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Sleep Habits and Dietary Intake Among Preschool Children in Qazvin

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Background: Sleep habits and total sleep duration are essential factors for healthy growth and development of children. There is evidence showing that eating time and quantity as well as proportion of foods macronutrients affect the sleep quality.
Objectives: The aim of this study was to investigate the sleep habits of preschool children in Qazvin and the role of calorie, macronutrients and caffeine intake in a mixed normal meal on sleep induction.
Materials and Methods: A total number of 210 children of 3 - 6 years old (108 boys and 102 girls) were randomly selected from a pediatric clinic in the city of Qazvin. Participants' heights and their weights were recorded using standard techniques. Sleep habits questionnaires were filled out and three 24-hour diet-recalls for one weekend and two weekdays were assigned by a trained health worker.
Results: The total night sleep duration, bedtime and wake-up time in the morning were 10.30 ± 1.30 hours, 23.30 ± 1.30 pm and 9.0 ± 1.30 am, respectively. Among all children, 21.9% had sleep onset latency and the bedtime of 56% was 10 pm or later. The results of this study showed no significant relationship between calorie, macronutrients, and caffeine intakes of the children, and the total sleep duration, bedtime, wake-up time, and sleep latency ($P > 0.05$).
Conclusions: Based on the results of this study, no significant relationship was observed between the dietary intake and sleep habits. This might be due to the small sample size or other factors, suggested to be investigated in the future.

Keywords: Pediatric; Sleep; Dietary; Child; Preschool

1. Background

The human sleep-wake pattern is controlled by a biological rhythm (1). Many factors such as socio-cultural aspects, lifestyle of modern culture, seasonal changes, family stress and parents behavior affects the biological rhythm, an important element in a child's growth, especially in the first year of life (1-6). Sleep habits and total sleep duration are essential factors for healthy growth and development of children (1, 7). Recent studies showed that sleep habits affect the child's mood, cognitive function, (8-10) behavior (11), and other health-related issues such as being overweight, obesity (1, 8-10), and diabetes (7). In addition, the child's sleep patterns have a direct effect on the parents' sleep (1, 2, 4). Anecdotal studies suggested that composition of meals and specific types of foods can improve the sleep quality (12). There is evidence showing that eating time and quantity as well as the proportion of food macronutrients affect the sleep quality (12-16). Sleep onset latency was reduced in men after a rich carbohydrate evening meal with a high glycemic index (GI) compared to a low GI, whereas a very low carbohydrate diet over a short period did not affect the bedtime or total sleep duration (17, 18). In another study, nonrapid eye movement (NREM) and total arousal index were higher in children who consumed high GI drinks 1 hour before sleep, compared to the low GI consumers. It seems that the high amount of carbohydrates close to bedtime is accompanied by frequent arousals and may affect the sleep quality (19). It is proposed that the effect of macronutrients on sleep is due to tryptophan (Trp), a precursor for serotonin (an sleep agent). A high glycemic index of carbohydrate showed to increase the ratio of circulating Trp to other large neutral amino acids (LNAA), via a direct action of insulin 2 - 4 hours after a high-carbohydrate, low-protein meal (17, 20, 21). The protein content of a meal is directly related to the plasma Trp level. Thus, a higher portion of protein in a meal reduces Trp to LNAA ratio and influences the concentration of brain serotonin (17, 20). Overall, the ratios of carbohydrates to protein around 5:1, yields notable variations in the ratio of

Implication for health policy/practice/research/medical education:
Regarding the importance of sleep in the first year of life, one of the objectives of Health People up to 2020 is to decrease the number of children with unhealthy sleep patterns and more studies are recommended on this issue. Anecdotal studies suggested that composition of meals and specific types of foods improve the sleep quality. This article focuses on the sleep habits of preschool Iranian children and their association with dietary intake.

Trp to other LNAAs (20, 21). It is shown that a carbohydrate-to-protein ratio of 13:1 in a high-carbohydrate meal significantly enhances the plasma Trp: LNAA ratio, compared to that of before the meal (20). Ingestion of a high-glycemic index, high-carbohydrate, low-protein (8% protein, carbohydrate to protein ratio of 12:1) evening meal 4 hours before bedtime, significantly reduced the sleep onset latency in adults (17). Results of a study performed on children up to 15 years old showed that a morning meal with a high protein and specifically tryptophan, significantly improved the night sleep onset latency; however, no data was presented regarding the relationship of Trp:LNAAs ratio or a possible alternative with morning meals enhancing the night brain serotonin (22). Diethelm et al. (8) showed that an evening meal with a high energy intake, particularly high GI sources and glycemic load (GL) with carbohydrate to protein ratio of 3:1 (15% protein energy) significantly influenced the sleep duration. However, in another study Rontoyanni et al. (23) did not find any association between daily energy intakes of women and sleep duration in a mixed diet with 15% protein energy. In a recent study performed in preschool children, Spruyt et al. (24) showed relations between obesity, obstructive sleep apnea, and dietary and beverage patterns. On the other hand, the mean sleep duration in normal preschool children is 11.5 ± 1.0 hours (25). There are many studies on effects of sleep quality and quantity as well as their relationship with health status (1, 2, 4, 10, 26), but there are a few studies on childhood sleep (1, 2, 4).

2. Objectives

The aim of this study was to investigate the sleep habits of preschool children in Qazvin and their possible association with calorie, macronutrients, and caffeine intake in a mixed normal meal and more specifically, the effect of macronutrients and composition of a day last meal on the sleep induction. It is hypothesized that the composition of meal affects the sleep habits in the children.

3. Materials and Methods

3.1. Study Design and Sampling

This was a cross-sectional study conducted in the city of Qazvin, during 2010. A total of 210 children, 3 - 6 years (108 boys and 102 girls) were randomly selected from a private pediatric clinic in Qazvin.

3.2. Procedure

At the beginning, parents were informed about the importance of sleep and dietary intake in preschool children. Only children whose parents were willing to participate and signed the informed consent were recruited. Afterwards, they were visited by a pediatrician and those with known medical conditions such as diabetes, cardiovascular diseases, failure to thrive (FTT), attention deficit hyperactivity disorder (ADHD), and depression or those on medication for sleep problems were excluded. Participants' heights and weights were recorded using standard techniques, and sleep habit questionnaires and three 24-hour diet-recalls for one weekend and two weekdays were completed by a trained health worker in an interview with children's mothers.

3.3. Statistical Analysis

Analysis of the dietary data was carried out using Nutritionist IV (diet analysis version 3.5.2, US Department of Agriculture) diet analysis software, in which the food composition table of Iran was inserted. Statistical analysis was performed using the paired t-test, Wilcoxon signed-rank test, and Pearson correlation coefficient (SPSS version 12, Inc. Chicago, IL, USA). Data are expressed as mean ± SD and Median ± IQR. The one-sample Kolmogorov-Smirnov test can be used to assess the normal distribution of variables. P value ≤ 0.05 was considered significant.

3.4. Findings

General information of the samples is presented in Table 1. The means of age, weight, height and BMI of children were 4.17 ± 0.8 years, 16.50 ± 4 kg, 107.10 ± 11.51 cm, and 14.61 ± 1.99 kg/m^2, respectively. The daily energy, macronutrients, and caffeine intake of the children and the last meal during weekdays and weekends are presented in Table 2. There was no significant difference between the daily energy, macronutrients, and caffeine intake in the regular and last meals during weekdays and weekends. The sleep habits of children are presented in Table 3. No significant difference was observed between the sleep habits of the children in weekdays and weekends. The total night sleep duration, bedtime, and wake-up time were 10.30 ± 1.30 hours, 23.30 ± 1.30 pm, and 9.00 ± 1.30 am, respectively. In addition, 21.9% of the children had sleep onset latency and in 56% the bedtime was 10 pm or later. The associations between energy, macronutrients, and caffeine intake of the children and the sleep habits are presented in Table 4. No association was seen between energy, macronutrients, and caffeine intake of the children and the total sleep duration, bedtime, and sleep latency. Comparisons of the average of nocturnal sleep, onset and wake-up times between preschool children in Iran and other countries are demonstrated in Table 5.

Table 1. Demographic Characteristics of 3 – 6 Years Old Children in the City of Qazvin (n = 210)

Variables	Mean ± SD	CI [a] 95%
Age	4.17 ± 0.8	(4.1 - 4.3)
Height, cm	107.10 ± 11.5	(105.4 - 108.6)
Weight, kg	16.50 ± 4.0	(15.9 - 17.0)
BMI [a], kg/m^2	14.61 ± 1.99	(14.3 - 14.8)

[a] Abbreviation: BMI, body mass index, CI, confidence interval.

Table 2. Mean and Standard Deviation (Confidence Interval) of Energy, Macronutrients, and Caffeine Intake of 3 - 6 Years Old Children in the City of Qazvin (n = 210)

	Calorie, kcal	Carbohydrate, g	Protein, g	Fat, g [b]	Caffeine, mg [b]
Week days					
Mean ± SD	1070 ± 464	137.0 ± 64	40 ± 20	35 ± 22	21 ± 12
CI [a]	1006.8 - 1133.1	128.3 - 145.7)	37.3 - 42.7	-- [c]	--
P value	0.982	0.888	0.617	0.825	0.430
Weekends					
Mean ± SD	1069 ± 453	137.9 ± 67	41 ± 21	34.5 ± 22	20 ± 11
CI	1007.4 - 1130.6	128.8 - 147.0	38.1 - 43.9	--	--
P value	0.982	0.888	0.617	0.825	0.430
Week Days Last Meal [b]					
Mean ± SD	168.9 ± 14.8	18.2 ± 5.1	8.5 ± 3.8	4.6 ± 3.7	0.00
CI	166.9 - 170.9	17.5 - 18.9	7.9 - 9.1	--	--
P value	0.080	0.460	0.400	0.165	--
Weekends Last Meal [b]					
Mean ± SD	166.7 ± 11.1	18.6 ± 6.1	8.1 ± 5.8	4.3 ± 5.7	0.00
CI	165.2 - 168.2	17.8 - 19.4	7.3 - 8.9	--	--
P value	0.080	0.460	0.400	0.165	--

[b] Median ± IQR.
[a] Abbreviation: CI, confidence interval.
[c] No information is available.

Table 3. Total Night Sleep Durations, Bedtimes, and Wake-up Times of 3 - 6 Years Old Children in the City of Qazvin (n = 210)

Days	Week days, [range]	Weekends, [range]	P Value	Average
Total night sleep duration, h	10 ± 1 [9.9 - 10.1]	11 ± 2 [10.7 - 11.3]	< 0.001	10:30 ± 1:30
Bed time, pm	23 ± 2 [22.7 - 23.3]	24 ± 1 [23.9 - 24.1]	< 0.001	23:30 ± 1:30
Wake up time, am	8 ± 2 [7.7 - 8.3]	9 ± 1 [8.9 - 9.1]	< 0.001	9:00 ± 1:30

Table 4. The Correlation Between Calorie, Macronutrients, and Caffeine Intake Based on a 24-hour Diet Recall and Sleep Habits of Children

Diet Composition	Total Night Sleep Duration	Bedtime, pm	Sleep Onset Latency, min
Calorie, kcal			
R [a]	0.1	0.1	0.1
P value	0.050	0.061	0.010
Carbohydrate, g			
R	0.1	0.1	0.1
P value	0.050	0.042	0.072
Protein, g			
R	0.1	0.1	0.1
P value	0.082	0.040	0.900
Fat, g			
R	0.08	0.1	0.1
P value	0.600	0.050	0.030
Caffeine, mg			
R	0.04	0.01	0.04
P value	0.080	0.070	0.200

[a] Spearman correlation coefficient.

Table 5. The Average Nocturnal Bedtime and Wake-up Times in the Literature [a]

Study Country	Year	Age	Total Night Sleep Duration	Wake up Time, am	Bedtime
Switzerland	1984	3 y	11:22	7:00	19:38
France	1991	3 y	11:18	7:18	20:00
Italy	1996	25 - 48 mo	9:20	7:08	21:48
USA	1995	3 y	10:00	7:42	21:42
USA	2000	36 mo	9:54	7:05	21:11
Japan (urban areas)	1999	42 - 43 mo	10:04	7:28	21:24
Japan (rural areas)	1999	42 - 43 mo	9:46	7:01	21:15
Japan (Tokyo)	1999 - 2000	3 y	10:04	7:48	21:44
Iran (Tehran)	2007	2 - 6 y	9:38	8:30	22:52
Iran, urban areas (Qazvin) [b]	2009	3 - 6 y	9:34	8:18	22:44
Current study, Iran urban areas, Qazvin	2010	3 - 6 y	9 :30	9:00	23:30

[a] Data are extracted from (25).
[b] Data are for weekdays.

5. Discussion

The sleep-wake pattern is an important factor for healthy growth and development of a child (1, 2, 4, 5, 7), with a direct effect on parents sleep (1, 2, 4). Regarding the importance of sleep in the first year of life, one of the objectives of Health People up to 2020 would be to decrease the number of unhealthy sleep cases in children and more studies are recommended on this issue (27). Based on the present study, the average total sleep time of preschool children was 10.30 ± 1.30 hours which was lower than the 11 – 12-hour sleep duration recommended for this age (27, 28). Compared to the previous studies in Iran, children of this study showed higher total night sleep duration, but later bedtime. However, the data corresponded with Mohammadi et al. (2) and Jalilolghadr et al. (5) results. A previous study in Iran showed that 85% of regular nap takers had bedtime of 22 pm or later (5). In the current study, 56% of children had bedtime of 22 pm or later, similar to Japanese children of 2 - 3 years (26). Surprisingly in 1990, 4.1% of 2 - 3 years Australian children had bedtime of 22 pm or later (5). In the current study, there was no significant relationship between the bedtime and BMI of the children, similar to 3 years old Japanese children (26). The increasing bedtime in last three decades might be due to the modern life style in urban regions including 24-hour commercialized societies (6, 7, 26, 29).

Results of the current study showed carbohydrate to protein ratio of < 4 in the ingested foods during a day and in the last meal, i.e. 14% protein energy during the entire day and 23% in the last meal was a pretty high-protein diet. Regarding the effects of energy intake, macronutrients, and caffeine, no significant correlations were observed between the energy intake, meal composition, and sleep habits of the children, similar to the Rontoyanni et al. findings (23). There was no association between macronutrients of the diet, containing carbohydrate-to-protein ratio of 3:1 (i.e. 15% protein energy) and the sleep duration of women. However, Harada et al. (22) demonstrated that higher tryptophan intake in the morning, which means higher percentage of protein, significantly reduced the night sleep latency in children. Diethelm et al. (8) found that an evening meal containing carbohydrate-to-protein ratio of 3:1, i.e. 15% protein energy significantly increased the night sleep duration in early childhood. There might be a specific mechanism for sleep inducing effects of proteins in children, which needs further investigations.

Limitations of the current study were that the selected sample was not representative of Iranian preschool children and the study was conducted in the summer and temperature affects the sleep. It is concluded that there is no significant relationship between calorie, macronutrients, and caffeine intake of children and total sleep duration, bedtime, wake-up time, and sleep latency in preschool children. Further studies are required with larger sample sizes to assess different factors including socio-cultural aspects, co-sleeping with parents, life style of modern culture, and climate differences as well as their possible relationships with sleep habits of Iranian children.

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Authors' Contribution

Maryam Javadi: conducted the research design and

literature review, and prepared the first and final draft of the manuscript. Naser Kalantari: conducted the research design and revised the final manuscript. Shabnam Jalilolgadr: conducted the research design and literature review and revised the manuscript. Nasrin Omidvar: consultant and reviser of the manuscript. Bahram Rashidkhani: data analysis. Parisa Amiri: consultant and reviewer of the manuscript.

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