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Effects of Cow Milk Intake at Breakfast on the Circadian Typology and Mental Health of Japanese Infants Aged 1 - 6 Years

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Tryptophan intake at breakfast has been known to be effective on promoting better mental health and morning-typed life through serotonin and melatonin synthesis. For Japanese children, milk seems to be important resource for taking tryptophan at breakfast because of limited meal time in the morning. This study tries to show the effects of milk intake at breakfast on circadian typology and mental health of Japanese infants aged 1 - 6 years. An integrated questionnaire was administrated to 1100 infants aged 1 - 6 years attending nursery schools or kindergarten in June 2012. Seven hundred and forty participants (67.3%, 360 females and 380 males, mean age: 3.5 ± 1.4) answered the questionnaire. The questionnaire included questions on sleep habits, the diurnal type scale by Torsvall and Åkerstedt (1980), questions on mental health (anger and depression), and meals contents and time. Infants who took milk at breakfast showed 21.2 (±3.4, n = 537) of the diurnal type scale scores on average which tended to be higher (more morning-typed) than 20.7 (±3.5, n = 142) (p = 0.085) shown by those who did not take milk. Infants who took carbohydrate (or carbohydrate and protein resource) plus milk at breakfast were significantly morning-typed than those who took only carbohydrate (or carbohydrate and protein resource) (p < 0.001). Infants who took milk at breakfast tended to be less frequently depressed than those who did not (p = 0.098). Taking milk at breakfast might be effective to promote serotonin synthesis in the morning which could improve mental health directly and become “inner” zeitgeber for circadian clocks in infants.

Keywords: Cow Milk in the Morning; Circadian Typology; Mental Health; Japanese Infants

Introduction

Breast-milk has been reported to have promoting effects of sleep health in human infants. For example, Engler et al. (2012) suggested that exclusively breast-fed infants had a significantly lower incidence of colic attacks, lower severity of irritability attacks, and a trend for longer nocturnal sleep duration due to a questionnaire study. They reported that breast milk (nocturnal) supplied substantial melatonin, while artificial formulas did not. These results showed melatonin supplied to the infant via breast milk might play a role in improving sleep and reducing colic in breast-fed infants compared to formula-fed ones.

On the other hand, Cubero et al. (2005) also reported similar results about circadian rhythms (daily fluctuation based on the biological clock with period of about one day) of tryptophan level in the breast milk of mothers and also 6-sulfatoxymelatonin circadian rhythm of the breast-fed infants. The tryptophan in the breast milk presented a circadian rhythm with the acrophase (peak time) at around 03:00. This rhythm was followed by the rhythm of the 6-sulfatoxymelatonin with the peak at 06:00 in the infants. This tryptophan intake might promote sleep of them, and assumed sleep, actual sleep, and sleep efficiency were significantly increased in the breast fed infants compared with the formula fed infants. Sánchez et al. (2009) reported that the nucleotides 5'AMP and 5'GMP in the human

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breast milk showed circadian rhythms, the acrophases of the first one being during the night, and of the latter one during the day. While 5'UMP did not show a clear circadian rhythm, there was an increase in its levels at night. The rise in nocturnal levels of 5'AMP, 5'GMP, and 5'UMP could be involved in inducing the "hypnotic" action of breast milk at night in the infant.

How about has been reported the effect of cow's milk on the sleep and mental health (better "mental health" means daytime activity with better concentration, lower level of depression, irritation and anger, well controlled emotion) of infants? Guesdon et al. (2006) augured that cow's milk has long been considered a relaxation beverage with sleep-inducing properties. Already eighty years ago, it was reported that adults consuming a meal of cornflakes and milk exhibited a stronger tendency toward uninterrupted sleep (Laird & Drexel, 1934). Electroencephalography showed that sleep was significantly improved in older people who fed a milk and cereal meal at bedtime (Brezinova & Oswald, 1972).

Tryptophan intake at breakfast has been known to be effective on promoting better mental health and morning-typed life through serotonin and melatonin syntheses (Harada et al., 2007; Nakade et al., 2009, 2012; Wada et al., 2013). For Japanese children, cow milk seems to be important resource for taking tryptophan at breakfast because of limited meal time in the morning. However, there have been no reports on the effect of cow milk intake at breakfast on the effect of circadian typology and mental health of human young children. This study aims to answer the question from the epidemiological point of view.

Methods

Participants

The data used was collected from responses to questionnaires completed in June of 2012 by 740 parents (more than 95% are mothers, response rate: 67.3%) of children aged 1 - 6 (360 girls and 380 boys) in 10 city-run nursery schools and 1 kindergarten affiliated to the Faculty of Education, Kochi University located in Kochi city (33.3˚N).

Materials and Procedure

The questionnaires included The Diurnal Type Scale by Torsvall and Åkerstedt (1980) and a revised version for children (Harada et al., 2007), questions on mental health of the children (such as anger and depression) (Harada et al., 2007) and question for children about breakfast contents. The version for children (Harada et al., 2007) of the Diurnal Type Scale (Torsvall & Åkerstedt, 1980) was used to objectively measure diurnal preference. This part consisted of seven questions: three pertaining to sleep onset, three to sleep offset and one to peak timing of activity. Each question allows for choice (scored from 1 to 4) and the Diurnal Type Scale score was the sum of the 7 answers. Scores ranged from 7 to 28, with lower scores representing evening-types and higher scores representing morning-types. The section of sleep habits consisted of questions on sleep onset and offset timings on weekdays and weekends and questions about the quality of sleep such as mood upon falling asleep and waking up. The data was statistically analyzed using χ^2-tests, Mann-Whitney U-tests, and Kruskal-Wallis test with SPSS 12.0 statistical software. Diurnal Type Scale scores were expressed as means plus or minus the standard deviation (Mean ± SD).

The study followed the guidelines established by the Chronobiology International journal for the conduct of research on human subjects (Portaluppi et al., 2010). Before administrating the questionnaires, each participant (parents or guardians) was given a written explanation that detailed the concepts and purposes of the study and stated that their answers would be used only for academic purposes. After the above explanation, all

Table 1.
Relationship between whether Japanese infants take cow milk (M) and/or produce made from cow milk (PM) at breakfast and dinner and the diurnal scale scores.

M and/or PM		The Diurnal Type Scores			One-Way ANOVA
		mean	s.d.	n	
Breakfast	not taken	20.4	3.6	122	df = 1, F value = 3.49, p = 0.062
	taken	21.1	3.2	323	
Dinner	not taken	20.9	3.3	311	df = 1, F value = 0.21,
	taken	21	3.4	134	p = 0.607
M		The Diurnal Type Scores			One-Way ANOVA
		mean	s.d.	n	
Breakfast	not taken	20.6	3.5	241	df = 1, F value = 3.46,
	taken	21.2	3.1	204	p = 0.063
Dinner	not taken	20.9	3.3	368	df = 1, F value = 0.45,
	taken	21.1	3.6	77	p = 0.504
PM		The Diurnal Type Scores			One-Way ANOVA
		mean	s.d.	n	
Breakfast	not taken	20.8	3.4	192	df = 1, F value = 0.41,
	taken	21	3.3	253	p = 0.524
Dinner	not taken	20.9	3.3	354	df = 1, F value = 0.04,
	taken	21	3.3	91	p = 0.833

parents (or guardians) agreed completely with the proposal. The study was also permitted by the kindergarten nurses' committees of the ten nursery schools and one kindergarten which carried out an ethical inspection of the contents of the questionnaire. As the young children could not complete the questionnaires themselves, their parents or guardians completed them on their behalf.

Results

Infants who took milk at breakfast showed 21.1 (±3.2 of SD, n = 323) of the diurnal type scale scores on average which tended to be higher (more morning-typed) than 20.4 (±3.6, n = 122) ($p = 0.06$) shown by those who did not take milk (**Table 1**).

Japanese infants taking only carbon hydrates (CH: in this case mostly bread and beverage like as fruit juice, with or without gas), carbon hydrates plus cow milk (CH + M), carbon hydrates plus main dish (protein resources) (CH + MD: in this case main menu is bread and boiled rice plus cooked eggs, ham & sausage and fermented soybeans = *Natto* in Japanese, sometimes salmon flakes), carbon hydrates plus main dish plus cow milk (CH + MD + M) showed mean ± SD of the diurnal type scores of 19.0 ± 3.9, 20.6 ± 2.8, 21.0 ± 3.3, 21.3 ± 3.1, respectively (One way ANOVA: df = 3, F = 6.082, $p < 0.001$) (**Figure 1**). Infants who took carbohydrate (or carbohydrate and protein resource) plus milk at breakfast were significantly morning-typed than those who took only carbohydrate (or carbohydrate and protein resource) ($p < 0.001$) (**Figure 1**).

Infants who took milk at breakfast tended to be less frequently depressed than those who did not (χ^2-test, χ^2-value = 6.288, df = 3, $p = 0.098$) (**Figure 2**). Infants who took cow milk at dinner showed less frequency to be anger with a small trigger than those who did not so (χ^2 test: χ^2-value = 9.46, df = 3 $p = 0.024$) (**Figure 3**), and infants who took cow milk and/or product made from cow milk at dinner showed again less frequency to be anger with a small trigger than those who did not so (χ^2 test: χ^2-value = 10.56, df = 3, $p = 0.014$) (**Figure 4**). Morning-typed infants showed less frequency to become anger with a small trigger than those of medium- and evening-typed ones (χ^2 test: χ^2-value=10.71, df = 3, $p = 0.013$) (**Figure 5**).

Discussion

Tryptophan included in cow milk taken at breakfast might be

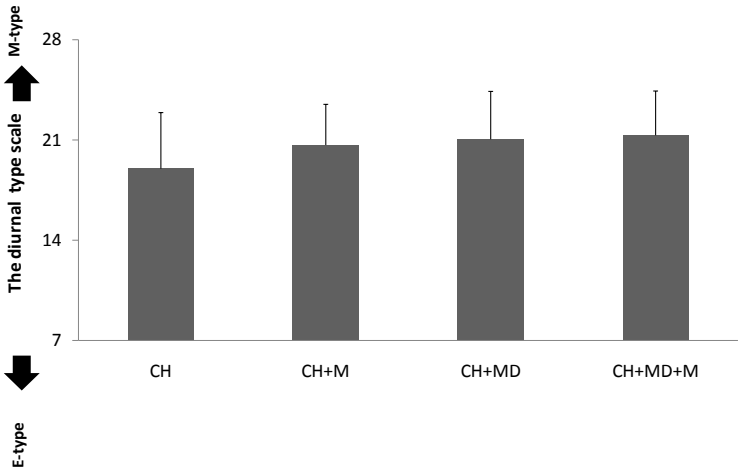

Figure 1.
Several patterns of breakfast contents and the diurnal type scales in Japanese infants. CH: carbon hydrates; CH + M: carbon hydrates plus cow milk; CH + MD: carbon hydrates plus main dish (protein resources); CH + MD + M: carbon hydrates plus main dish plus cow milk.

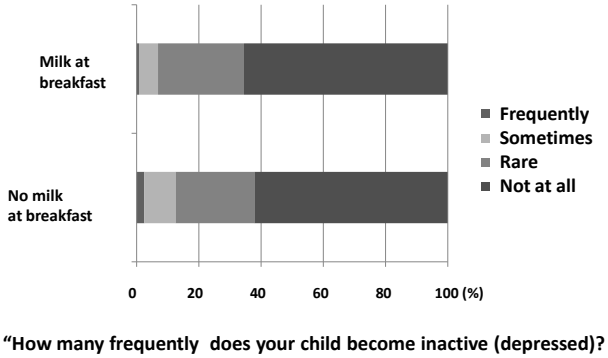

Figure 2.
Relationship between whether Japanese infants take milk at breakfast and the frequency to be inactive (depressed).

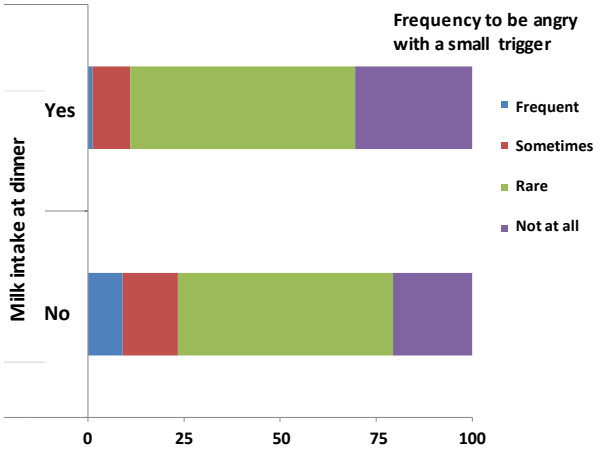

Figure 3.
Relationship between whether Japanese infants take milk at dinner and the frequency to be angry with a small trigger.

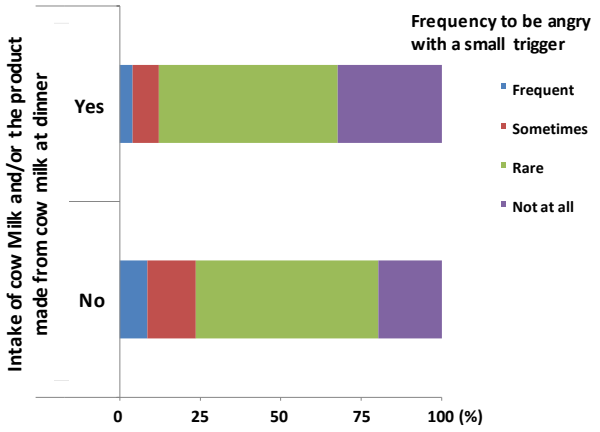

Figure 4.
Relationship between whether Japanese infants take cow milk and/or a product made from milk at dinner and the frequency to be angry with a small trigger.

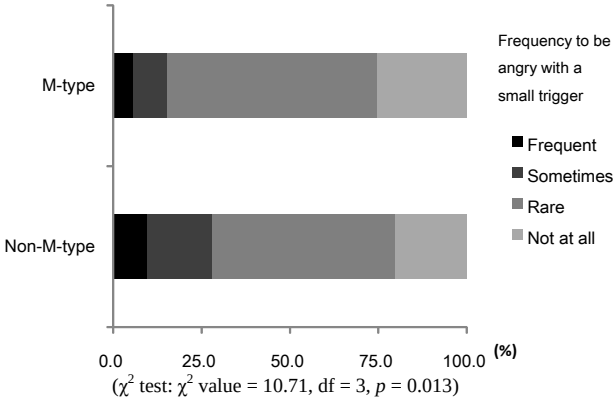

Figure 5.
Relationship between the frequency to be angry with a small trigger and the circadian typology. M-type: 21 - 28 scores of the diurnal type score; Non-M-type: 7 - 20 scores.

effective on promoting better mental health and morning-typed life through serotonin and melatonin synthesis like as other protein resources of fermented soybeans, eggs, dried fishes, hams and so on (Harada et al., 2007; Nakade et al., 2009, 2012; Wada et al., 2013). For Japanese children, cow milk may be important resource for taking tryptophan at breakfast because of limited meal time in the morning.

Taking cow milk promoted the integrated health score consisting of four issues on catching a cold, attack of fever, appetite level, irritation and diarrhea in Japanese infants (Nakagawa, 1991). Intervention study for Japanese elementary school students to which cow milk was supplied revealed that the after-school supply of cow milk promoted the preference to take breakfast and lunch (Ishii et al., 2012), and inter-classes supply in the morning enhanced the concentration into classes after taking cow milk (Ishii et al., 2011) compared with the control group which has not been supplied. However, these physiological and psychological positive effects of cow milk did not mention about "circadian timing" of the milk supplement. This study implies that the "morning supply" of the cow milk is important to promote both physical and mental health of children at first.

Taking milk (tryptophan and Vitamin B6 resource) at breakfast might be effective to promote serotonin synthesis in the morning which could improve mental health directly and become "inner" zeitgeber for circadian clocks in infants.

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