 12 años. Se recopiló información sobre la percepción de los cuidadores acerca del riesgo cariogénico de los MLP, así como sobre sus patrones de consumo. Además, se registraron las prácticas de higiene oral y se evaluó el nivel de información proporcionado por los profesionales de la salud.

Resultado: Los hallazgos de la investigación revelaron que un 78,95% de los cuidadores principales desconocen el riesgo cariogénico asociado al consumo de medicamentos líquidos pediátricos (MLP), y un 47,37% de ellos no eran conscientes de la presencia de azúcares en dichos medicamentos. Además, se observó un elevado índice de consumo de MLP, con un 63% de los cuidadores que los utilizaron en el último año. Se destacó la falta de orientaciones por parte de los profesionales de la salud, ya que, un 91,45% de los tutores afirmaron no haber recibido instrucciones sobre el cepillado dental posterior a la administración de los MLP.

Conclusión: Este estudio evidencia un relevante porcentaje de desconocimiento entre los cuidadores principales acerca del riesgo cariogénico asociado a la ingesta de medicamentos líquidos pediátricos. La falta de información y medidas preventivas constituye un desafío significativo para la salud oral de los niños. Es imperativo que los profesionales de la salud proporcionen información detallada y fomenten prácticas de prevención.

Palabras Clave: Caries Dental; Conocimiento; Cuidadores; Niño; Preparaciones Farmacéuticas; Higiene bucal.

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INTRODUCTION

Dental caries is a widespread global issue, impacting roughly 2 billion individuals with permanent teeth and approximately 514 million children with primary teeth. In Chile, caries prevalence at age 6 reaches 70.4%, increasing with advancing age.^{1,2}

Caries disease is a chronic, multifactorial condition influenced by behavior and various other factors. Achieving effective control requires consideration of multiple elements. The interaction between protective and risk factors affects the demineralization-remineralization processes of teeth, often favoring demineralization and resulting in the formation of carious lesions.

Maintaining a proper balance is crucial in the expression of this disease, with fermentable carbohydrates, particularly sugar, being the primary disruptor that tilts this balance towards dental tissue demineralization. Giacaman *et al.*,³ asserts that these carbohydrates act as the primary substrate for acid production by bacterial plaque; this acid is ultimately responsible for the development of caries disease.

A significant portion of pediatric liquid medications (PLM) contains sugars, posing a risk to oral health that remains largely overlooked. This issue stems from their high sugar content, low pH below the enamel demineralization threshold, high viscosity, and frequent consumption, leading to detrimental effects on saliva and diminishing its protective properties for teeth.^{4,5}

Liquid medications are primarily favored in pediatric care for their convenient form, enjoyable taste, and ease of administration.⁶ However, children are particularly vulnerable to caries development due to the increased susceptibility to demineralization of their primary teeth, as

they possess a thinner, more permeable enamel layer with higher water content compared to permanent teeth.⁷ As a result, the caries process can progress more rapidly, potentially leading to early pulp inflammation due to a larger pulp chamber.

Pediatric patients, with their developing immune systems, are particularly vulnerable to infections,⁸ often resorting to pediatric syrups to alleviate symptoms. The American Academy of Pediatric Dentistry (AAPD) notes that children suffering from chronic illnesses and reliant on liquid medications face a higher risk of developing dental problems.⁶

The rise in the consumption of pediatric liquid medication is a growing public health concern, exposing more children to dental caries disease.^{5,9} This highlights a notable gap in the understanding of this problem among primary caregivers. Hence, this study aimed to assess the knowledge of caregivers of 5 to 12-year-old children concerning the cariogenic risks associated with PLMs. Furthermore, it sought to determine whether caregivers possess the necessary information and resources to contribute to risk reduction.

MATERIALS AND METHODS

A cross-sectional analytical observational study was conducted with the approval of the ethical scientific committee of Universidad Andrés Bello, Viña del Mar, Chile, under resolution number N°90-22.

The determination of the sample size involved assessing 74 students from the 2022 Pediatric Dentistry course, each overseeing around four patients within the clinical program, totaling 296 patients. Calculation of sample size was

conducted with a 95% confidence level, 5% significance level, and a medium effect size of 0.3 using the G*Power 3.1.9.7 software, which resulted in a sample size of 152 participants. The 152 primary caregivers participated anonymously, having provided prior informed consent for the research.

The study focused on primary caregivers of pediatric patients aged 5 to 12 years, recognized as the individuals with the most comprehensive understanding of children. Convenience sampling was used to select participants from the Pediatric Dentistry Clinic at Universidad Andrés Bello, Viña del Mar, Chile, from June to September 2022.

Participants eligible for the study were required to be primary caregivers of children aged 5 to 12 who attended the Pediatric Dentistry course, irrespective of nationality. However, illiterate primary caregivers and those offering emotional or physical support during dental treatment were excluded from the study. The survey used was designed specifically for this study and underwent corrections and approvals by a panel of experts consisting of a nutritionist, a pharmaceutical chemist, a pediatric dentist, and two pediatricians.

The survey consisted of 12 questions, with interviewers answering the first one. Following a clinical examination, interviewers used the "International Caries Detection and Assessment System" (ICDAS) to determine the highest code. Prior to this, researchers received calibration from a Cariology professor, who provided guidance and evaluation using images depicting diverse stages of carious lesions, ensuring diagnostic consistency.

Following the initial assessment, caregivers responded to questions 2 through 12. These questions encompassed various aspects, including

the age range of the child, spanning from 5 to 12 years, among other multiple selection variables.

Furthermore, variables including "Age of the child" (5-12 years) and "Usual place of care" (Office, Family Health Center (CESFAM), Community Family Health Centers (CECOSF), Private Clinic, Hospital, and Primary Emergency Care Service (SAPU) were included. The frequency of pediatric liquid medication consumption in the past year was assessed, ranging from "Daily" to "Complete absence." Additionally, caregivers were asked whether the child's teeth were brushed after medication intake, with response options including "Never," "Rarely," "Most of the time," and "Always." These comprehensive details contributed to a thorough understanding of the studied population.

Two subsequent multiple-choice questions permitted multiple answers. The first question aimed to identify the PLMs consumed by the child in the previous 12 months. To aid selection, a list of PLMs categorized by their active ingredient, along with respective trade names and illustrations of their presentations, was provided. The second question aimed to identify the specific times the caregivers recalled having administered the PLM to the child. The available choices were: "Before bedtime," "Between meals," "During meals," "During breakfast," "After breakfast," and "Other time."

The following questions addressed dichotomous variables, with "yes" or "no" response options:

1. Does the child have any chronic illness?
2. Did the health care professional who prescribed these pediatric liquid medications mention brushing the child's teeth after consumption?
3. Did you know that the pediatric liquid medications mentioned above increase the risk of caries?
4. Did you know that the pediatric liquid medications listed above contain sugar within their components?

Additionally, the caregiver was asked about the gender of the child, with the response options: “female” or “male.”

Data collection occurred during the Pediatric Dentistry course, where interviewers extended invitations to primary caregivers and patients to participate in the study. Upon acceptance, participants accessed the survey via a web link (www.questionpro.com), where they provided their informed consent. Subsequently, study data were automatically gathered at the same link. Additionally, a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, Washington) was used to document each child's initials and care box number, facilitating the acquisition of results per patient.

Analysis of the data was conducted using the Stata17 software (StataCorp LLC, College Station, Texas). Percentage and descriptive analyses were performed using tables and graphs. Following this, the study identified the percentages of the three primary factors increasing cariogenic risk within the group of caregivers reporting PLM administration. These factors included post-ingestion brushing, frequency of consumption, and time of ingestion.

Following that, two descriptive and bivariate analyses were performed on the variables under study. Pearson's Chi-square test was used to determine statistical significance. First, the study delved into the correlation between primary caregivers' knowledge of the sugar content in pediatric liquid medications and their awareness of the cariogenic risk linked to their consumption.

Subsequently, the same test was used to assess the association between caregivers' understanding of the cariogenic risk linked to pediatric liquid medication consumption and the occurrence of cavitated caries within the group reporting

administration of these medications. In this analysis, cavitated lesions were categorized into two groups: ICDAS (codes 1 a 4), representing mild to moderate lesions; and ICDAS (codes 5 and 6), indicating severe lesions with noticeable cavitation. Ultimately, the study examined the relationship between these two groups and the awareness level of primary caregivers.

RESULTS

In the descriptive analysis, 152 surveys were included. The average age of the patients was approximately 8.18 years, with a variation of around ± 0.6789 years. Among the entire sample, 48% were caregivers of male patients, while 51.97% were caregivers of female patients. Regarding the type of care, most patients (71.7%) received treatment within the public healthcare system, which included primary care, hospitals, and primary emergency care services.

During the clinical examination, it was observed that a significant portion of patients (67.76%) exhibited carious lesions with exposed dentin (ICDAS codes 5 or 6), whereas 34.24% presented lower ICDAS codes.

Figure 1 shows the consumption frequency of different pediatric liquid medications containing sugar, commonly available in the Chilean market. Notably, a significant number, accounting for 30.06%, reported having used some variant of ibuprofen. Regarding the frequency of pediatric liquid medication consumption, findings revealed that only 25.66% of children did not use them in the last 12 months, while a substantial 67.76% required such medications.

Furthermore, it was noted that 3.29% of children had chronic conditions necessitating periodic use of pediatric liquid medications (Table 1).

Table 1. Consumption frequency of pediatric liquid medications (PLM) in the last year, according to information provided by primary caregivers.

CONSUMPTION FREQUENCY OF PLM	FREQUENCY	PERCENTAGE
Every day	5	3.29
1 to 6 days per week	6	3.95
7 days a month	8	5.26
7 days every 2-5 months	26	17.11
7 days every 6-12 months	51	33.55
7 days a year	34	22.37
Has not consumed during the last year	22	14.47
Total	152	100.00

Table 2. Tooth brushing practice after ingesting pediatric liquid medications (PLM), according to the response of primary caregivers.

TOOTH BRUSHING AFTER PLM INTAKE	FREQUENCY	PERCENTAGE
Never	39	25.66
Rarely	73	48.03
Most of the time	30	19.74
Always	10	6.58
Total	152	100.00

Table 3. Times of pediatric liquid medication (PLM) intake, identified by primary caregivers.

TIME OF PLM INTAKE	FREQUENCY	PERCENTAGE (%)
Before sleeping	83	40.29
Between meals	55	26.70
With meals	6	2.91
At breakfast	12	5.83
After breakfast	33	16.06
Other	17	8.25

Table 4. Relationship between caregivers' knowledge of cariogenic risk with the variables of the patient's highest ICDAS code and the cariogenic risk associated with the administration of pediatric liquid medications (PLM).

Knowledge of cariogenic risk	KNOWLEDGE OF PRESENCE OF SUGAR IN PLM		HIGHER ICDAS CODE	
	Yes (%)	No (%)	1-4	5-6
Yes	19.1 (n= 29)	33.55 (n= 51)	8.55% (n= 13)	12.5% (n= 19)
No	1.97 (n= 3)	45.39 (n= 69)	23.68% (n= 36)	55.26% (n= 84)
Pearson Chi² Calculation	23.46 (p=0.000)		1.30 (p=0.253)	

ICDAS: International Caries Detection and Assessment System.

In terms of tooth brushing following the consumption of pediatric liquid medications, findings revealed that only 6.58% of primary caregivers consistently performed tooth brushing on the children after ingestion, while a substantial 48.03% reported rarely carrying out this practice. Additionally, 25.66% indicated that they never performed oral hygiene procedures after administering the medication (Table 2). Moreover, concerning health personnel's advice on tooth brushing post-consumption of pediatric liquid medications, it was observed that a significant majority (91.45%) of primary caregivers did not receive such recommendations.

Concerning the times of ingestion of pediatric liquid medication, analysis revealed that a considerable number of primary caregivers had risky practices. Specifically, 39.90% administered the medications before putting the child to sleep, 26.44% did so between meals, and 15.87% administered them after breakfast (Table 3).

Upon analyzing the caregivers' knowledge, it was noted that 52.63% were aware that pediatric liquid medications contained sugar in their ingredients, while 47.37% lacked this information (Table 4). Furthermore, a significant majority, comprising 78.95% of those surveyed, admitted to being unaware of the increased risk of cavities associated with the consumption of pediatric liquid medications, while only 21.05% reported awareness of this risk. In the bivariate analysis, the associations between qualitative variables were examined using Pearson's Chi-square test. Firstly, this research studied the correlation between primary caregivers' knowledge of the sugar content in pediatric liquid medications and their awareness of the increased cariogenic risk associated with their consumption. A statistically significant difference was observed between knowledge of sugar content and awareness of cariogenic risk ($p < 0.05$). Notably, this disparity

remained significant at the 1% level, suggesting the presence of an explanatory pattern within this association, (Table 4).

Secondly, the hypothesis concerning the relationship between primary caregivers' knowledge of the cariogenic risk associated with pediatric liquid medications and the presence of carious lesions was examined. Carious lesions were categorized into mild-moderate (ICDAS 1 to 4) and severe (ICDAS 5 or 6), treating both variables as model variables in the analysis. As shown in Table 4, no statistically significant association was observed ($p = 0.25$). Therefore, the analysis yielded no evidence supporting a significant relationship between caregivers' knowledge of cariogenic risk and the presence of carious lesions.

DISCUSSION

The findings from this research highlight the need to address the cariogenic risk associated with the consumption of PLMs. The study involved 152 primary caregivers of pediatric patients, and descriptive as well as bivariate analyses were conducted to explore relationships between qualitative variables.

In the study, it was noted that a significant proportion (85.53%) of caregivers admitted to administering at least one of the listed pediatric liquid medications within the past 12 months. This finding raises concerns due to the presence of high concentrations of free sugars and their adverse effects on salivary flow, as highlighted by the CariesCare platform.¹⁰ Moreover, the literature highlights that these medications typically exhibit pH levels below the critical threshold for enamel demineralization and possess high viscosity. Regular consumption of these medications, particularly before bedtime,

compounds the risk, adding an additional factor for dental cavities.^{4,5}

The consumption of pediatric liquid medications has been linked to a decrease in saliva production and its buffering capacity.⁷ The concentration of bicarbonate in saliva is directly proportional to the rate of salivary production, resulting in lower saliva production with a more acidic pH and reduced buffer capacity.⁷ The study also identified three additional contributing factors: frequent consumption of fermentable carbohydrates, consumption between meals, and inadequate dental hygiene practices post-consumption. Epidemiological literature consistently underlines the significant role of consumption frequency¹⁰ and between-meal intake in the development of carious lesions.¹¹

In terms of intake frequency, a small proportion of children (3.29%) were found to suffer from chronic diseases. The American Academy of Pediatric Dentistry (AAPD) classifies such children as being at high risk for cavities,¹² emphasizing the importance of addressing cariogenic risk in this vulnerable group. Numerous studies, including one conducted by Goyal *et al.*,¹³ indicate that frequent exposure to sugars in pediatric liquid medications significantly increases the risk of developing carious lesions as a side effect of treating these medical conditions. Furthermore, it was noted that 33.55% of primary caregivers administered some medications with a frequency ranging from once every six to twelve months. While this percentage of children may not be classified as chronically ill, it is crucial to recognize that with each administration of a PLM containing free sugars, the daily sugar intake increases, consequently raising the number of instances of decreased pH. This, in turn, inhibits the remineralization process and promotes demineralization.¹⁴ Such disturbances in the

mineral balance of tooth enamel can contribute to the development of carious lesions.

In terms of intake patterns, research indicates a significant association between consuming sugars between meals and within two hours before bedtime and the prevalence of caries in pediatric patients.¹⁵ It is worth noting that consuming sugars between meals poses a greater risk than during meals,¹¹ since while eating or drinking, there is an increase in salivary flow, aiding in quicker and more effective neutralization of acids.¹⁵ This study observed that 26.44% of caregivers admitted to administering medications between meals, extending the periods during which oral pH remains below the critical threshold for enamel demineralization.

Therefore, it is essential for healthcare professionals, when prescribing such medications, to advise caregivers to administer them during meals. Furthermore, it has been documented that about 70% of dental caries incidents are linked to consuming food before sleeping.¹⁵ This is due to the body's diminished physiological response during sleep, leading to reduced salivary self-cleaning and prolonging the period during which the oral cavity remains at a critical pH.¹⁶ In the current study, it was noted that 39.9% of respondents reported that pediatric patients consumed pediatric liquid medications before bedtime.

Regarding tooth brushing, extensive research has consistently confirmed that brushing with fluoride toothpaste stands as the most effective, straightforward, and cost-efficient measure for managing dental caries.¹⁷

The primary goal of tooth brushing is to disrupt bacterial plaque, thus hindering the growth and arrival of late colonizers, which trigger the transition of plaque towards a pathogenic state. These bacteria metabolize dietary sugars, generating acidic byproducts that

demineralize tooth enamel.¹⁸ In this scenario, it is recommended to practice proper oral hygiene techniques following the administration of pediatric liquid medications.¹⁹

This practice aims to counteract the decline in plaque pH induced by these medications, disrupt the bacterial plaque retaining drug remnants, and minimize the duration of exposure to demineralization processes.¹⁷ Furthermore, the use of fluoridated toothpaste aids in the remineralization of affected areas and, when used in appropriate concentrations, stimulates salivary secretion by increasing oral pH.¹⁷ Despite the compelling evidence supporting these practices, the findings of this study revealed that 25.66% and 48.03% of children either never or rarely, respectively, engaged in tooth brushing post-medication intake. Only 6.58% reported to do it regularly.

In addition to the above, a previous study²⁰ found that 65% of pediatricians overlook recommending tooth brushing following the consumption of prescribed PLMs. These findings align with the outcomes of the current study, where 91.5% of primary caregivers stated that they had not been provided with any oral hygiene guidance after the prescription of medication by healthcare professionals. The findings of this study highlight that, despite extensive research on intake patterns, a large percentage (66.34%) of patients exhibit a potentially cariogenic intake and brushing pattern. This suggests a lack of adequate awareness among primary caregivers regarding preventive measures and behaviors that increase the risk of dental caries.

Concerning the knowledge of primary caregivers about pediatric liquid medications, 52.6% said they were aware of the presence of sugar in these medications. However, surprisingly, 78.95% were unaware that the consumption of these medi-

cations increases the risk of dental cavities. These findings suggest that most primary caregivers do not recognize the association between the sugar content in pediatric liquid medications and the development of caries, associating such risks more with conventional sugar sources like candy and cookies.²¹ This lack of awareness poses a significant risk for children, as without understanding this association, necessary preventive measures to mitigate the onset of caries may not be taken.

Additionally, a statistically significant correlation was observed between caregivers' lack of knowledge regarding the sugar content in medications and their unawareness of the associated cariogenic risks. Specifically, 45.4% of caregivers acknowledged being uninformed about both variables. These findings imply that professionals prescribing these medications may not adequately provide caregivers with the necessary information and resources for the proper oral care of children. It is essential to note that the study did not find a statistically significant correlation between the presence of cavitated and non-cavitated caries in patients and caregivers' knowledge of the cariogenic potential of pediatric liquid medications. This lack of correlation could stem from unaccounted variables that may influence the outcome, such as salivary flow and buffer capacity, dietary habits, oral hygiene practices, frequency and timing of tooth brushing, frequency of dental visits, among others. Hence, it is insufficient to solely link these two variables in isolation, given the multitude of factors influencing caries development. However, it is noteworthy that 55.3% of caregivers of patients with cavitated caries expressed unawareness regarding the cariogenic risk of pediatric liquid medications.

This emphasizes the need to enhance the informative and educational role of healthcare professionals in educating and training

caregivers. The findings of this study underscore the vital role of healthcare professionals in informing patients about the cariogenic risks associated with pediatric liquid medications. It is incumbent upon these professionals to offer clear guidance aimed at mitigating such risks, including recommendations such as administering medications during meals, avoiding consumption before bedtime and immediately after tooth brushing. Moreover, protective measures should be promoted, such as rinsing with water post-medication intake, brushing teeth with fluoride toothpaste, chewing sugar-free gum to increase salivary flow, and attending regular preventive dental check-ups and treatments.

Additionally, there is a need to reinforce the responsibility and public accountability of health institutions in reevaluating PLMs. Implementing policies that ensure transparency regarding the high sugar content in these medications and their impact on oral health is imperative. This entails highlighting the cariogenic risks associated with their consumption to the population. Such a comprehensive approach is crucial for mitigating the risks linked to the use of PLMs and improving oral health outcomes among the pediatric population.

CONCLUSION

This study highlights the alarming exposure of pediatric patients to liquid medications containing high sugar content, significantly increasing the risk of carious lesion development. The widespread lack of awareness, with 78.95% of primary caregivers admitting to their unawareness regarding the cariogenic potential of these medications, emphasizes the pressing necessity for enhanced education efforts, particularly guided by healthcare professionals.

Moreover, the absence of clear directives from health professionals is evident, as indicated by 91.45% of primary caregivers reporting that they did not receive oral hygiene instructions following medication prescriptions. This issue demands immediate attention to encourage awareness and promote better oral hygiene practices. Furthermore, the statistical analysis revealed important associations, such as the correlation between caregivers' unawareness of sugar content in medications and their lack of knowledge regarding associated cariogenic risks. These findings emphasize the need for targeted interventions and focused educational initiatives.

CONFLICT OF INTERESTS

Authors declare no conflict of interest.

ETHICS APPROVAL

This study was approved by the Ethical-Scientific Committee of Universidad Andres Bello, Viña del Mar, Chile, under resolution number No. 90-22, and was carried out considering the principles of The World Medical Association Declaration of Helsinki.

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AUTHORS' CONTRIBUTIONS

Cáceres-Riveros F: Methodology development, data collection, data analysis, writing, review and adaptation for the magazine.

Karin-Navea P: Methodology development, data collection, data analysis, writing and review.

Barrera-Gutiérrez C: Developed methodology and editing.

Brantt-Brantt J: Developed methodology and editing.


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PEER REVIEW

This manuscript was evaluated by the editors of the journal and reviewed by at least two peers in a double-blind process.

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