

# Physiological responses of preterm newborn infants submitted to classical music therapy

*Respostas fisiológicas de recém-nascidos pré-termo submetidos à musicoterapia clássica*

*Respuestas fisiológicas de recién nacidos pretérmino sometidos a musicoterapia clásica*

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## ABSTRACT

**Objective:** To evaluate the physiological effects of music therapy on hospitalized preterm newborns.

**Methods:** A noncontrolled clinical trial including 12 newborn infants with gestational age  $\leq 36$  weeks, spontaneously breathing. The preterm infants were submitted to 15-minute sessions of classical music therapy twice a day (morning and afternoon) for three consecutive days. The variables: heart and respiratory rates, oxygen saturation, diastolic and systolic arterial pressures, and body temperature were analyzed before and immediately after each music therapy session.

**Results:** There was a decrease in the heart rate after the second session of music therapy (paired t-test;  $p=0.002$ ), and an increase at the end of the third session (paired t-test;  $p=0.005$ ). Respiratory rate decreased during the fourth and fifth sessions (paired t-test;  $p=0.01$  and  $0.03$ , respectively). Regarding oxygen saturation, there was an increase after the fifth session ( $p=0.008$ ). Comparison of physiological parameters among sessions, for the six studied sessions, showed only that the gain in oxygen saturation during the fifth session was significantly higher than during the sixth one (Tukey's test after variance analysis;  $p=0.04$ ).

**Conclusions:** Music therapy may modify short-term physiological responses of hospitalized preterm newborn infants.

**Key-words:** music therapy; physiological processes; newborn.

## RESUMO

**Objetivo:** Avaliar o efeito da musicoterapia nas respostas fisiológicas de recém-nascidos pré-termo hospitalizados.

**Métodos:** Ensaio clínico não controlado realizado com 12 recém-nascidos pré-termo, com idade gestacional  $\leq 36$  semanas, em respiração espontânea. Os pacientes foram submetidos a sessões de musicoterapia durante 15 minutos duas vezes ao dia, nos períodos matutino e vespertino, por três dias consecutivos. As variáveis: frequências cardíaca e respiratória, saturação de oxigênio, pressões arteriais sistólica e diastólica e temperatura corporal foram analisadas antes e imediatamente após a sessão de musicoterapia.

**Resultados:** Observou-se a diminuição da frequência cardíaca imediatamente após a segunda sessão de musicoterapia ( $t$  pareado;  $p=0,002$ ) e o aumento ao final da terceira sessão, em relação ao início ( $t$  pareado;  $p=0,005$ ). A frequência respiratória diminuiu após a musicoterapia na quarta e quinta sessões ( $t$  pareado;  $p=0,01$  e  $0,03$ , respectivamente). Em relação à saturação de oxigênio, houve aumento após a quinta sessão de musicoterapia ( $p=0,008$ ). A análise de variância realizada entre as seis sessões, após o cálculo da média das diferenças entre os parâmetros iniciais e finais, demonstrou que o ganho médio de saturação de oxigênio na quinta sessão foi maior do que na sexta (teste de Tukey após análise de variância;  $p=0,04$ ).

**Conclusões:** A musicoterapia pode modificar em curto prazo as respostas fisiológicas de recém-nascidos pré-termo hospitalizados.

**Palavras-chave:** musicoterapia; processos fisiológicos, recém-nascido.

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## RESUMEN

**Objetivo:** Evaluar el efecto de la musicoterapia en las respuestas fisiológicas de recién nacidos pretérmino hospitalizados.

**Métodos:** Ensayo clínico no controlado realizado con 12 recién nacidos pretérmino internados en la Unidad de Terapia Intensiva Neonatal y en la Unidad Intermediaria, con edad gestacional  $\leq 36$  semanas en respiración espontánea. Los recién nacidos pretérmino fueron sometidos a sesiones de musicoterapia durante 15 minutos dos veces al día, en los periodos matutino y vespertino, durante tres días consecutivos. Las variables: frecuencia cardíaca y respiratoria, saturación de oxígeno, presiones arteriales sistólica y diastólica y temperatura corporal fueron analizadas antes e inmediatamente después de la sesión de musicoterapia.

**Resultados:** Fueron observados la reducción de la frecuencia cardíaca inmediatamente después de la segunda sesión de musicoterapia ( $t$  pareado;  $p=0,002$ ) y el aumento al final de la tercera sesión, respecto al inicio ( $t$  pareado;  $p=0,005$ ). La frecuencia respiratoria se redujo después de la musicoterapia en la cuarta y quinta sesiones ( $t$  pareado;  $p=0,01$  y  $0,03$ , respectivamente). Respecto a la saturación de oxígeno, hubo aumento después de la quinta sesión de musicoterapia ( $p=0,008$ ). El análisis de variancia realizado entre las seis sesiones después del cálculo del promedio de las diferencias entre los parámetros iniciales y finales demostró que la ganancia mediana de saturación de oxígeno en la quinta sesión fue más grande que en la sexta (prueba de Tukey después de análisis de variancia;  $p=0,04$ ).

**Conclusiones:** La musicoterapia puede modificar en corto plazo las respuestas fisiológicas de recién nacidos pretérmino hospitalizados.

**Palabras clave:** musicoterapia; procesos fisiológicos; recién nacidos.

## Introduction

Neonatology has undergone profound changes in recent decades, both from a technological standpoint and of diffusion of scientific evidence, a fact that has provided significant improvements in care for premature newborns (PTNB) and their families<sup>(1)</sup>. The survival of PTNBs has increased, enabling neonates with extreme gestational ages and/or of very low birth weight to survive. Despite technological advances and development in Brazil, prematurity rates, unfortunately, remain high, around 7%<sup>(2)</sup>.

The newborn has psychological and anatomical features that emphasize its own systemic frailty, as the immaturity of the respiratory and central nervous system. The fragility conditions, such as extreme prematurity, low birth weight, and perinatal conditions, can lead the newborn to require long periods of hospitalization, promoting early separation between mother and child. This may be associated, in the long-term, to disturbances of affectivity, limited abstract thinking, and cognitive difficulties<sup>(3)</sup>.

The use of music as a complementary tool for health promotion has been recently reported in the medical literature. Defined as the therapeutic use of music or musical activities in the treatment of mental and somatic diseases, music therapy has accumulated scientific evidence of its effectiveness in pain management, anxiety and emotional stress, among other conditions<sup>(4-7)</sup>.

The PTNBs in Neonatal Intensive Care Units (NICU) are often exposed to continuous noise, which can interfere with development, since excessive auditory stimulation creates negative physiological responses, such as apneas and fluctuations in heart rate, blood pressure and oxygen saturation ( $O_2$ Sat), besides making patients more vulnerable to hearing loss, abnormal sensory development, and speech and language problems<sup>(8)</sup>. The reduction of noise levels in the NICU can improve physiological stability of sick newborns and, thus, increase the potential of infant brain development.

The available literature suggests that the presence of harmonic and rhythmic sound can relieve the pain of emotional and physical causes<sup>(9)</sup> and act on hemodynamic parameters such as heart rate (HR), systemic blood pressure (BP), and body temperature (BT), in addition to relaxing the patient, with adjustment of respiratory rhythm, muscular relaxation, and sleep improvement<sup>(10)</sup>.

The present study aimed at evaluating the effect of classical music therapy on physiological responses regarding the variables: respiratory rate (RR), HR,  $O_2$ Sat, systolic blood pressure (SBP), and diastolic blood pressure (DBP), and BT, taken before and immediately after the session of music therapy applied on PTNB with gestational age (GA)  $\leq 36$  weeks.

## Method

The project was approved by the Research Ethics Committee on Humans of Universidade Católica Dom Bosco (UCDB), and the signature of the consent form (CF) was required from the legal guardians of the newborns. This is

an uncontrolled study type, whose inclusion criteria were: preterm infants spontaneously breathing, hemodynamically stable, with non-invasive monitoring of HR, RR, O<sub>2</sub>Sat, and BP during complete data collection, with GA ≤36 weeks, assessed by the Ballard method, appropriate weight for age or not, regardless of chronological age and sex, born and admitted to the University Hospital (UH) and admitted to the NICU and in the Intermediate Unit of Doutor Helio Mandetta Medical School, within Universidade Federal de Mato Grosso do Sul (UFMS). The exclusion criteria were: Preterm infants with congenital malformations, mechanical ventilation, hemodynamic instability and/or clinical deterioration that would prevent data collection. The research also excluded the following newborns: those who were discharged before the end of collection and presented hemodynamic decompensation with sudden drops in saturation, hypotension, and bradycardia.

The hearing system function was assessed according to the form, consistency, and implantation of pinnae, presence of external auditory canals, retroauricular fistulae and preauricular tags, as well as through the cochlear-palpebral reflex. Generally, low ear implantation is accompanied by posterior rotation of the axis of the external ear (pinna) and is associated with renal defects, malformation of the first branchial arch and chromosomal abnormalities<sup>(11)</sup>.

The values of HR, RR, O<sub>2</sub>Sat, BP and BT were selected as parameters. Once included, the PTNBs were observed in supine position during the collection. Patients underwent two sessions of music therapy daily, one in the morning and another in the afternoon, totaling six sessions, at the end of 3 consecutive days. Each session lasted 15 minutes, and it should be conducted after breastfeeding. During the session, a single song was used, being heard by 15 uninterrupted minutes. This time interval was chosen based on the literature and hospital routine, since there is no evidence of the superiority or inferiority of any interval for music therapy.

The selection of songs was based on studies that showed the "Mozart effect", term used to refer to the powers of transformation of music in health, education, and well-being, representing, in general, the use of music to reduce stress, pain, depression, and anxiety; induce relaxation and sleep; restore the body; and improve memory and alertness<sup>(12)</sup>. The choice of music was based on previous studies, which have shown that relaxing music (soft classical) is composed of low amplitudes, simple rhythm, and frequency (time) of approximately 60 to 70 beats per minute<sup>(7)</sup>.

In order to avoid the risk of hearing damage to the PTNB, a measure of the ambient noise level was held through a decibel

meter, according to the guidelines suggested by the American Academy of Pediatrics<sup>(13)</sup>. The noise of the room was added to that of music, so that it would not exceed 55 decibels and, inside the incubator, next to the ear of the PTNB, at 45 decibels, according to the recommendations suggested by the available literature. The stereo was positioned outside the incubator, opposite the closest access port to the head of the baby. During the session, the access doors remained open so that the speakers could be correctly positioned outside.

The researchers followed the preterm infants during 3 consecutive days, not more than that, because of the possibility of hospital discharge and possible sample loss, once the study was conducted with stable newborns in stable environment. Body temperature was measured by a Premium thermometer mercury column, positioned in the axillary fold of the upper right limb (URL) in horizontal position, parallel to the sagittal axis, for 4 minutes. This measure was performed by only one of the researchers, selected in a draw. Heart rate and O<sub>2</sub>Sat were verified with DIXTAL DX2515 pulse oximeter; positioned in the right lower limb (RLL), according to standards, for 3 minutes, except in infants who received intravenous medication in the RLL, due to risk of interruption of drug flow. In such cases, we used the left lower limb (LLL).

Blood pressure was assessed with a DIXTAL noninvasive monitor connected to a cuff selected according to the weight of the newborn, which was placed in the upper right limb (URL) or, in case it was not possible, in the upper left limb (ULL). To measure BP, the newborn should be at rest, calm, with no signs of discomfort, according to published guidelines<sup>(15-16)</sup>.

The same researcher performed the administration of music therapy to ensure the reliability of the collected data. During the music therapy session, no professional was supposed to manipulate the NBPTs. In case of medical complications, the newborn would be assisted and excluded from the study. At the time of collection, the staff members and mothers who were in the unit sought to remain silent.

The variables analyzed in this study at onset and end of music therapy had their values calculated as mean and standard deviation. To assess the immediate effect of music therapy on the vital parameters analyzed, a comparison was made between the mean values at the onset and end of each session using the *t* paired test. To analyze the cumulative effect over the course of six sessions of music therapy, the researchers calculated the difference between the vital parameters collected at the initial and final moments of each session of music therapy, identifying gains or losses. Subsequently, the evaluation of the mean value of the differences between the six sessions was made by

analysis of variance (ANOVA) for repeated measures, followed by Tukey's post-test. The calculations were performed with the Graph pad® statistical software, version 3.06 – Windows, and values of  $p < 0.05$  were considered significant.

## Results

The study assessed 12 preterm newborns in the period of August to October 2011, six of each sex. The median GA was 34 weeks, ranging between 27 and 37 weeks. The median postnatal age of the newborns was 9 days, ranging from 8 to 25 days. Among the collected sample, 41.5% had

respiratory distress syndrome; 25%, neonatal infection; 8.5%, peri-intraventricular hemorrhage (PIVH) grade II; and 8.5%, PIVH grade III, diagnosed through skull ultrasonography.

It is observed in Table 1 that music therapy had various effects on HR, both with decrease (comparison between the beginning and the end of the second session – paired  $t$ ;  $p = 0.002$ ), and increase (third session – paired  $t$ ;  $p = 0.005$ ). There was no difference between HR variations in the six sessions of music therapy.

As for the RR, it is observed in Table 1 a decrease in this variable after the third and fourth sessions of music therapy (paired  $t$ ;  $p = 0.01$  and  $p = 0.03$ , respectively). While

**Table 1** - Heart rate, respiratory rate and oxygen saturation: initial and final moment of each music therapy session

Moment of collection (session)	Vital parameters by session of music therapy								
	Heart Rate			Respiratory Rate			O <sub>2</sub> Saturation		
	Initial	Final	<i>p</i> -value <sup>1</sup>	Initial	Final	<i>p</i> -value <sup>1</sup>	Initial	Final	<i>p</i> -value <sup>1</sup>
1st	139.0±16.0	145.9±21.7	0.30	56.1±14.1	56.7±9.1	0.84	95.6±2.5	96.3±1.7	0.25
2nd	140.4±15.6	131.5±14.8	0.002	53.2±10.8	53.2±5.9	1.00	95.3±2.9	96.3±1.8	0.25
3rd	117.9±21.0	134.9±16.8	0.005	55.8±10.1	52.0±8.4	0.12	95.8±2.2	96.4±2.4	0.22
4th	142.5±12.3	137.7±15.7	0.21	60.0±11.6	55.7±11.1	0.01	95.7±2.4	95.7±2.4	0.91
5th	139.9±18.9	136.4±14.1	0.93	57.8±5.9	52.7±8.0	0.03	94.2±2.4	96.2±2.1	0.008
6th	144.7±13.5	141.9±15.1	0.55	57.8±12.2	54.3±7.5	0.10	95.9±2.2	95.0±2.2	0.11

<sup>1</sup>paired Student's  $t$  test; values expressed as mean±standard deviation

**Table 2** - Variation in physiological variables between the initial and final moments of the six sessions of music therapy

Variables	Mean differences between the initial and the final moment						<i>p</i> -value <sup>1</sup>
	Music therapy sessions						
	1st	2nd	3rd	4th	5th	6th	
Heart Rate	6.9±22.1	-8.9±8.1	-13.0±13.2	4.8±12.8	-0.5±20.3	-2.8±16.0	0.06
Respiratory Rate	0.6±9.8	0.0±8.9	-3.8±7.9	-4.3±5.1	-5.1±7.0	-3.5±6.9	0.35
O <sub>2</sub> Saturation	0.8±2.1	1.0±2.9	0.6±1.6	-0.1±2.5	2.0±2.2	-0.9±1.8	0.04 <sup>2</sup>
Systolic blood pressure	1.4±15.0	1.7±9.9	-2.4±13.0	-0.5±12.7	-1.4±6.4	-0.6±11.6	0.95
Diastolic blood pressure	3.8±22.1	1.9±6.8	0.3±8.8	3.1±10.2	-1.9±9.1	3.1±20.9	0.30
Body Temperature	0.1±0.4	0.0±0.4	0.1±0.2	0.0±0.3	0.1±0.2	0.2±0.3	0.34

<sup>1</sup>ANOVA test with Tukey's post-test. <sup>2</sup>5th>6th session. The negative sign indicates that the variable decreased, and the positive, that it has increased

**Table 3** - Systolic and diastolic blood pressure and body temperature: initial and final moment of each session of music therapy

Moment of collection (session)	Vital parameters by music therapy session (mean±standard deviation)								
	Systolic blood pressure			Diastolic blood pressure			Body Temperature		
	Initial	Final	<i>p</i> -value <sup>1</sup>	Initial	Final	<i>p</i> -value <sup>1</sup>	Initial	Final	<i>p</i> -value <sup>1</sup>
1st	87.8±20.9	89.3±21.3	0.75	48.4±18.9	52.2±20.0	0.56	36.6±0.5	36.4±0.6	0.39
2nd	80.2±16.1	81.8±13.9	0.57	44.2±9.4	46.1±8.9	0.35	36.3±0.7	36.3±0.6	1.00
3th	89.1±17.7	86.7±12.2	0.53	47.7±12.0	47.9±9.6	0.92	36.6±0.5	36.6±0.5	0.28
4th	81.7±18.1	81.2±11.5	0.89	43.1±0.7	46.2±10.6	0.31	36.6±0.5	36.6±0.4	0.57
5th	85.0±15.7	83.5±14.8	0.46	44.0±12.9	42.2±6.9	0.47	36.4±0.5	36.5±0.4	0.13
6th	85.8±13.2	85.2±17.7	0.86	50.3±13.9	53.4±16.9	0.62	36.2±0.4	36.4±0.5	0.07

<sup>1</sup>paired Student paired test; values expressed as mean±standard deviation

comparing the variation of HR in the six sessions of treatment, no significant difference was observed.

As for O<sub>2</sub>Sat, Table 1 shows its increase at the end of the fifth session, compared to the initial moment of that session (paired *t*; *p*<0.0001). In other sessions, this variable showed no changes. In Table 3 it is possible to observe that the variation of O<sub>2</sub>Sat differed between the fifth and the sixth session of music therapy, and the gain of O<sub>2</sub>Sat was higher on the fifth in relation to the sixth session (Tukey's post-test; *p*=0.04).

There was no immediate effect of music therapy on the variables systolic blood pressure, diastolic blood pressure, and body temperature in the six sessions, as shown in Tables 2 and 3.

## Discussion

After the study of 12 preterm infants undergoing sessions of music therapy, it was possible to observe that music therapy decreased HR in one of the sessions, but increased it in the next session; besides, it led to the reduction of HR in two sessions and promoted different variations in O<sub>2</sub>Sat when compared to the fifth and sixth session of music therapy.

Some studies have shown that listening to music is a viable possibility in clinical neonatal units that can reduce the stress of parents, especially maternal anxiety. The effect of music therapy related to the respiratory variables and the behavioral state of the newborns is still subject of study, so an isolated conclusion cannot be made on this matter<sup>(17-19)</sup>.

Hatem *et al*<sup>(7)</sup> assessed the behavior of HR in children undergoing sessions of music therapy in the postoperative period of cardiac surgery and found that the reduction of this variable may be related to reduced anxiety of patients hospitalized in NICU.

The preterm infant, during the period of hospitalization, is exposed to invasive and potentially painful procedures and techniques that may impact their quality of life and neuropsychomotor development<sup>(1)</sup>. Acute painful stimuli in newborns trigger a global response to stress, including changes in cardiovascular, respiratory, immunologic, hormonal and behavioral levels, among others. These physiological responses are accompanied by an endocrine and metabolic stress reaction, with release of hormones such as adrenaline, noradrenaline, and cortisol, which can result in hyperglycemia and lipid protein catabolism, interfering with the homeostatic balance of the preterm infant<sup>(20)</sup>. Therefore, the imbalance in the body's physiology may lead to decrease in O<sub>2</sub>Sat, increase in heart and respiratory rates and stress<sup>(21)</sup>.

The use of music as an associated therapeutic resource is based on studies such as the one conducted by Ikonomidou *et al*<sup>(17)</sup>. The authors analyzed in a randomized, placebo-controlled study, 84 children subjected to music therapy for 30 minutes in the pre-operative and immediate postoperative period, defined as the first 24 hours after cardiac surgery. They observed that music exerts beneficial effects by presenting an action on the autonomic nervous system, with consequent reduction in HR.

Fernández *et al*<sup>(22)</sup> conducted a study with 98 newborns and concluded that light and temperature are factors that influence the circadian and ultradian rhythms of RR, varying in periods of 3 hours and working as synchronizing factors in neonatal units. The authors recommend that the interpretations of variations in physiological parameters take into consideration the period in which the analyses were performed. In this study, measurements were performed in the morning and afternoon shifts, ensuring reliable interpretations in relation to the time of collection.

A meta-analysis composed of ten clinical trials showed that music therapy has a significant clinical benefit for premature infants in the NICU<sup>(10)</sup>. The results indicate a positive effect on long-term variables such as length of stay, weight gain, and nonnutritive sucking rate, besides beneficial effects in variables such as oxygenation, HR, and behavioral scoring<sup>(23)</sup>.

According to the available literature, evidence regarding the real benefits that music therapy can bring to preterm infants is still controversial. However, it is believed that this practice can reduce stress and stimulate development during a critical period of growth, promoting the bond with parents and facilitating communication with the family, as well as the neurological and social development of the patient<sup>(19)</sup>.

It is suggested to administer music therapy with a frequency of 55 to 80 decibels, which can be associated to the improvement of the behavioral state and contribute to the decrease of HR and RR, increase of O<sub>2</sub>Sat, greater weight gain, better suction, in addition to decreasing length of hospital stay. Noise above 45 decibels should be avoided in the NICU and inside incubators, although Brazilian law recommends 60 decibels as the maximum sound pressure level allowed inside the incubator<sup>(24,25)</sup>.

Arnon *et al*<sup>(26)</sup> observed that the therapy with live music in the NICU was associated to a significant decrease in heart rate, leading to a calmer and deeper sleep of newborns 30 minutes after the end of the session, in addition to improvements in the RR and O<sub>2</sub>Sat. However, when the authors

compared recorded music with no music, no differences were observed in the tested parameters. In Obstetrics, a study showed that the fetus responds to musical stimuli and to the human voice with increased HR and increase of movements in significant higher levels when compared to a non-musical placebo<sup>(27)</sup>.

Hatem *et al*<sup>(7)</sup> describe that the introduction of music in NICUs should be seen as a way to optimize patient care through pain and stress relief and reduced activity of the sympathetic system. Cevasco<sup>(28)</sup> evaluated the behavior of preterm and term infants exposed to music therapy during 20 minutes for 3 to 5 days in two consecutive weeks, comparing them to a group of newborns not exposed to music, and observed a shorter hospitalization time in the Experimental Group. However, a study by Choul *et al*<sup>(29)</sup> with 30 preterm babies, measured the O<sub>2</sub>Sat for the first time while they received regular endotracheal suctioning. Four hours after the control period, the same variable was collected during an experimental period, in which the song “Transitions” was played. One minute before aspiration, the level of O<sub>2</sub>Sat was measured to provide the baseline data. For 30 minutes after suctioning, O<sub>2</sub>Sat was verified every minute to examine the clinical effects of music therapy. The results showed that premature infants who received music therapy during endotracheal aspiration had significantly higher O<sub>2</sub>Sat.

Cassidy<sup>(30)</sup> assessed 63 PTNB with GA between 28 and 33 weeks, which listened to classical music (Mozart) for 20 minutes during 2 consecutive days. The authors assessed the physiological data (HR, RR and O<sub>2</sub>Sat) and head circumference, and observed a statistically significant difference

between the newborns submitted to music therapy and the Control Group for head growth. However, the tendency to gain greater head circumference in the days of observation of children not exposed to music was also noted by the authors. Regarding the other variables, there was no statistically significant difference.

Lubetzky *et al*<sup>(12)</sup> assessed 20 healthy PTNB in order to test the hypothesis that the “Mozart effect” reduces the resting energy in growing patients, and observed that those submitted to sessions of 30 minutes of music therapy twice a day presented reduction of energy expenditure compared to the group that was not exposed to music therapy. Schlez *et al*<sup>(19)</sup>, in turn, compared the use of the “Kangaroo Mother” Method (KMM) alone and in combination with music therapy, recommending the use of music therapy as an adjuvant for the preterm infants and their mothers while in the NICU.

In the present study we did not observe an immediate effect of music therapy on the variables SBP, DBP, and BT in the six sessions performed. However, it had already been observed inconsistencies in the results of several clinical trials with respect to the physiological effects, highlighting the need for studies in the area about the influences of musical elements, such as: rhythm, tempo, harmony, and timbre in these parameters<sup>(31)</sup>.

A generalization of the results obtained in this study is hampered by sample size and the heterogeneity of the sample, such as chronological age, birth weight, previous medications, clinical complications, use of endotracheal tube, as well as lack of calculation of sample power. However, such limitations alert for the variables to be considered in future studies, with bigger samples, to confirm the results.

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