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ORIGINAL ARTICLE

External influences on birth deliveries: Lunar gravitational and meteorological effects☆

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KEYWORDS
Delivery;
Moon phases;
Meteorological factors.

Abstract
Objective: To investigate the influence of external factors such as lunar and meteorological effects on the frequency of birth deliveries. It includes the lunar gravitational force using the scarcely investigated lunar apogee and perigee (furthest and closest distance to earth, respectively).
Material and methods: A retrospective study was conducted by reviewing the medical records of all spontaneous single deliveries during a 4 year period (2015–2018). A statistical analysis was performed on the relationship of the deliveries using birth rates with qualitative lunar variables (four classic phases, lunar apogee- perigee, and super moons) and quantitative atmospheric variables (mean atmospheric pressures, mean temperature, and mean wind velocity).
Results: No relationship was found between the variables studied and the birth rate. There were periods with more births in the months of May and June.
Conclusion: Despite the myth on the meteorological, and in particular, the lunar influence on birth deliveries, no statistical association was found to support this. Furthermore, the classic moon phases and the lunar gravitational force do not seem to trigger birth delivery either.

PALABRAS CLAVE
Parto;
Fases lunares;
Factores meteorológicos

Influencia externa en los partos: Efecto lunar gravitacional y meteorológico

Resumen
Objetivo: Investigar influencia externa tanto lunar como climatológica en la frecuencia de partos. Incluye fuerza gravitacional lunar mediante apogeo y perigeo lunar apenas investigado.

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Material y métodos: Estudio retrospectivo mediante revisión de historias clínicas de todos partos únicos de inicio espontaneo durante un periodo de 4 años (2015–2018). Se analiza estadísticamente la relación de los partos mediante coeficiente de nacimientos con variables cualitativas lunares (cuatro fases clásicas, apogeo-perigeo lunar y superlunas) y variables cuantitativas atmosféricas (presiones atmosféricas medias, temperatura media y velocidad media de viento).
Resultados: No se encontró relación entre las variables estudiadas y el coeficiente de nacimientos. Se encontró periodicidad de partos con más nacimientos en los meses de mayo y junio.
Conclusión: Pese al mito existente de la influencia meteorológica y, sobre todo, lunar en los partos, no se encuentra razón estadística que lo apoye. Además de las fases clásicas, la fuerza gravitacional lunar tampoco parece desencadenar el parto.

Introduction

In many societies around the world, there is a belief that the frequency of births is associated with the phases of the moon and especially with the full moon.[1,2]

The median duration of a singleton pregnancy following conception is 265 days (which is equivalent to exactly 9 synodic months). Although there may be variations, the menstrual cycle has a mean duration of 28 days (approximately 1 sidereal or 1 synodic month). This has led to the belief since ancient times that there is a link between the moon, fertility, conception and/or childbirth.

In addition, water is the medium where the embryo and the foetus develop. Thus, it may be reasonable to propose an association between the moon and childbirth on account of the influence exerted by the moon on fluid masses on earth through its gravitational pull, as is the case of the tides, which in this case would affect the amniotic fluid. Uterine distension due to its contents is one of the factors associated with the onset of labor.[3]

Although most studies to date have not found an association between the phases of the moon and the frequency of spontaneous childbirth,[4–6] this belief persists, even among some health care professionals.

Previous studies analysing the association between births and the moon have mostly compared the number of births in the days corresponding to each lunar phase. These studies have focused on the light that the moon casts on earth. Few studies have addressed the association with the distance between the moon and the earth in terms of the apogee and perigee. The distance between moon and earth varies through each orbit of the moon around earth. Thus, the gravitational pull of the moon is stronger at the perigee (closest distance) and weaker at the apogee (farthest distance). This could have an effect on the onset of labour and therefore on the number of births.

Other scientific studies have assessed the influence of certain meteorological variables, such as atmospheric pressure, temperature and rainfall, on the number of births.[7–13] The findings of Noller et al[12] and Driscoll et al[13] suggested that atmospheric pressure could trigger labour in humans, although this effect has not been observed in other studies.[7,9,10]

The aim of our study was to assess the potential influence of the moon and other environmental variables in the frequency distribution of childbirth. We included the variables of the lunar apogee and perigee, which have rarely been considered, and analysed the largest sample of births to date in research on this subject.

Lunar motion, phases and apogee-perigee

The orbit of the moon around the earth can be studied as 2 different periods: the sidereal month and the synodic month.

The sidereal month is defined as the time is the moon takes to complete one full revolution around the earth with respect to the background stars (sidereal space). This time corresponds to approximately 27.3 days. The moon moves in an elliptical orbit in which the earth occupies one of the focal points, and the distance between moon and earth varies on a regular basis. The point at which the moon is closest to earth is known as the lunar perigee, and the point at which it is farthest as the lunar apogee. The mean distance between moon and earth is of 384 400 km. At the perigee, this distance can reach a minimum of about 356 000 km and at the apogee a maximum of about 407.000 km. When the perigee and the full or new moon coincide, the phenomenon is referred to as a supermoon, and the gravitational forces that affect the earth are increased due to the alignment of the sun, earth and moon.

The synodic month is a better-known term and refers to the time that it takes the moon to do a revolution around the earth and return to the same point in respect to the sun. This period is of approximately 29.5 days. This period corresponds to the traditional phases of the moon that are based on the sunlight that the moon reflects upon the earth (full moon: maximum brightness and new moon: minimum brightness). Thus, the time elapsed between 2 moons in the same phase is a synodic month.

Material and methods

We conducted a retrospective study through the review of health records concerning all singleton deliveries with a spontaneous onset of labour between 2015 and 2018 (1461 days) in a public tertiary care hospital in Spain (latitude 41°37′44″N, longitude 4°42′41″O). We excluded multiple ges-

tations, induced deliveries and elective or urgent caesarean deliveries performed before the onset of labour. We also established a subset of births that took place at term (TBs at 37–41 weeks' gestation)

We obtained lunar data (moon phases and apogee/perigee, both qualitative variables) from the website www.timeanddate.com, retrieving the days corresponding to the 4 phases of the moon (new moon, first quarter moon, full moon, last quarter moon) and the dates corresponding to the perigee and the apogee in the city of Valladolid for each synodic month included in the period under study. We also documented the dates of supermoons when the full or the new moon coincided with the perigee.

Each of the phases and the perigee and apogee occur at an exact hour and minute. The distance and brightness of the moon vary only slightly from one day to the next. For this reason, we considered that the moon was at the perigee, apogee or a given phase the day before, the day of and the day after the actual event. We categorised the days that were not included in any of these intervals as ''other days''.

We contacted the Agencia Española de Meteorología (Spanish Meteorology Agency) to request the mean atmospheric pressure (hectopascals), mean temperature (°C) and mean wind speed (m/s) recorded by the weather station nearest to the unit for each day in the period under study (all quantitative variables).

To try to decrease the potential bias associated with seasonal patterns in childbirth, we used a weighting coefficient to weight the birth count of each month already used in a previous study[7]; thus, we divided the birth count for each day by the total births in the corresponding month and multiplied the result by 100. Thus, if there were 4 births on May 14, 2016 and a total of 105 births in May 2016, the resulting weighting coefficient would be 3.81.

We analysed the association between lunar data and the daily birth coefficients using the Kruskal-Wallis test and the Mann-Whitney *U* test (for non-normally distributed variables). We analysed the association of meteorological variables and birth coefficients by means of the Spearman correlation coefficient.

The dates of birth may not coincide with the date of the onset of labour. For this reason, we carried out the same analyses for the lunar and meteorological variable values 1 day and 2 days before the birth date.

Results

Between 2015 and 2018, there were a total of 8012 live births from 7845 pregnancies (163 twin pregnancies and 2 triplet pregnancies) in the hospital under study. The number of births decreased over the period under study, from 2172 in 2015 to 1820 in 2018.

We included 5476 of the births in the study, product of a singleton pregnancy and with spontaneous onset of labour. There were 5194 in the TB group.

The analysis by month (Fig. 1) revealed that the mean number of singleton births was significantly greater in May (4.05) and June (4.08) compared to October (3.45) and December (3.33) (Kruskal-Wallis, $P = .03$). This significant difference was maintained in the TB group ($P = .04$).

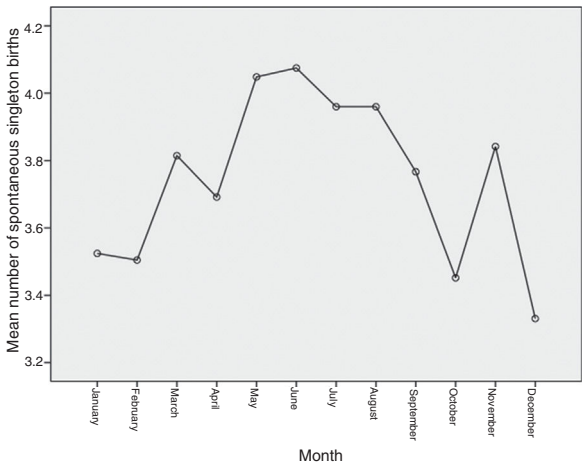

Fig. 1 Mean number of spontaneous singleton births by month of the year.

Table 1 Moon phase cycles.

49 moon cycles	Days counted (x 3)*
New moon (49)[a]	147 days
First quarter moon (49)[a]	147 days
Full moon (50)[a]	150 days
Last quarter moon (50)[a]	150 days
Other days	867 days

[a] We counted 3 days per moon phase.

Table 2 Lunar apogee/perigee periods.

53 apogee/perigee periods	Days counted (x3)*
Apogee (53)[a]	159 days
Perigee (53)[a]	159 days
Other days	1143 days

[a] We counted 3 days for each apogee and each perigee.

Tables 1 and 2 present data for the intervals for the moon phases and the apogees/perigees comprehended in the period under study. There were also 4 super full moons (perigee on the same date as the full moon) and 4 super new moons (perigee on the same date as the new moon).

We did not find any statistically significant associations between the daily birth coefficient and the meteorological variables under study (mean daily temperature, atmospheric pressure and wind speed) (Table 3).

We also did not find any statistically significant associations between phases of the moon in the synodic month (4 phases and other days) and the sidereal month (perigee/apogee and other days) (Fig. 2). This was also the case in the term birth group.

An additional analysis was also made considering 3 dichotomous variables: perigee/apogee, full moon/new moon and supermoon/no supermoon, which also did not detect significant differences (Table 4).

Discussion

Superstitions are found in every area of our lives, and can also be found in medicine, a field that takes pride on being

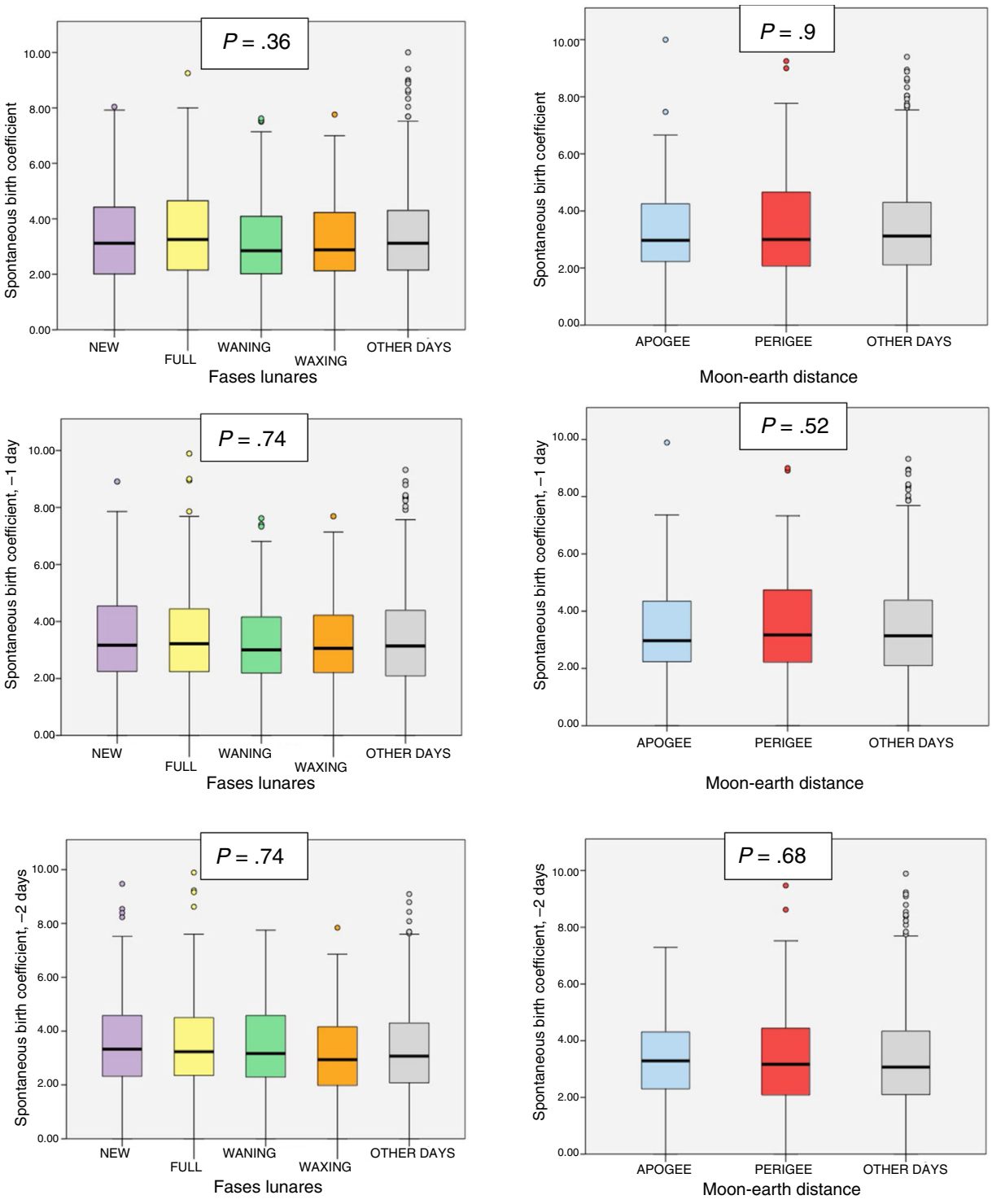

Fig. 2 Coefficient of spontaneous singleton births for the different moon phases and distances from the moon (Kruskal-Wallis test).

based on solid evidence. One of the widespread superstitions is the variation in the frequency of labour and births with different phases of the lunar cycle, specifically in the full moon, and with changes in the weather. If variations in births followed a predictable pattern, it would influence the staffing and expectations of teams working in labour and delivery units.

In the past, there have been claims about an association between the moon and terrestrial events, such as births, accidents and mood changes,[14] and the specific association between labour and the position of the moon has attracted the interest of many authors. Although this association is not supported by scientific evidence, this belief persists in the general population, and even obstetricians will refer to this notion of increased demand for services on full moons.[15,16]

One possible explanation proposed for the persistence of this belief is that the daily distribution of births is variable, and when a peak of births coincides with a full moon, professionals find this notion reinforced, whereas on days with few births no attention is paid to the current phase of the moon.[17]

Table 3 Meteorological variables.

	Spontaneous singleton births		Term births		Spontaneous singleton births (−1 day)		Term births (−1 day)		Spontaneous singleton births (−2 days)		Term births (−2 days)	
	Spearman coefficient	*P*	Spearman coefficient	*P*	Spearman coefficient	*P*	Spearman coefficient	*P*	Spearman coefficient	*P*	Spearman coefficient	*P*
Mean daily temperature (°C)	−0.03	.32	−0.03	.28	−0.04	.13	−0.03	.23	−0.04	.13	−0.03	.23
Mean daily atmospheric pressure (hPa)	−0.003	.92	−0.01	.64	−0.02	.52	−0.02	.54	−0.003	.91	−0.008	.77
Mean daily wind speed (m/s)	−0.03	.23	−0.02	.44	−0.002	.95	−0.004	.89	−0.03	.23	−0.04	.09

Table 4 Lunar dichotomous variables.

		Spontaneous singleton births	Term births	Spontaneous singleton births (−1 day)	Term births (−1 day)	Spontaneous singleton births (−2 days)	Term births (−2 days)
Full moon/new moon	Mann-Whitney U	*P* = .4	*P* = .32	*P* = .8	*P* = .59	*P* = .78	*P* = .68
Perigee/Apogee	Mann-Whitney U	*P* = .9	*P* = .97	*P* = .36	*P* = .42	*P* = .78	*P* = .77
Supermoon/No supermoon	Mann-Whitney U	*P* = .27	*P* = .16	*P* = .92	*P* = .91	*P* = .39	*P* = .36

In most studies focused on this subject, the brightness of the moon, and in particularly the full moon, has been proposed as a possible factor that could affect the onset of labour. Most studies have not found an association between the moon phase and childbirth.[4,7,9,17–24] A review by Bueno et al[6] reached the same conclusion. The few studies that found an association disagree as to which is the most influential phase. Ghiandoni et al[25,26] found a greater number of births in days 1 and 2 following the full moon, although the association was weak and only in multiparous women with multiple pregnancies. In a study of nearly 6 million births in France, Guillon et al[27] found greater numbers of births in the new moon and the first quarter, although the authors also emphasized the presence of a rhythmic pattern in the number of births (weekly and seasonal) that could have influenced those results. On his part, Lentz[28] found greater numbers of births on the full moon and the new moon.

An interesting study conducted recently by Marco-Gracia et al[5] in Spain gathered data for 23 689 births in rural areas between 1810 and 1920, all of them vaginal births without any form of medical intervention and did not find any evidence of an association with the phases of the moon.

Most studies focus on the traditional phases of the moon and analyse the influence of the full moon compared to other days,[7] the 4 classic phases of the moon[25] or even 8 phases of the moon.[4] The distance between the earth and the moon is addressed in few studies, and more specifically, we have only found mention to the lunar apogee and perigee in a non-medical article.[28] The moon could influence labour through gravitational forces, with an increase in the gravitational pull during the perigee that would keep the foetus, amnios and uterus further from the neck of the uterus, making labour more unlikely. The study published by Lentz[28] included 1259 spontaneous vaginal births and did not find an association between births and the apogee or the perigee in either the individual analysis or the synergic analysis combining lunar position with atmospheric pressure, although this study did not take into account the periodic patterns in childbirth. A study in Japan by Wake et al[29] addressed the moon-earth distance, although the analysis used gravitational force as a variable and found a significant association of a greater number of births with a gravitational force of less than 31.5 Newtons, that is, with an increasing distance between moon and earth. The influence of tides (which are influenced by the moon) on childbirth has also been investigated in a study that found an association between a higher tide (greater gravitational pull) and a lower number of hospital admissions of mothers in labour.[8]

Consistent with the majority of the literature, our study did not find an association between childbirth and the phases of the moon. It also did not indicate an association between the gravitational force exerted by the moon at its apogee or perigee, or the supermoon periods, and childbirth frequency.

As is the case of the influence of the moon, there is no conclusive evidence on the effect of meteorological conditions, and the data in the literature are contradictory. A possible mechanism that would explain the influence of atmospheric pressure would be the stimulation of baroreceptors that induce uterine contractions. However, this physiological explanation is purely speculative and the physiological mechanisms underlying a potential association between atmospheric pressure and childbirth require further study.

Noller et al[12] and Driscoll et al[13] in the United States and Akutagawa et al[30] in Japan found that a decrease in atmospheric pressure was associated with a lower frequency of childbirth, but King et al[31] found data in opposition in the United States. Driscoll et al[13] also found an association between lower temperatures and greater wind speeds with spontaneous birth. Hirsch et al[32] fitted a logistic regression model that included gestational age, maternal age, parity, pregnancy multiplicity and uterine infection to assess the influence of atmospheric pressure, temperature and humidity, and while they found significant differences, the effect size was very small. In Brazil, Ochiai et al[8] performed a multivariate analysis that detected an association of decreasing atmospheric pressure and increasing temperature with increasing frequency of childbirth. On the other hand, Lentz[28] did not find an association with atmospheric pressure, and a large-scale study by Morton-Pradhan et al[7] that included 167 956 did not find an association with temperature or rainfall.

Our study did not detect an association between childbirth and atmospheric pressure, ambient temperature, rainfall or wind speed.

Studies that assess external influences on childbirth usually exclude medically induced deliveries. Some studies only include term births,[8,25] and others further restrict the sample to spontaneous vaginal births.[7,17] In our study, we also eliminated multiple births, as there is ample evidence of their association with preterm birth, and therefore could have a confounding effect.

Some authors use the variable of the time of delivery (births), while others use the variable of the time of spontaneous labour hospital admission.[8] The logical choice would be to document the time of onset of labour as the initial process triggered by potential external influences. However, determining the exact time of the onset of labour would be difficult, and for this reason, in our study we analysed not only the day corresponding to the birth, but also the data for the 2 days prior, when the onset of labour could have occurred.

Another common problem in this type of studies is the potential confounding effect of periodic patterns in childbirth. Several researchers have identified patterns in human births, daily, monthly and seasonal.[33–37] In the United States, Cesario[34] found a greater number of births in September, a phenomenon known as ''the Christmas effect'' that could be explained by the increase in the number of conceptions during holidays that would culminate 9 months later with an increased number of births. Our study yielded no evidence of a Christmas effect, although we did find a higher frequency of spontaneous births in May and June that could be explained by a preference to give birth around the summer months. In addition, in our study the number of births decreased over the years, from 2172 in 2015 to 1820 in 2018. To try to correct for this factor, which could have affected the results, we resorted to the birth coefficient.

Limitations

We conducted a retrospective study in a single centre. For this reason, and since the data collection was the same for the 4 years under study, there could be a non-differential misclassification bias. The use of birth coefficients and the statistical tests performed, while easy for readers to understand, could have been replaced by more complex statistical methods, such as time series analysis or Poisson regression,

which would have increased the power of the study. Another aspect to consider is that interventions by obstetricians may affect the time of birth, even in case of spontaneous onset of labour, as the uterus may be stimulated with oxytocin, epidural analgesia may affect uterine dynamics, the delivery expedited if indicated due to findings of foetal monitoring, or the membranes may be ruptured artificially (amniotomy), among other possibilities.

As we commented in the discussion, the ideal moment to record in this type of study would be the exact time of the onset of labour (which is practically impossible) as opposed to the time of birth.

Conclusion

This study, which investigated the influence of the moon, both in terms of gravitational pull and brightness, on the onset of labour, also failed to find statistically significant evidence supporting this myth. We also found no evidence of an association with meteorological factors.

Thus, we found no evidence that would support adjusting the staffing of hospitals based on the moon cycle or meteorological events

Despite the evidence, we assume that this superstition will endure and that we will continue to overhear references to the lunar myth in delivery rooms.

Conflicts of interest

The authors have no conflicts of interest to declare.

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