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The Impact of Environmental Factors in X-Ray Rooms on Pediatric Patients

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This study explores how environmental factors within X-ray rooms affect pediatric patients' anxiety, stress, and cooperation during radiologic procedures. A cross-sectional descriptive study was conducted among 80 radiology professionals from hospitals in Jeddah. Findings indicate that environmental elements such as noise, lighting, temperature, room aesthetics, parental presence, and music significantly influence pediatric patients' experiences and procedural outcomes. There was a statistically significant relationship between years of experience and the perception of parental presence improving comfort ($p = 0.030$). However, job role showed no such association ($p = 0.219$). There was also a significant link between job role and the preferred room temperature ($p < 0.001$), while experience level did not show a significant association in this regard ($p = 0.649$). Although awareness of these factors is high among practitioners, most lack formal training in pediatric care. The study advocates for child-friendly radiologic environments to improve patient cooperation, reduce procedural errors, and enhance diagnostic imaging accuracy.

Keywords: Pediatric radiography, environmental factors, patient anxiety, child-friendly design, X-ray rooms

INTRODUCTION

X-rays are a form of electromagnetic radiation used to produce images Baek et al. (2017). of internal body structures by targeting a plate with a focused electron beam. They are essential in modern medicine for diagnosing a range of conditions affecting bones, organs, and tissues without invasive procedures. Biddiss et al. (2007). In addition to diagnostic use, X-rays are also employed in cancer treatment and forensic investigations. Their high-resolution imaging capabilities significantly contribute to early disease detection, especially in oncology, where they help identify conditions such as breast cancer. Fluoroscopy, a real-time imaging technique, further demonstrates the versatility of X-ray technology Baek et al. (2017). Despite their utility, careful usage is critical to minimize radiation exposure, particularly in vulnerable populations like children Birnie, K. A. et al. (2018).

Pediatric radiography focuses on imaging infants, children, and adolescents, who often experience heightened stress in clinical environments. This stress is most pronounced in X-ray rooms due to unfamiliar surroundings, intimidating equipment, and excessive sensory stimuli. Elements such as loud machine noises, bright lights, strong disinfectant smells, and alien-looking devices can be overwhelming. When healthcare professionals use complex language, it can further exacerbate a child's anxiety.

Such anxiety not only affects the child's psychological state but also compromises image quality due to movement during the procedure. This may necessitate repeat exposures, increasing the child's radiation dose and prolonging the distress. Addressing these environmental factors is crucial for improving diagnostic outcomes and patient well-being.

Interventions such as age-appropriate communication, noise reduction, and child-friendly decor can make the environment less intimidating. Distraction techniques—including virtual reality, music therapy, and parental presence—also help mitigate stress Hagan et al. (2017), Hardy et al. (2008)., Johns Hopkins Medicine. (n.d.). X-rays. In cases of extreme anxiety, the use of sedation or anesthesia may be necessary. These strategies can significantly improve patient cooperation and image clarity, thereby enhancing diagnostic accuracy Biddiss et al. (2007).

Children are especially vulnerable to environmental stressors due to their developmental stage and limited coping mechanisms.

Variable	n (%)
Current Job.	
Radiologist	3 (3.8)
Radiology Technologist / Technician	40 (50.6)
Trainee / Student	36 (45.6)
Years of Experience.	
Less than 1 year	43 (54.4)
1 - 5 years	25 (31.6)
6 - 10 years	1 (1.3)
More than 10 years	10 (12.7)

Table 1: Demographic descriptive analysis.

Research in pediatric psychology and healthcare design consistently highlights the profound influence of physical surroundings on children's emotional and physiological responses during medical procedures. Studies have shown that environmental stressors—such as unfamiliar equipment, lack of comforting stimuli, and inadequate sensory control—can elevate cortisol levels, increase resistance during procedures, and reduce trust in healthcare professionals Caruana et al. (2023). Thus, pediatric imaging environments require a thoughtful approach that balances technical functionality with child-centric design to optimize patient care outcomes.

MATERIALS AND METHODS

Study Design

A cross-sectional descriptive study was conducted between February and May 2024. A structured, electronically distributed questionnaire was used to collect data from radiology professionals, including radiologists, technologists, and trainees, working in Jeddah hospitals. The questionnaire collected demographic data and information regarding environmental factors affecting pediatric patients.

Sample and Data Collection

The study sample comprised 80 participants, recruited through social media platforms. Inclusion was limited to professionals currently working in radiology departments.

Statistical Analysis

Data were cleaned using Microsoft Excel and analyzed using SPSS. Descriptive statistics (frequency and percentage) were used for categorical variables. Chi-square tests were employed to assess associations between job title, experience level, and perceptions of environmental impacts.

RESULTS

Participant Demographics

Table 1 shows that the majority of the 79 participants were radiologic technologists or technicians (50.6%), followed by trainees or students (45.6%), and radiologists (3.8%). In terms of professional experience, over half (54.4%) had less than one year of experience. About 31.6% had between 1 and 5 years, 12.7% had more than 10 years, and only 1.3% reported having 6 to 10 years of experience.

Table 2: Descriptive analysis of main categorical variables.

Variable	n (%)
Number of pediatric Patients per week.	
1 - 5	47 (59.5)
5 - 10	16 (20.3)
10 - 15	5 (6.3)
More than 15	11 (13.9)
Difficult pediatric patients' group to deal with.	
Infancy (29 days to 12 months of age)	14 (17.7)
Toddler (13 months to 2 years of age)	43 (54.4)
Early childhood (2 years to 5 years of age)	20 (25.3)
Middle childhood (2 years to 5 years of age)	2 (2.5)
Encountering difficulties calming anxious or scared children during X-ray.	
Yes	64 (81)
No	15 (19)
Presence of parents help improve the child comfort.	
Yes	76 (96.2)
No	3 (3.8)
What measures do you believe can help maintain a comfortable temperature in the x-ray room for pediatric patients?	
Adequate isolation	7 (8.9)
Adjustable temperature	38 (48.1)
Use of warming blankets or pads	33 (41.8)
Other	1 (1.3)
For pediatric, what is the best temperature in X-ray room?	
15 - 20 C	3 (3.8)
20 - 22 C	47 (59.5)
25 - 30 C	29 (36.7)
Does the shielding increase pediatric patient anxiety?	
Yes	65 (82.3)

No	14 (17.7)
Does the long exam time can affect patient outcomes?	
Yes	69 (87.3)
No	10 (12.7)
How do you think high noise levels in the x-ray room can affect pediatric patients? (Choose all can apply)	
Increased anxiety	49 (62.03)
fear and stress	53 (67.09)
Difficulty staying still during the procedure	44 (55.70)
Impaired communication between the staff and the patients	18 (22.78)
Does the smell of x-ray room can destruct the pediatric patient?	
Yes	44 (55.7)
No	35 (44.3)
Does the bright walls design with painting and images can make friendly environment for the pediatric patients?	
Yes	68 (86.1)
No	11 (13.9)
Is the examination table comfortable for children to lie on?	
Yes	27 (34.2)
No	52 (65.8)
Have you received any training or guidelines regarding the care of pediatric patients in the X-ray room?	
Yes	2 (2.53)
No	77 (97.37)
In your experience, how do pediatric patients typically react to the environmental factors in the X-ray room?	
Anxious and stressed	40 (50.6)
Fearful and apprehensive	35 (44.3)
Unresponsive	4 (5.1)
Do you believe there is a correlation between a child-friendly environment in the X-ray room and improved patient outcomes?	
Yes	75 (94.9)
No	4 (5.1)
Does the presence of music systems in X-ray room can improve pediatric patient cooperation and avoid repetition of the exam?	
Yes	60 (75)
No	19 (25)
Which environmental factors do you believe can have an impact on pediatric patients in the X-ray room? (Choose all can apply)	
Noise level	45 (56.96)
Lightning conditions	39 (49.37)
Room temperature	36 (45.57)
Color scheme and decor	53 (67.09)
Availability of toys/distractions	47 59.49)
Staff behavior and communication	53 (67.09)

Pediatric Patient Load and Challenges

According to Table 2, 59.5% of respondents reported seeing 1 to 5 pediatric patients per week. Smaller proportions encountered 5 to 10 (20.3%), more than 15 (13.9%), or 10 to 15 (6.3%) patients. The most difficult group to manage during imaging was toddlers (13 months to 2 years), as reported by 54.4% of respondents, followed by children in early childhood (25.3%), infancy (17.7%), and middle childhood (2.5%).

Additionally, 81% of participants reported difficulties calming anxious or frightened children during X-ray procedures. Most respondents (96.2%) agreed that the presence of a parent improved the child's comfort during the exam.

Environmental Conditions in the X-ray Room

Table 2 also explores thermal preferences. The most common method to maintain room comfort was using adjustable temperature controls (48.1%), followed by warming blankets or pads (41.8%). The preferred room temperature for pediatric patients was 20–22°C, as selected by 59.5% of respondents. Others preferred 25–30°C (36.7%) and 15–20°C (3.8%).

Regarding shielding, 82.3% believed it increased pediatric patient anxiety. Furthermore, 87.3% of participants indicated that long exam durations negatively affected patient outcomes.

Sensory Factors and Design Features

As shown in Table 2, respondents believed high noise levels could lead to increased anxiety (62.03%), fear and stress (67.09%), difficulty in staying still (55.7%), and hindered communication (22.78%). Over half (55.7%) noted that the smell of the X-ray room could distract pediatric patients.

Design elements also played a role, with 86.1% stating that bright wall designs and images made the environment more child-friendly. However, the examination table was seen as uncomfortable by 65.8% of participants.

Training and Pediatric Sensitivity

Table 2 further indicates that 97.37% of participants had not received formal training or guidelines for pediatric care in the X-ray room. When asked how children typically react to the environment, 50.6% reported signs of anxiety and stress, while 44.3% observed fear and apprehension. Only 5.1% noted a lack of response.

Most respondents (94.9%) believed that a child-

friendly environment positively impacts outcomes. Furthermore, 75% stated that music systems in the X-ray room improved cooperation and reduced exam repetition.

Influential Environmental Factors

The environmental factors believed to influence pediatric patient experience (as listed in Table 2) included color scheme and decor (67.09%), staff behavior and communication (67.09%), availability of toys or distractions (59.49%), noise level (56.96%), lighting conditions (49.37%), and room temperature (45.57%) (Table 2)

Statistical Association

As detailed in Table 3, there was a statistically significant relationship between years of experience and the perception of parental presence improving comfort ($p = 0.030$). However, job role showed no such association ($p = 0.219$). There was also a significant link between job role and the preferred room temperature ($p < 0.001$), while experience level did not show a significant association in this regard ($p = 0.649$).

No significant associations were found between job or experience and factors such as shielding, exam duration, smell, room decor, table comfort, or use of music. These findings suggest consistency in perspectives across different experience levels and roles.

Table 3: Association between Current job and experience with main

factor	Current Job			Years of experience				P-value (Job)	P-value (Experience)
	Radiologist	Technician	Student	<1	1-5	6-10	>10		
	n (%)								
Presence of parents									
Yes	0 (0)	3 (3.8)	0 (0)	0 (0)	1 (1.27)	0 (0)	2 (2.53)	0.219	0.030*
No	3 (3.8)	37 (46.84)	36 (45.57)	43 (54.43)	24 (30.38)	1 (1.27)	8 (10.13)		
Best temperature									
15-20 C	2 (2.53)	1(1.27	0(0)	2(2.53)	0(0)	0(0)	1(1.27)	<0.001*	0.649
20-22 C	1(1.27)	26(32.91)	20(25.32)	27(34.18)	15(28.99)	1(1.27)	4(5.06)		
25-30 C	0(0)	13(16.46)	16(20.25)	14(17.72)	10(12.66)	0(0)	5(6.33)		
Shielding									
Yes	3(3.38)	34(43.04)	27(34.18)	33(41.77)	21(26.58)	1(1.27)	9(11.39)	0.227	0.787
No	0(0)	5(6.33)	9(11.39)	9(11.39)	4(5.06)	0(0)	1(1.27)		
Long exam time									
Yes	3(3.8)	33(41.77)	33(44.77)	36(45.57)	23(29.11)	1(1.27)	9(11.39)		
No	1.(1.27)	18(22.78)	16(20.25)	22(27.85)	8(10.13)	1(1.27)	4(5.06)		
Bright wall design									
Yes	3(3.8)	34(43.04)	31(39.24)	38(48.1)	22(27.85)	1(1.27)	7(8.86)	0.770	0.460
No	0(0)	6(7.59)	5(6.33)	5(6.33)	3(3.8)	0(0)	3(3.8)		
Comforting of examination table									
Yes	1(1.27)	15(18.99)	11(13.92)	15(18.99)	8(10.13)	0(0)	4(5.06)	0.816	0.866
No	2(2.53)	25(31.65)	25(31.65)	28(35.44)	17(21.52)	1(1.27)	6(7.59)		
Music system									
Yes	3(3.8)	28(35.44)	28(35.44)	34(43.04)	19(24.05)	0(0)	6(7.59)	0.365	0.166
no	0(0)	12(15.19)	7(8.86)	8(10.13)	6(7.59)	1(1.27)	4(5.06)		

Table 3 presents Pearson Chi-square test results showing the relationships between job role, years of experience, and environmental considerations. Significant findings include associations with parental presence and preferred temperature.

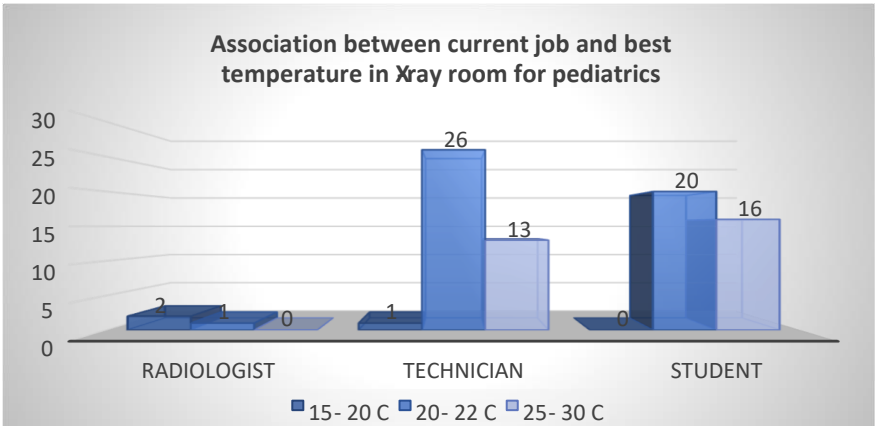

Figure1: Association between years of experience and presence of parents

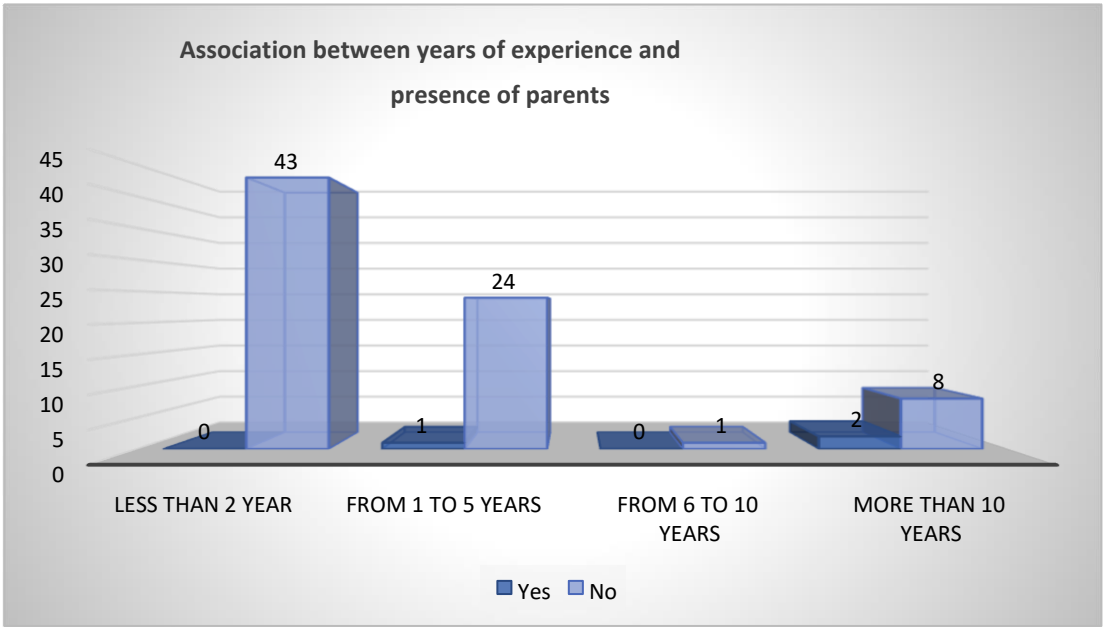

Figure 2: Association between current job and best temperature in X-ray room for pediatrics

DISCUSSION

The environmental factors of the X-ray room believed to have an impact on pediatric patients, as chosen by respondents, included noise level (56.96%), lightning conditions (49.37%), room temperature (45.57%), color scheme and decor (67.09%), availability of toys and distractions (59.49%), and staff behavior and communication (67.09%). There are no studies that state a significant variation in the impact of these factors, but the majority of respondents agreed that staff communication and behavior have the most significant impact. The majority of X-ray rooms examined pediatric patients in the load of 1-5 (59.5%). A smaller percentage of Xray rooms had patient loads of 5-10 (20.3%), 10-15 (6.3%), and more than 15 (13.9%). The highest percentage of difficult pediatric patients belonged to the toddler age group (54.4%), other groups included infancy (17.7%), early childhood (25.3%), and middle childhood (2.5%). Participants believe the most difficult age to deal with is toddlers ranging from 13 months to 2 years of age Coyne et al. (2006). A significant percentage of respondents (81%) reported encountering difficulties calming anxious or scared children during X-ray procedures a a minority of participants (19%) reported not

facing difficulties in this regard. Majority of studies stated that the impact of environmental factors makes calming anxious children difficult Birnie, K. A. et al. (2018).,Curtis et al. (2021). Hagan et al. (2017)., Hall et al. (2017).

The majority of respondents (96.2%) believed that the presence of parents helped improve the comfort of pediatric patients during X-ray procedures. Only a small percentage (3.8%) did not believe that parental presence had a positive impact. A previous study identified that the presence of parents minimizes fear and anxiety and improves cooperation Birnie, K. A et al. (2018). The most prevalent measure chosen by participants was the availability of an adjustable temperature (48.1%). Other measures included the use of warming blankets or pads (41.8%), adequate isolation (8.9%), and other unspecified measures (1.3%). Other studies recommend the use of blankets or warmers to adequately insulate a child from room temperature (about 18–22°C which is the best room temperature), especially newborns who are more susceptible to hypothermia Biddiss et al. (2007). The majority of participants (59.5%) believed that a temperature range of 2022°C was ideal for pediatric patients in X-ray rooms. Which align with other studies. The majority of respondents (82.3%) believed that shielding increased anxiety in pediatric patients, while a minority (17.7%) did not share this view. There are no previous studies that confirm the relationship between physical shielding and child anxiety, but we suggest studying it among practitioners. The majority of respondents (87.3%) believed that long exam time could negatively affect patient outcomes. A smaller percentage (12.7%) had an opposite opinion. The majority of previous studies confirmed that the length of the exam results in child anxiety, which can affect patient outcomes.Biddiss et al. (2007)., Birnie, K. A. et al. (2018)., Hagan et al. (2017).

The majority of respondents identified increased anxiety (62.03%), fear and stress (67.09%), difficulty staying still during the procedure (55.70%) as potential effects of high noise levels in the X-ray room. A smaller percentage believed that high noise levels impaired communication between staff and patients (22.78%). Other studies stated that the environment should be welcoming and noise-free so that patients can relax [3]. Which means that patient relaxation can reduce these potential effects. More than half of the participants (55.7%) believed that the smell of the X-ray room could be distracting and disruptive to pediatric patients. While a slightly less amount (44.3%) did not believe the smell had a negative impact. Ambient smell influences children's emotional responses, affecting service experience evaluation. Diffusing pleasant, mild smells humanizes hospitals by stimulating emotions and improving adolescent patients' experiences Hardy et al. (2008). According to majority of participants, our strongly supports with this study. A large number of participants (86.1%) believed that a bright wall design with paintings and images could create a friendly environment for pediatric patients. A smaller percentage (13.9%) did not think it made a difference. Another study, which corresponds with the majority of our responses, stated that the room should have brightly colored walls with artwork and pictures, as well as toys, play figures, and cartoons arranged throughout [6]. The majority of respondents (65.8%) believed that the examination table was not comfortable for children to lie on. A slightly less amount of participants (34.2%) believed that the table was comfortable. There are no previous studies that confirm the relationship between the surface of the examination table and child comfort, but we suggest studying it among practitioners. The majority of respondents reported that pediatric patients typically reacted with anxiety and stress (50.6%) or fear and apprehension (44.3%) to the environmental factors in the X-ray room. A smaller percentage of patients were unresponsive to the environmental factors (5.1%). The previous studies identified that the impact of environmental factors can result in anxiety, stress, fear, and apprehension Birnie, K. A., et al. (2018)., Curtis et al. (2021)., Hagan et al. (2017)., Hall et al. (2017).

The majority of respondents (94.9%) believed that there was a correlation between a child-friendly environment in the X-ray room and improved patient outcomes. A minority (5.1%) did not believe in such a correlation. Other study agreed that the radiological room environment must be improved to support psychological stability and to find a good way to reduce radiation doses in order to reduce the rejection of X-rays and increase the satisfaction of medical treatment Hagan et al. (2017).

The majority of respondents (75%) believed that the presence of music systems in the X-ray room could improve pediatric patient cooperation and help avoid repetition of exams. A smaller percentage (25%) did not believe music had a positive impact. This study stated that people can overcome their tensions and worries with positive distractions. In another study, children who watched cartoons or listened to music reported feeling less discomfort and anxiety, which improved child cooperation [6]. The majority of respondents (97.37%) reported that they haven’t received any training or guidelines regarding the care of pediatric patients in the X-ray room while the rest had received training. We suggest providing special training in hospitals for technologists working in the pediatric ward.

These findings align with global research emphasizing the value of holistic care in pediatric radiology. For example, Kain et al. (2007) demonstrated that preoperative preparation, including exposure to calming visuals and sensory aids, significantly reduced anxiety in pediatric surgical patients. Similarly, Lambert et al. (2022) found that multisensory environments—integrating soundscapes, soft lighting, and interactive displays—contributed to greater compliance and lower sedation rates during imaging procedures.

The role of parental presence is also critical. Studies by Power and Franck (2008) indicate that parents not only provide emotional comfort but also help mediate communication between child and staff, reducing misunderstandings and improving procedural flow. This synergy is especially important in high-stress environments like radiology departments.

Additionally, advancements in distraction techniques—including digital storybooks, augmented reality (AR), and tailored audio programs—are becoming increasingly effective. These methods, supported by neurodevelopmental theories, target attention redirection and emotional regulation, yielding higher success rates in unmedicated procedures Johns Hopkins Medicine. (n.d.). X-rays.

Despite this, your study reinforces a global issue: the lack of formal pediatric training among radiologic staff. This gap limits the practical implementation of best practices, especially in resource-limited settings. Structured programs and guidelines from organizations such as the Society for Pediatric Radiology and the WHO's Health Promoting Hospitals initiative could support more consistent, evidence-based interventions.

Limitations

- The majority of respondents had less than one year of experience, potentially limiting the study's depth.
- A sample size of 80, drawn from a single city, limits the generalizability of findings.

CONCLUSIONS

Environmental factors in X-ray rooms significantly influence pediatric patients' stress levels, cooperation, and diagnostic outcomes. Most practitioners are aware of these factors, but the lack of formal training and standardized protocols may hinder optimal patient care. Enhancing practitioner communication skills and modifying environmental conditions can lead to better imaging results and improved patient experiences.

Recommendations

- Provide pediatric-focused training for radiology staff.
- Redesign X-ray rooms to include calming visuals, ambient sounds, and temperature controls.
- Further investigate the impact of shielding and table design on patient anxiety.
- Standardize caregiver presence during pediatric procedures.
- Establish standardized protocols for pediatric patient preparation and engagement before imaging procedures.
- Incorporate digital technologies like interactive screens or AR games to help distract and educate pediatric patients.
- Develop pediatric radiology units with input from child psychologists, designers, and pediatricians to ensure environments meet developmental needs.
- Promote interdisciplinary research and knowledge-sharing through conferences and workshops focusing on pediatric imaging and environmental psychology.

Supplementary materials

The supplementary material / supporting for this article can be found online and downloaded at: https://www.isisn.org/article/

Author contributions

All author contributed in all parts of the paper. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declared that present study was performed in absence of any conflict of interest.
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Conflict of interest

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