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Brief Report

Time of Dinner may Contribute to Keep Majorcan Children Free from Otitis

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Abstract: Running at odds with the timing imposed by the circadian clock plays an important role in the process that leads to communicable and non communicable diseases. The primary objective of this study was to analyse whether early dinner eater children were at lower risks of acute respiratory infections than late dinner eater children, during the COVID-19 pandemic. Methods: This cross sectional study was conducted from July to December 2020 on children attending Majorcan emergency services. Clinical data collected included timing, symptoms, laboratory tests and imaging studies of current illness. Each diagnosis was validated by general paediatricians. Our survey on dinner time habits was carried out by using self-administered questionnaires. Results: A total of 669 children under age 18 were included in the study. The median of dinner time was 8:30 pm. Late dinner eaters accounted for a higher proportion of acute otitis media than early dinner eaters (7% vs 3%; P=0.028). Other infectious diseases were not associated with dinner time habits. Conclusions: We make a preliminary estimate of the link between late dinner habits and acute otitis media in children. However, no conclusions about causality can be established due to the observational design of the study.

Keywords: circadian clock; otitis media; late dinner; common cold; Mediterranean diet; oxidative stress; chronotype

1. Introduction

More than 50 years ago, it was reported that circulating lymphocyte counts in humans were aligned with the circadian clock [1]. The relationship between all levels of immunity and circadian rhythms is not that surprising given the necessity to align rhythms of feeding with activity. For humans and other diurnal species, most food consumption and physical activity occur during the light phase. When there is a misalignment between the endogenous circadian rhythms and feeding throughout the inactive phase, the body's ability to maintain homeostasis is impaired [2]. Specifically, the timing of caloric intake conditions the immune response; and the host defense alterations that associate to a late dinner seem to result from the increased free-radical production as much as from the reciprocal circadian interaction of the microbiota with the innate immune system [3,4].

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Evening chronotype has a tendency to wake up later and prefers to time peak activity during the evening, while morning chronotype usually wakes up earlier and prefers activities earlier in the day. A relevant characteristic of subjects with evening chronotype is not only to consume more calories after 8:00 pm, but also to have lower fruit and vegetable consumption [5,6]. In addition, evening chronotype has the lowest adherence to the Mediterranean diet (MD) [7], and has a tendency to have more cardio-metabolic health problems and host immune disorders compared to morning chronotype [8]. On the other hand, the link between abandonment of the MD and appearance of paediatric common colds and their bacterial complications [9], also reflects the anti-inflammatory effects of the MD [10].

Taken together, these findings point to a synergy between early dinner and MD adherence, which might contribute to prevent childhood respiratory infections. In this regard, both recurrent and severe episodes of acute otitis media (AOM) in childhood are associated with an unbalanced diet, a higher preference for high-fat products, and subsequently with overweight [11,12]. Moreover, there is a bidirectional relationship between AOM and childhood overweight. It seems that middle ear inflammation may involve damage to the chorda tympani nerve with taste sensation impairment [13]. Alterations in taste sensation may explain why otitis media patients need a considerable higher fat intake than healthy patients [14].

During the COVID-19 pandemic, it has been shown that children who went to bed earlier had fewer psychosocial problems [15]. In addition to this, we propose to investigate whether early dinner eater children (EDE) were at lower risks of infectious disorders when compared to late dinner eater children (LDE) Finally, the secondary objective of this research was to assess Majorcan children's dinner time variations during the early stages of the COVID-19 pandemic.

2. Results

A total of 669 children 8 days to 17 years old were included in the study. Table 2 shows the general characteristics of the study subjects. Mean age was 54 months, and 44% of the participants were girls. Timing of dinner is summarized in Figure 1; the most frequent dinner time was 8:00 pm (26%), followed by 9:00 pm (25%), and 8:30 pm (21%). The median of dinner time was 8:30 pm (IQR=1); the mean of dinner time was 8.49 (SD: 0.73); measures of skewness and kurtosis were -0.114 and 0.571, respectively.

Sociodemographic characteristics according to dinner time. Compared with LDE (after 8:30 pm), children whose families reported early dinner habits (before or at 8:30 pm) were more likely to attend private health care facilities and to be slightly younger. In addition, LDE were found to live in households with less children under five years old, as opposed to EDE. No statistically significant differences were found in gender distribution, type of infant feeding, or children's BMI across dinner times.

Association between dinner time and clinical characteristics. LDE accounted for a higher proportion of acute otitis media (AOM) (P=0.028) than EDE. The remaining clinical characteristics were not associated with dinner time habits.

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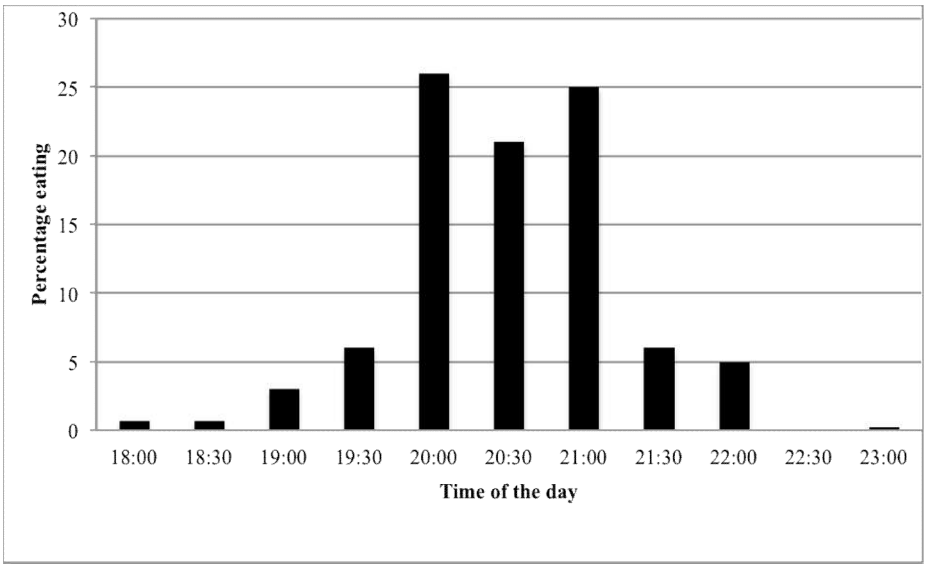

Figure 1. Dinner time.

Table 1. Table 1. Participant recruitment.

Recruitment date (year 2020)	Number of elegible participants	Number (%) of recruited participants
2nd August	103	72 (69.9)
16th August	117	73 (62.3)
2nd September	84	43 (51.1)
16th September	159	87 (54.7)
2nd October	168	101 (60.1)
16th October	189	58 (30.6)
2nd November	167	89 (53.2)
16th November	176	70 (39.7)
2nd December	182	57 (31.3)
16th December	45	19 (42.2)
Total	**1,390**	**669 (48.1)**

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Table 2. Baseline characteristics of total, early dinner eaters and late dinner eaters.

Variables	Total	Early dinner (n=409)	Late dinner (n=260)	p
Sex:				
Boys	371 (55%)	226 (55%)	145 (56%)	0.94
Girls	298 (44%)	183 (45%)	115 (44%)	
Breastfeeding	451 (68%)	272 (67%)	179 (70%)	0.49
Age, months	54 (95.5)	39 (110.7)	44 (82.5)	0.011*
BMI (kg/m^2)	17.2 (3.9)	16.8 (3.8)	17.6 (4.4)	0.07
Heath care:				
Public	454 (68%)	252 (55%)	202 (44%)	<0.001***
Private	215 (32%)	157 (73%)	58 (27%)	
Bedrooms in the household:				0.71
0-3	592 (89%)	363 (89%)	229 (88%)	
>3	75 (11%)	44 (11%)	31 (12%)	
Children under 5y in the household:				
0	206 (35%)	111 (30%)	95 (45%)	<0.001***
1	300 (51%)	198 (53%)	102 (48%)	
2	70 (12%)	56 (15%)	14 (7%)	
3	8 (1%)	8 (2%)	0 (0%)	

Data are presented in numbers (%), or median-interquartile range..

ABBREVIATIONS: BMI, body mass index; y, years of age

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Table 3. Differences of clinical characteristics between early and late dinner eaters.

	Early dinner, before or at 8:30 PM N= 409	Late dinner, after 8:30 PM N= 260	P
Comorbidity	84 (20%)	49 (19%)	0.62
Positive PCR test for SARS-Cov-2	7 (2%)	7 (3%)	0.42
Respiratory rate/minute	30 (16)	26 (19.2)	0.056
% oxygen saturation	98 (1)	98 (0)	0.51
ºC axillary temperature	36.6 (0.7)	36.5 (0.7)	0.83
Body mass index	16.8 (3.8)	17.7 (4.4)	0.07
Asthenia	39 (9%)	29 (11%)	0.51
Headache	34 (8%)	24 (9%)	0.67
Myalgia	11 (3%)	8 (3%)	0.81
Sore throat	55 (13%)	43 (16%)	0.31
Otitis	14 (3%)	19 (7%)	0.028*
Breath shortness	28 (7%)	14 (5%)	0.51
Abdominal pain	43 (10%)	31 (12%)	0.61
Diarrhea	38 (9%)	22 (8%)	0.78
Pain score	5 (4)	5 (3)	0.23
Disease severity			
mild	382 (93%)	253 (97%)	0.074
moderate	26 (6%)	7 (3%)	
severe	1 (0.2%)	0 (0%)	

Data are presented in numbers (%), or median (interquartile range).

ABBREVIATIONS: C, Celsius; N, number of participants;

PCR, polymerase chain reaction; PM, post meridiem.

3. Discussion

Temporal distribution of dinner. In our sample, there is a very sharp peak at 8:00 pm-9:00 pm, when around 72% of respondents were found to eat dinner. This finding is in agreement with previous reports of pronounced peak times of dinner in Mediterranean countries compared to Central/Northern European countries where dinner times were more evenly spread across the evening [19]. Studies on meal timing in Spanish children are scarce; to the best of our knowledge only Martinez-Lozano et al. [20] have recently reported that the mean dinner time for 397 school-aged children (8-12 years) was 9:07 pm (95%CI: 8:08; 10:06). There is therefore no major difference between their results for dinner time (~9:00 pm) and our own results, since the median dinner time in our study was roughly half an hour earlier (8:30 pm) than in the aforementioned study.

The impact of dinner time on pediatric respiratory infections. We did not find increasing rates of flu-like syndrome or lower respiratory tract infection among LDE. However, a new finding is that a late dinner habit was associated with increased risk of AOM (7% vs 3%; P=0.028). On the other hand, overall there were 33 (4.9%) physician-diagnosed episodes of AOM among 669 pediatric emergency visits between July and December 2020. This figure compares with findings from comprehensive research on emergency visits in which AOM diagnoses encompassed 6.8% of all pediatric emergency room visits with significant variation in month of presentation (peak: January; trough: September) [21]. In addition, the incidence of AOM peaks between age 6 - 12 months and overcrowding is a risk factor for otitis [22]; remarkably, there was no difference in number of bedrooms between study groups within our sample, but EDE were a little younger than LDE.

Allergic rhinitis [23] and oxidative stress [24] are key factors in the pathogenesis of otitis that might provide an understanding on how late dinner contributes towards developing otitis. Regarding allergic rhinitis, Wasilewska et al. [25] have recently

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studied the times of meals consumed by children with allergy symptoms, and they have found incorrect dietary habits such as eating < 1 hour before bedtime among most children with respiratory allergies; the researchers suggested that their findings indicated that eating immediately before bed might have contributed to gastroesophageal reflux resulting in further local respiratory inflammation and vasomotor changes in this group of children. With regard to late dinner as a risk factor for oxidative stress, a 2004 study [26] of the systemic antioxidant status of patients with otitis, showed that children requiring tube insertion have significantly increased erythrocyte levels of malondialdehyde, one of the most frequently used indicators of oxidative stress, compared to healthy controls. Similarly, a 2013 article [27] reported that serum malondialdehyde levels were significantly higher in patients with chronic otitis media than in healthy controls, and a 2019 study has found that patients with otitis have significantly increased serum levels of antioxidant enzymes involved in defense against oxidative stress [24]. In this same field of research, it has been proven that childhood obesity and total cholesterol levels are significantly higher in children with AOM [28]. Accordingly, our study shows a trend towards higher BMI (P=0.07) among LDE. The main mechanisms for developing otitis media in obese patients include gastroesophageal reflux and/or alteration in cytokine profile [29]. The importance of circadian rhythm in the pathophysiology of diseases of the airways that are subject to systemic inflammation such as chronic obstructive pulmonary disease, chronic sinusitis, idiopathic pulmonary fibrosis or asthma, has been reported many times [30]. The inclusion of otitis in this select group, therefore, should be given serious consideration.

Limitations. Spain is located relatively westward within its time zone, resulting in sun set occurring at a later time as compared to many other countries within the same time zone, and is using the Central European Time, which runs along the border between Germany and Poland, which does not adequately reflect the solar time on Spain's longitude. The late meal timing in Spain is thus less extreme than what the clock time suggests as compared to solar time. Since we used questionnaires to analyze dinner timing, the dinner-time patterns identified in the present study should not be viewed as indisputable. We looked at primary complaints in pediatrics emergency visits; thus, this study may underestimate underlying diagnoses in this cohort of children. Another limitation of this study is the case definition for AOM: clinical judgement made by physicians might have not been accurate, but primary care is a good proxy to general population epidemiology; when specialised clinics are included, the better accuracy of diagnosis takes a toll on the representativeness of the studied population. Although the relationship between dinner-time habits and AOM in children is supported by our findings, no conclusions about causality can be established due to the observational design of the study. In addition, considering that a number of factors were correlated with each other, and that we did not correct for multiple comparisons, further research is needed in order to confirm the different issues raised by this preliminary study.

4. Materials and Methods

This is a secondary analysis of a cross sectional study that tests the hypothesis that the risk of COVID-19 is attenuated for ever breastfed children [16]. This study was conducted from July to December 2020 on children attending Majorcan emergency services of nine healthcare centers for community Pediatrics, a Private Hospital, a District Hospital, and two University Hospitals, where no-cost COVID-19 tests were widely available. The extent of illness in children attending emergency services ranged from mild (ambulatory care) to moderate (admission to the pediatric ward), and severe (admission to intensive care). Eligible patients were those younger than 18 years of age who presented to a participating emergency room and who were tested for SARS-CoV-2 because of COVID-19 symptoms, routine pooled testing or scheduled hospital procedures on the 2nd and 16th of each month from July to December 2020. Table 1

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represents the data about how many patients were eligible and finally recruited on these dates.

Data collection. Health interview. On enrollment, team members undertook in-person interviews to collect clinical data. A list of all components of the Balearic Health Service medical interview [17] (not-validated) were ticked by the clinician (self-introduction, checking the patient's name and date of birth, obtaining interview consent, asking family and social history, as well as history of present illness, of past medical history, or allergies. Data collected included specially past medical history of chronic diseases, current weight and height, as well as timing, symptoms, laboratory tests and imaging studies of current illness. Any diagnosis made was validated by trained medical staff by means of a detailed clinical interview and physical examination. Although cross sectional studies are useful at identifying associations that can then
be more rigorously studied using a cohort study, the authors recognize that carrying out the study in the emergency room introduces an important bias with respect to causality. Confounding factors. Age, gender, infant feeding, body mass index (BMI), public vs. private healthcare, and household composition were examined.

Classification of Late and Early Dinner Eaters. Since most prior studies of dinner timing have been carried out using questionnaires, our survey on dinner time habits was carried out by using self-administered questionnaires (a paper-and-pencil version). Children were classified into two groups according to the median of the dinner time 8:30 pm. Children who had dinner before or at 8:30 pm were considered EDE, while those who had dinner after 8:30 pm were LDE. In addition, we calculated the following variables: (A) Mean of dinner time. (B) Dinner phase deviation: the standard deviation of the mean of dinner timing. (C) Measures of skewness or kurtosis.

Sample size. At the time of surveying, the wide variation of pediatric COVID-19 incidence (1%-16%) [18] precluded a robust sample size estimate. Hence, we have opted for a convenience sample of children screened for COVID-19.

Data analysis. Statistical analyses were performed with IBM SPSS v.28 statistical software. Categorical data is presented as percentages. Proportions were compared using the Fisher's exact or the chi-squared tests. Quantitative and qualitative variables were compared by the Mann-Whitney U test. A P value < 0.05 (two tailed) was considered significant for all statistical analysis.

Ethics. The study was approved by the Balearic Conjoint Health Research Ethics Review Board (COVID IB4221/20PI) and carried out in compliance with the ethical standards of the Declaration of Helsinki. There is no direct benefit of study participation. A research team member at each institution contacted in-person the guardian/caregiver/child to obtain written informed consent and assent, as appropriate .

Preregistration: Aspredicted Trials Registry number of COVID IB4221/20PI is #62721

5. Conclusions

Our study shows that late dinner is a risk factor for AOM in children visiting the emergency room. However, this is an initial exploration, and more research should be carried out to substantiate its findings.

If the evidence presented in this report were to be confirmed, child health would benefit from consuming a greater proportion of calories earlier in the day, as compared to consuming a large number of calories later at night. However, compliance with this recommendation may not be feasible for many families and represents a paradigm shift from section is not mandatory but can be added to the manuscript if the discussion is unusually long or complex traditional eating pattens in many parts of the world.

Abbreviations: AOM,acutre otitis media; BMI, body mass index; EDE, early dinner eater; IQR, interquartile range; LDE, late dinner eater; MD, Mediterranean diet .

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Balearic Conjoint Health Research Ethics Review Board (COVID IB4221/20PI) the 7th of May, 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. In addition, written informed consent has been obtained from the patients to publish this paper.

Data Availability Statement: The datasets generated during the current research are not publicly available since patients could be identified by knowing the date of attendance at the health service, but are available from the corresponding author on reasonable request.

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Conflicts of Interest: The authors declare no conflict of interest.

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