

Reliability and validity of a questionnaire of child development for national surveys

Confiabilidad y validez de un cuestionario de desarrollo infantil en encuestas nacionales

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What do we know about the subject matter of this study?

Latin America has little published information about the situation of child development in its population, possibly due to the lack of a valid and reliable screening instruments to establish developmental disorders and formulate public policies to address them timely.

What does this study contribute to what is already known?

It provides evidence about reliability and convergent construct validity of the Screening Questionnaire of Child Development for Household Surveys (DIEH) as a potential instrument to be used in national surveys quickly and at low cost.

Abstract

The child development screening in national surveys supports the formulation of public policies that contribute to its diagnosis and early intervention, aimed at promoting comprehensive development and successful school performance until adolescence, however, few countries in Latin America have this information. **Objective:** To assess the reliability and convergent validity of a cultural adaptation of the Screening Questionnaire of Child Development for Household Surveys (DIEH) and to describe the prevalence of developmental alterations in children aged between 2 months and 5 years in Bucaramanga-Colombia. **Subjects and Method:** Between July and December 2016, an evaluation of diagnostic tests was carried out in which participated 224 children aged between two months and five years and their parents or caregivers from Bucaramanga, Colombia. The Abbreviated Developmental Scale was applied by trained physiotherapists and the DIEH was answered by the parents or caregivers. The reliability of the DIEH was established using the Cronbach's alpha, the Intraclass Correlation Coefficient (ICC) and the Bland and Altman limits of agreement, and the convergent validity was established through the Spearman Correlation Coefficient. **Results:** Based on the DIEH, the prevalence of lags and delays was 38.8% and 11.2% respectively; internal consistency ranged from 0.23 to 0.76; reproducibility showed an ICC between 0.60 and 0.92; and the convergent validity was almost perfect ($p: 0.96$). **Conclusion:** The cultural adaptation of the DIEH showed acceptable psychometric properties, which could be complemented with additional studies to recommend its use in national surveys in Latin America.

Keywords:

Child development; screening; children; surveys and questionnaires; results reproducibility

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Introduction

Development process is characterized by its constant change dynamic, differentiated by stages of increasing and consecutive complexity^{1,2}, essential for the performance in adult life³. It includes several interdependent domains such as the language-cognitive, the sensory-motor, and the social-emotional, which are predictors of academic achievement, productive and social functioning throughout life⁴.

Interaction between an individual's genetic load, his or her biological condition, and the family and social environment interact in child development process², which is characterized by its rapid evolution, mainly in the first years of life¹, a fundamental stage where situations, such as socioeconomic disadvantage can have a significant impact on the child's development process⁵, particularly in low- and middle-income countries, where it is estimated that 43% of children are at risk due to extreme poverty⁶.

Developmental disorders are chronic and early-onset conditions that have a significant negative impact on children's developmental progress and are evident when they do not achieve the expected goals for their age^{7,8}. The prevalence in Latin America, according to surveys conducted locally in San Isidro, Argentina⁹, statewide in Querétaro, Mexico¹⁰, and nationally in Chile¹¹ range from 20% to 36%. Colombia does not have this information.

Developmental alterations can be classified into two categories, the first one is *delay*, understood as the motor development milestones attainment slower than that expected for age¹² and the second one is *disorders*, related to the acquisition of abnormal patterns during development¹³. Their early detection allows timely intervention to improve the children's prognosis^{1,12,14}.

Child development screening tests are focused on identify the risk of presenting some kind of delay, which allows prioritizing access to medical services, in order to promote early health care for children^{1,15} through transitory assessments, which must be validated with diagnostic tests to confirm or rule out findings from the initial examination⁸. However, there are several obstacles that hinder their implementation, such as lack of time during the primary health care consultation and insufficiently trained staff for the application of tests^{14,16}.

In Colombia, the evaluation and follow up of child development are carried out through the Abbreviated Scale of Development (EAD), which evaluates four specific areas¹⁷ and requires trained staff, as well as 20 minutes on average for its application, situation that probably has hindered its use in growth and development programs. Regarding its psychometric properties and based on the reviewed literature, only one study has assessed the convergent validity between the EAD

and the Neurosensory Motor Development Assessment, showing a moderate correlation ($r = 0.51$) between these two instruments¹⁸.

Several screening questionnaires, some aimed to parents and others to the primary care physicians or pediatricians, allow rapid, simple, and low-cost detection of possible alterations in expected development for age^{12,19}, being fundamental qualities for their use in national surveys, and also requiring minimal training for the interviewers. However, it is necessary that they have acceptable psychometric properties.

The Chilean National Quality of Life and Health Survey 2006 (ENCAVI)¹¹, used the DIEH completed by the primary caregiver, to assess the development of children aged between 2 months and 5 years and 11 months. This questionnaire was created in response to the need for an instrument to assess early childhood development at a very low cost, without the need for more specific diagnostic tests and with the objective of recording estimated data about the child's developmental status. It has an 88% sensitivity and a positive likelihood ratio of 1.96, compared with the Battelle-2 developmental inventory²⁰.

Authors of DIEH have proposed its use in other regions after cultural adaptation, which would allow us to know the global situation of child development through population surveys at national level²⁰. Therefore, the objective of this study was to evaluate the internal consistency, test-retest reliability, level of agreement, and convergent construct validity of a cultural adaptation of the DIEH for Colombia and, additionally, to describe the prevalence of developmental delay in children aged between 2 months and 5 years in Bucaramanga, Colombia.

Subjects and Method

A diagnostic tests evaluation was conducted with a cross-sectional sampling between July and December 2016.

Study population

The population consisted of children aged between 2 and 60 months and their parents, selected by convenience from three Child Development Centers, which are part of the Instituto Colombiano de Bienestar Familiar (ICBF) and other preschool institutions in the municipality of Bucaramanga.

The legal representatives of the three Child Development Centers, as well as the parents or guardians of each child, signed the informed consent to authorize the children's participation. The study was approved by the Ethics Committee of the Universidad Industrial de Santander.

Study variables

Sociodemographic information was collected about children and their social security system filiation, classified into two categories: contributory, which refers to affiliation through the payment of an economic contribution, financed directly by the affiliate²¹ and subsidized, which is the mechanism whereby the poorest population of the country, unable to pay, has access to health services through a subsidy provided by the government²². Additionally, they were asked if the children had immunization record card and growth and development record card, as well as the length of time they were enrolled and the frequency of assessments. Also, birth weight and term birth information were obtained through mother or caregiver report. In addition, mother's age at childbirth, the number of children born alive and the socioeconomic stratum between 1 and 6 were recorded, being 1 the lowest and 6 the highest.

Child development

EAD was selected as a reference test, despite not being recognized as a 'gold standard', since it is the instrument defined for Colombia, according to the Technical Standard for the Early Detection of Growth and Development Disorders in Children under 10 Years of Age (Resolution 412 of the Colombian Ministry of Health, 2000)^{23,24}.

The EAD assesses child development in children aged between 1 and 72 months in four specific areas: gross motor skills, fine motor-adaptive skills, hearing-language, and personal-social area; each of them has 30 items, which are rated [1] if the child completes the activity and [0] if not. The sum of the scores of each area and the total, classify the child according to age in four developmental categories: alert, medium, medium-high, and high, establishing 'alert' as the need of a more exhaustive evaluation, in order to diagnose or discard alterations or delays in development¹⁷.

The DIEH includes 4 to 9 items per age group and covers four developmental areas: social, language, cognitive, and motor skills, which classified into three categories: normal development, delayed development, and development retardation. The information is collected sequentially, placing the child in the module according to his or her age, but starting with the questions from the previous younger age group. Thus, when the parent or caregiver reports that the child does not complete the activities for the age group younger than his or her age group, it is classified as retardation, and when the child completes the activities for the previous younger age group, but does not perform all the activities for his or her age group, it is classified as delay. The performance of all the activities for his or her age group and for the previous younger age group

is classified in the normal category^{3,20}. All answers are coded in a dichotomous way (yes/no)³.

Procedure

Due to the DIEH is a Chilean questionnaire, a cultural adaptation was made with three adjustments to the original terms. In section 3 (children aged from 1 year to 23 months) item 6, in the example the term 'show me (mostrame) your favorite toy' was changed to 'show me (muéstrame) your favorite toy'; in section 5 (children aged from 3 years to 3 years 11 months) item 2, in the example 'let's go to the hammocks' was changed to 'let's play', and in section 6 (children aged from 4 years to 4 years 11 months) item 9, in the example 'he's going to get his jacket (campera)' was changed to 'he's going to get his jacket (chaqueta)'.

Subsequently, two physical therapists were trained and the protocol for applying the two instruments was standardized. A pilot test was conducted with three children per age group, gathering 24 children, in whom the EAD was applied. All assessments were recorded on video, with the consent of the respondent. Based on this audiovisual material, three days after the end of the data collection, the reproducibility between evaluators was established, obtaining Kappa coefficients ≥ 0.70 for the four areas evaluated.

The information collection started with a home visit for the application of the DIEH and a new visit was arranged seven days later for the second evaluation. In the intermediate period, each child was evaluated with the EAD during a school day in the Child Development Centers. During the assessment process, four children aged between 13 and 24 months refused to perform the EAD's activities, and, additionally, one girl aged 49-60 months performed only gross motor activities.

Analysis

Descriptive statistics were used to present the findings of the variables studied. The internal consistency was established with Cronbach's Alpha, the reliability through the Intraclass Correlation Coefficient ($ICC_{2,1}$), and its interpretation following the Landis and Koch recommendations²⁵. In addition, the degree of agreement was determined using the Bland-Altman method²⁶. Convergent validity of the DIEH, compared with the EAD was established using the Spearman's correlation coefficient (ρ) for total and age groups scores. It should be noted that it was not possible to compare the categories alert, medium, medium-high, and high obtained from the EAD with the categories of retardations, delay and normal derived from the DIEH. This difficulty was mainly due to the number of items assigned to each dimension by age group in the two questionnaires, which left cells without participants to ap-

ply Cohen's Kappa. The entire analysis was performed with STATA 14.1 software ($\alpha = 0.05$).

Results

General description

224 children participated and 46.9% of them were girls. There was a homogeneous distribution by age, except for the 49-60 month group which represent 28.1% of the participants. The 57.9% were from contributory regime at the social security system and all of them had an immunization record card. Regarding the Growth and Development Program, only 96.9% had a card, with a median age of 30 months in the program and 50% had two visits per year. Table 1 shows the sociodemographic characteristics of the caregiver and additional findings.

Prevalence from the DIEH

Figure 1 shows the results of the first DIEH application according to age group, where there is a higher prevalence of delays between 0 and 6 months (74.2%), followed by the group between 25 and 36 months (48.6%). In general, there was a 38.8% prevalence of delays and 11.2% of retardations.

Prevalence from the EAD

Figure 1 shows the findings of the four EAD categories by age group, where the highest prevalence of alerts was in the 13-24 months group (46.4%), followed by the 25-36 months group (26.7%). In total, the prevalence of alerts was 18.7% and of the medium level was 52.0%.

DIEH reliability

Table 2 shows the findings of internal consistency, reproducibility, and degree of agreement. There was internal consistency ranged from low (0.23) for the 36-47 months group, to a good (0.76) for the 12-23 months group. Reproducibility showed a moderate ICCs (0.60) for the 36-47 month group and an almost perfect (0.92) for the 2-6 month group. The Bland-Altman analysis showed near-zero difference averages with narrow limits for most age groups and the reproducibility was essential to detect delays and retardations.

Convergent construct validity of the DIEH vs. EAD

There was a near-perfect correlation ($\rho = 0.96$) between the total scores of both instruments (Figure 2), however, the age-conditioned scores had a large variability, with ICCs between 0.20 and 0.78. The lowest ICCs were recorded in the 25-36 months and the 37-48 months groups, and there were moderate correlations

in the groups of 7-12 months, 13-24 months and in the 49-60 month, and high ICCs in the 0-6 months group (Table 3).

Discussion

This is the first study in Latin America that makes a cultural adaptation and also evaluates the psychometric properties of the DIEH, creating an opportunity to show the potential of a questionnaire to estimate the child development in children aged between 1 and 5 years, through national surveys under screening contexts, at low cost and in a quick and simple way.

After applying the DIEH, we found an 11.2% prevalence of retardations and 38.8% of delays, where the

Table 1. Sociodemographic characteristics and clinical history of study participants

Sociodemographic characteristics of children	N = 224	
Female N° (%)	105	(46.9)
Age group N° (%)		
2 – 6	31	(13.8)
7 – 11	36	(16.1)
12 – 23	30	(13.4)
24 – 35	35	(15.6)
36 – 47	29	(13.0)
48 – 59	63	(28.1)
Socioeconomic stratum N° (%)		
1	70	(31.2)
2	71	(31.7)
3	56	(25.0)
4	21	(9.4)
5	6	(2.7)
Social security system filiation N° (%)		
Contributory	129	(57.9)
Subsidized	94	(42.1)
Immunization record card N° (%)	224	(100.0)
Growth and development record card N° (%)	217	(96.9)
Clinical history of children N° (%)		
Full term birth	193	(86.2)
Pregnancy complications	62	(27.7)
Caregiver characteristics		
Female N° (%)	213	(95.1)
Age (years) - Mean (SD)	32	(10.9)
Mother's age at childbirth - Mean (SD)	26.1	(6.2)
Years of schooling – Mean (SD)	11.0	(3.0)
Marital status N° (%)		
Single/divorced/widowed	62	(27.7)
Married/cohabitant	162	(72.3)
Number of children - Median (min. - max.)	2	(1 - 7)
Number of children born alive - Median (min. - max.)	2	(1 - 7)

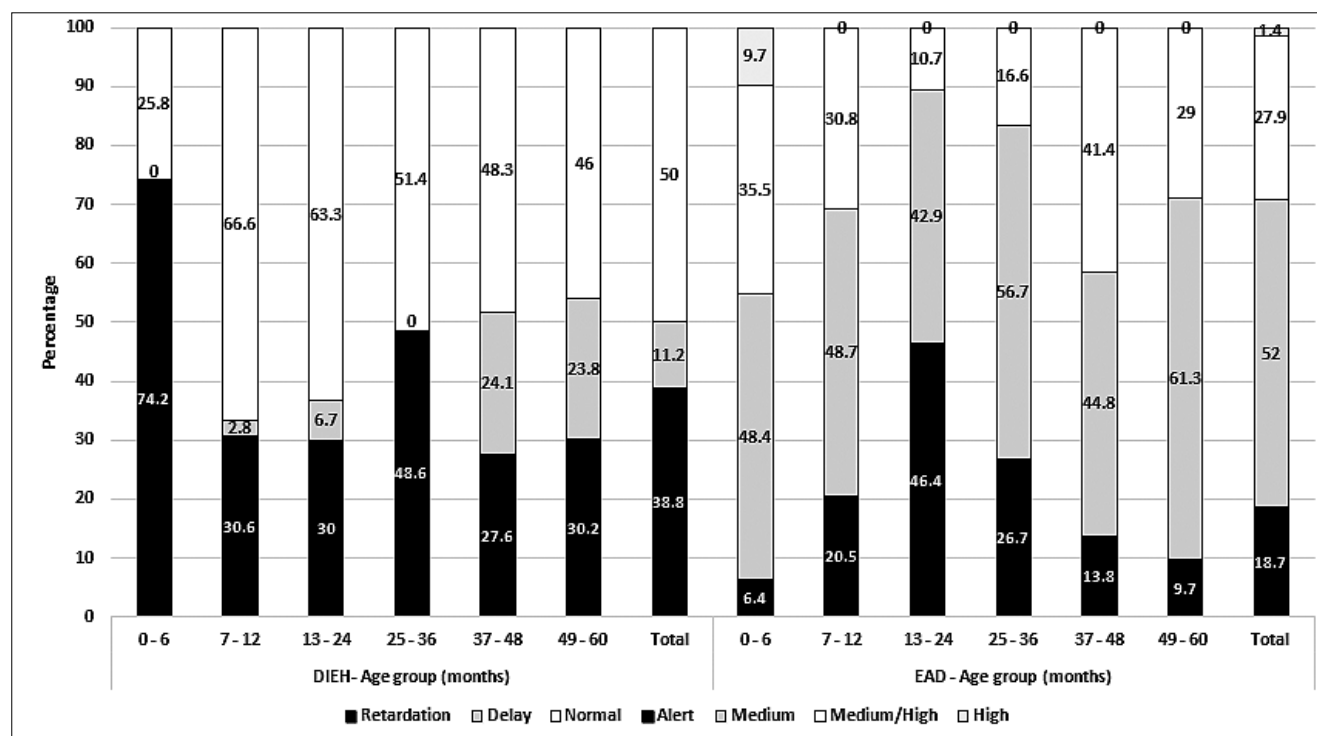


Figure 1. Results of the Screening Questionnaire of Child Development for Household Surveys (DIEH) in its first measurement and the Abbreviated Scale of Development (EAD).

last one was higher than that reported in the ENCAVI-II (11). These differences may be due to the studied population and the national representativeness of the ENCAVI, unlike our study. In contrast, there were similar prevalence to the Child Development Evaluation (CDE) questionnaire in Mexico²⁷, designed to be applied in screening contexts with similar items.

As for the differences in the retardations prevalence detected with the DIEH (11.2%) compared with

the EAD alerts (18.7%), firstly, they may be due to the conditions of application of both questionnaires, - that is, in screening and diagnosis setting, respectively. Secondly, the survey is answered by the parents or caregivers vs. a trained health professional, who performs the direct assessment. Finally, they may be due to the structure of each questionnaire since the EAD has an equal number of items for each development area and age group and the DIEH has a variable number of items.

Table 2. Results of the Screening Questionnaire of Child Development for Household Surveys (DIEH) reliability analysis

Age (months)	Children N°	Items N°	Cronbach α	Retardation		Delay	
				ICC CI95%	Mean dif ($L_1 - L_u$)	ICC CI95%	Mean dif ($L_1 - L_u$)
2 - 6	31	5	0.47	0.92 0.87; 0.95	0.0 (-0.59; 0.59)	---	---
7 - 11	39	5	0.60	0.80 0.70; 0.87	-0.08 (-0.87; 0.72)	1.0 1.0; 1.0	0 (0; 0)
12 - 23	28	8	0.76	0.91 0.86; 0.95	0.03 (-0.75; 0.81)	0.78 0.60; 0.89	-0.03 (-0.39; 0.33)
24 - 35	34	7	0.40	0.72 0.55; 0.82	-0.21 (-1.3; 0.90)	0.48 0.19; 0.70	-0.06 (-0.52; 0.41)
36 - 47	29	4	0.23	0.60 0.45; 0.72	-0.04 (-0.95; 0.87)	0.53 0.22; 0.75	0.14 (-0.56; 0.84)
48 - 59	63	9	0.60	0.69 0.54; 0.80	-0.11 (-1.43; 1.21)	0.67 0.51; 0.79	0.05 (-0.6; 0.7)
Total	224	38	---	0.75 0.69; 0.80	0.05 (-0.62; 0.71)	0.70 0.63; 0.76	-0.03 (-0.43; 0.48)

These differences can lead to different scores, rankings, and prevalence.

It is possible that the socioeconomic level explains in part the prevalence of delays and retardations, since 63% of the sample corresponded to the lowest levels (1 and 2), a factor that, in previous studies, has been positively associated with alterations in child development, mainly with language skills^{28,29}.

Regarding the ICC, few studies record data from screening questionnaires addressed to parents. One of the most studied is the Ages and Stages Questionnaire (ASQ) with Cronbach's α between 0.49 and 0.87 in different populations³⁰⁻³³. Likewise, the Child Development Inventory (CDI), designed for children between 15 and 72 months, contains 3 to 8 items per age group and takes 30 to 50 minutes to apply, showed a Cronbach's α between 0.8 and 0.9³⁴.

It is important to note that the ICC of the DIEH has not been evaluated before. However, our findings are similar to the ASQ and CDI, although they vary among age groups, with Cronbach's α ranging from 0.23 in the 36-47 months group to 0.76 in the 12-23 month group. This wide coefficients range may be due to several factors. Firstly, the number of items evaluated affected the Cronbach's α , which varies from 4 items with an α of 0.23 to 9 items with an α of 0.60; secondly, it is affected by the characteristics of the studied population; and thirdly, what is determined is the internal correlation of the items in each domain or subgroup evaluated³⁵. When comparing our reliability findings with other parent screening questionnaires, is limited. The ICC for the total score (0.75) was lower than the ASQ with an ICC between 0.75 and 0.94 (36.37). Armijo et al³³, reported a Pearson's correlation coefficient between 0.73 and 0.94 of the ASQ in children aged from 8 to 18 months, however, this coefficient evaluates association and not reliability, as does the degree of agreement, which in our work ranged from 62.1% to 76.9%, compared with the ASQ, which was between 92% and 94%³⁰⁻³⁷. It is necessary to emphasize that the degree of agreement does not evaluate reliability since it does not correct the one found by chance, such as that obtained with Cohen's Kappa coefficient. Also, the purpose of the DIEH application is to get population information on the children's developmental condition through screening, while the ASQ is applied specifically to parents and aims at their active participation in the growth and development process of their child.

Regarding the convergent construct validity between both questionnaires, it was almost perfect ($\rho = 0.96$), however, when stratifying by age group, there was a progressive decrease as the age increase, except for the 49-60 month group. It was not possible to compare these findings with other studies since there were no studies in the reviewed literature; however, it is

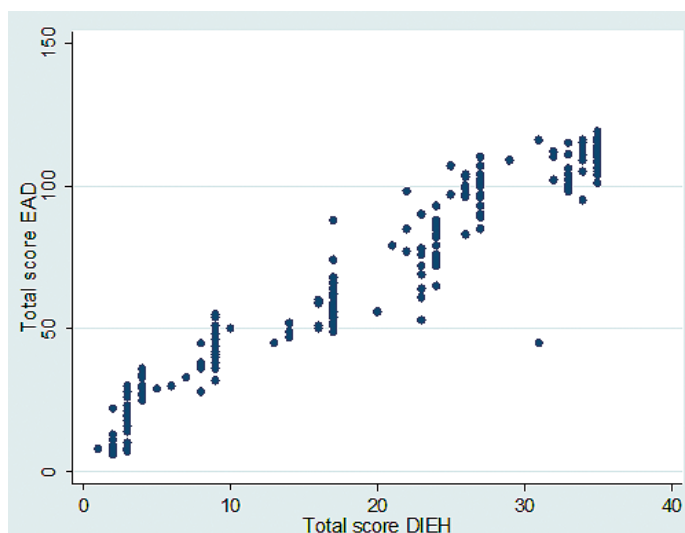


Figure 2. Correlation between general total scores of the Abbreviated Scale of Development (EAD) and the Screening Questionnaire of Child Development for Household Surveys (DIEH) ($\rho: 0.96$ $p < 0.001$).

Table 3. Spearman's correlation coefficients (ρ) between total and age conditioned score of Abbreviated Scale of Development (EAD) and score of the Screening Questionnaire of Child Development for Household Surveys (DIEH)

Age group (months)	Nº	Correlation coefficient (ρ)	p
0 – 6	31	0.8	< 0.001
7 – 12	39	0.69	< 0.001
13 – 24	28	0.31	0.110
25 – 36	30	0.24	0.196
37 – 48	29	0.10	0.587
49 – 60	62	0.36	0.004
Total	219	0.96	< 0.001

possible that the low correlation presented in some age groups is due to the differential distribution of items by developmental area according to age group, since the EAD has three questions per area and age group, while the DIEH has a variable number of items per age group and does not discriminate the assessment area.

The limitations of the study include the small sample size by age group, which diminishes the accuracy level of the estimations. In addition, the sample does not represent the population, given the link between the participants and the ICBF in the city, which would leave out a child population with different sociodemographic characteristics and possibly generate a lower prevalence of delays, retardations, and alerts.

However, it is important to note that, in general, the reliability of the DIEH shows promising findings for its application in national surveys, data that complement the findings of the convergent construct validity analyzed.

Conclusion

This study provides relevant information on the reliability and validity of the DIEH and suggests that the cultural adaptation of this questionnaire for Colombia and other Latin American and Caribbean countries could be a useful screening tool for child development disorders in national surveys; however, there is a need for further studies to recommend a wider use. Finally, it is worth to emphasize the need for having a formal system for monitoring child development, in order to promote decision-making in public policy, aimed at guaranteeing a diagnosis and timely attention that favors the inclusion and participation of this population in equitable conditions³⁸.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimental

tion developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

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