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Original Article

Preschool children's eating and sleeping habits: late rising and brunch on weekends is related to several physical and mental symptoms

Kazuhiko Fukuda [a,*], Tomoko Hasegawa [b], Ikko Kawahashi [c], Sumio Imada [d]

[a] *Department of Psychology and Humanities, College of Sociology, Edogawa University, Japan*
[b] *Department of Human Sciences, Faculty of Psychology and Sociology, Taisho University, Japan*
[c] *Department of Psychology, Faculty of Psychology, Meiji Gakuin University, Japan*
[d] *Department of Psychology, Faculty of Health Sciences, Hiroshima Shudo University, Japan*

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ABSTRACT

Objective: As the relationships of sleep-wake schedule and mealtime with children's behaviors have not often been studied together, we investigated the relationships of these lifestyles variables with preschool children's well-being.
Methods: Using a network survey, we investigated several lifestyle variables of 1000 families with preschool children.
Results: Our previous articles reported that preschool children's bedtime was delayed by the compulsory nap routine in Japanese nursery schools. The present study revealed similar results. We conducted a cluster analysis with children's meal and sleep time data, which yielded five different lifestyle groups. Cluster 1 was characterized by “extremely late and irregular” meal and sleep times; similar to Cluster 1, Cluster 2 was a “late and irregular” lifestyle group. Cluster 3 was a “mildly late” lifestyle group. Cluster 4 was an “early bird and regular lifestyle” group, and Cluster 5 resembled the “early bird and regular lifestyle” group on weekdays, but was “late and irregular on weekends.” It was found that the later and more irregular the children's meal and sleep times, the worse their physical and mental condition. Even for Cluster 5, the children who had early and regular meal and sleep times on weekdays, getting up and having breakfast late and irregularly on weekends showed worse physical and mental conditions. These problematic symptoms observed in children with late meal and sleep times on weekends might be partly associated with the irregularity of their habits and partly associated with delayed mealtime, especially for breakfast (brunch).
Conclusion: A stable lifestyle, including a regular sleep and wake schedule and mealtime, is important for preschool children's mental and physical health.

1. Introduction

In Japan, teachers and educational researchers have paid close attention to students who do not have breakfast. Eating education, called *Shokuiku*, meaning “education for eating, food, and nutrition” is now very popular in Japanese schools. *Shokuiku* educational practice is promoted by a law called *Shokuiku Kihon Ho*, Basic Law of Food Education, which was enacted in 2005 [1,2]. *Shokuiku* practice is aimed at enhancing the quality of life and preventing obesity and lifestyle diseases through education of children, families, and the local community, including non-profit organizations and food companies [3,4]. In *Shokuiku* educational practice, although the importance of eating, nutritional knowledge, and the social and cultural aspect of eating (eg, communicating with family members during meals) is emphasized, the timing aspect of meals is frequently overlooked.

Additionally, delayed and disturbed sleep is known to be closely related to undesirable symptoms in children [5–7] as well as their scholastic achievements [8–10]. Disturbed sleep patterns have been shown to contribute to children's morning moodiness, unwillingness to go to school [5,6], poor resilience [7], hyperactivity/inattention [7], and chronic fatigue syndrome [11]. Children's sleep problems are associated with undesirable symptoms in children, as well as family problems [12,13].

* Corresponding author. 474 Komagi, Nagareyama, Chiba, 270-0198, Japan.
E-mail address: kfukuda@edogawa-u.ac.jp (K. Fukuda).

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Sleep pattern and mealtime are closely associated with each other [14]. While the two behaviors are linked, these two fundamental behaviors have not been fully examined in a single study. They have primarily been examined individually, [15–18]. There is research which has demonstrated a close relationship between children's sleep and feeding disturbances [19]. Mealtimes have been shown to have effects on circadian rhythm in mice [20] and humans [21]. These studies suggest that mealtime has effects on peripheral clocks but not directly on the master clock (the Suprachiasmatic Nucleus, SCN) resulting in internal desynchronization, which is thought to be an underlying factor in problems of health [22] and school achievement [23]. Therefore, meal and sleep time should be given greater attention and importance by those engaged in childhood education.

Japanese nursery schools have adopted an obligatory afternoon nap routine for children. Previous research has demonstrated that regular afternoon naps in nursery schools contributed to delayed bedtime in children [6,12]. We also have to consider which preschool institute the children attend as important for analyzing preschool children's sleep pattern.

In the present study, we aimed to investigate children's meal and sleep times, and their relationship with children's mental and physical health.

2. Methods

2.1. Procedure

We conducted a network survey, recruiting survey participants through a database offered by a network survey company. The survey consisted of items related to sociodemographic variables of the family (ie, parent and child age; child gender; annual family income; academic qualifications of the parents; body mass index of the mother and the child), as well as time variables for sleep (wake time and bedtime) and for meals (breakfast, lunch, and supper) on weekdays and weekends. Additionally, the survey included items related to the physical and mental well-being of the target children (ie, a tendency toward poor health, tendency to catch colds, morning moodiness, fear of novelty, attention deficit, mental stability, fear of new food, and restlessness during meals [24]; actual questions used in the study are available in The Appendix). Other items related to the mother's stress over raising children, attitudes about preparing meals and picky eating, and other life patterns of the mother.

2.2. Participants

Participants were randomly selected from the database, based on the inclusion criteria of being a mother aged 25–44 years old, living in a two-generation family and with three or fewer children, one of them being one to five years old. We surveyed mothers with three or fewer children because there are very few (4%) mothers who have more than three children in Japan. Participants with two or three children were asked to answer questions about their youngest child. Based on the child's age (1–2 years, 2–3 years, 3–4 years, 4–5 years, and 5–6 years), there were five groups of participants of 200 families each, resulting in a total sample of 1000 families. In each age group, half ($n = 100$) of the families had children who attended nursery schools that imposed regular lengthy afternoon naps on children; only children with working mothers are allowed to attend these schools.

The remaining half had children who stayed at home or attended a kindergarten, only during morning hours. In Japan, nursery schools and kindergartens are administered under different regulations. Kindergartens are educational institutions that are supervised by the Ministry of Education, Culture, Sports, Science and Technology, where children are taken care of mostly during morning hours, while nursery schools, which are supervised by the Ministry of Health, Labour and Welfare, take care of children from 9 a.m. to 5 p.m. or later. In almost all nursery schools, the children routinely take an afternoon nap for about one and a half hours. As Japanese nursery schools are regarded as institutes for taking care of children, only children, both of whose parents work outside the home, are allowed to attend. Three to six-year-old children may attend nursery school for three years (from three to six years of age), two years (four to six years of age), one year (five to six years of age), or not at all, according to their parents' decision. It is not compulsory to attend such institutes, but at present most children in Japan attend one.

Of the 1000 families, we excluded five families due to inconsistencies (eg, later supper than bedtime) in their data. An additional 38 families were excluded due to insufficient data. The mean age of the mothers was 35.9 (SD = 4.3; minimum–maximum: 25–44) years, and that of the children was 4.0 (SD = 1.4; minimum–maximum: 1.5–6.5) years. The demographic variables of the children in each group are shown in Table 1. These families agreed to take the survey after being informed of the

Table 1
Demographic data of the target children and mothers.

Age Grade	Age (years)[a]	Boys (n)	Girls (n)	Total (n)	mother's age (mean ± sd)[b]	mother's BMI (mean ± sd)[c]
Nursery School Children (with an obligatory afternoon nap):						
1: 1–2 years old	2.1 (1.5–2.5)	45 (47.4%)	50 (52.6%)	95 (100%)	34.5 ± 4.42	20.2 ± 2.35
2: 2–3 years old	3.1 (2.6–3.5)	58 (59.8%)	39 (40.2%)	97 (100%)	34.8 ± 4.61	20.6 ± 3.07
3: 3–4 years old	4.0 (3.5–4.5)	48 (51.1%)	46 (48.9%)	94 (100%)	35.7 ± 4.51	20.8 ± 3.19
4: 4–5 years old	5.1 (4.6–5.5)	46 (46.9%)	52 (53.1%)	98 (100%)	37.3 ± 3.84	21.2 ± 3.55
5: 5–6 years old	6.1 (5.6–6.5)	48 (50.0%)	48 (50.0%)	96 (100%)	37.8 ± 4.25	21.1 ± 3.01
Total number		245 (51.0%)	235 (49.0%)	480 (100%)		
Kindergartners and Others: (without obligatory naps):						
1: 1–2 years old	2.0 (1.5–2.5)	47 (48.5%)	50 (51.5%)	97 (100%)	34.0 ± 4.25	20.8 ± 2.90
2: 2–3 years old	3.0 (2.5–3.5)	46 (50.5%)	45 (49.5%)	91 (100%)	34.3 ± 3.97	21.0 ± 3.31
3: 3–4 years old	4.0 (3.5–4.5)	51 (53.1%)	45 (46.9%)	96 (100%)	36.9 ± 3.77	20.7 ± 2.44
4: 4–5 years old	5.0 (4.6–5.5)	48 (49.5%)	49 (50.5%)	97 (100%)	36.4 ± 3.67	20.9 ± 3.02
5: 5–6 years old	6.0 (5.5–6.5)	39 (40.6%)	57 (59.4%)	96 (100%)	36.7 ± 4.29	20.9 ± 3.33
Total number		231 (48.4%)	246 (51.6%)	477 (100%)		

[a] The Japanese academic year begins in April, and this survey was conducted in October. Age grade was determined according to this academic year grade. Children in each year grade on average earned six months of age at the time of this survey, so we showed actual ages in each age grade. Children's minimum and maximum ages were presented in parentheses.
[b] Mother's age was significantly different among children's age groups [$F(4, 947) = 20.317$, $p < 0.001$]. Mother's age was not different between the two institute groups [$F(1, 947) = 1.794$, $p = 0.181$].
[c] Mother's BMI was not different among children's age groups [$F(4, 947) = 1.035$, $p = 0.388$]. Mother's BMI was not different between the two institute groups [$F(1, 947) = 0.335$, $p = 0.563$].

purpose of the survey and its confidential and voluntary nature. The instructions included a statement about the participants' right to withdraw their participation and quit the survey at any time during the study. The ethical review board of Edogawa University approved the current protocol.

2.3. Statistical analyses

We conducted a cluster analysis using variables related to meal and sleep time to classify the lifestyle of the families. The variables included wake time, bedtime, time of breakfast, time of lunch, and time of supper, on both weekdays and weekends, and their variability. These data were converted into the decimal system; the variability of sleep and meal time was rated by alternative judgment (variable or constant). This judgment was made by the mothers. While we used a ratio scale for the time data, for the variability data we used an ordinal scale. Ordinary hierarchical cluster analysis could not be applied. We employed a “two-step cluster analysis,” [25,26] which can simultaneously deal with ordinal and ratio scales on our statistical system (IBM SPSS Ver. 25). ANOVA and chi-squared analyses were used to investigate the differences among the classified groups. IBM SPSS Statistics Ver. 25 was used for these analyses. A p-value of <0.05 was considered statistically significant.

3. Results

3.1. Kindergartners and nursery school children

We compared the bedtime of children attending nursery schools and that of others (mostly those attending kindergartens or staying at home). Fig. 1 shows the average weekday bedtime of both groups at different ages. The kindergartners (without regular afternoon naps) group's weekday bedtime became earlier as they grew older, probably due to the disappearance of natural diurnal naps. While in the nursery school children (with regular afternoon naps) group, the weekday bedtime remained constant in all age groups, probably due to the compulsory regular afternoon naps in nursery schools. The main effects of the type of institute factor (nursery school or others) and the interaction of the factors (type of institute and age grade) were significant [type of institute: $F(1, 947) = 44.588$, $p < 0.001$, $\eta^2_p = 0.045$; interaction: $F(4, 947) = 3.501$, $p = 0.008$, $\eta^2_p = 0.015$].

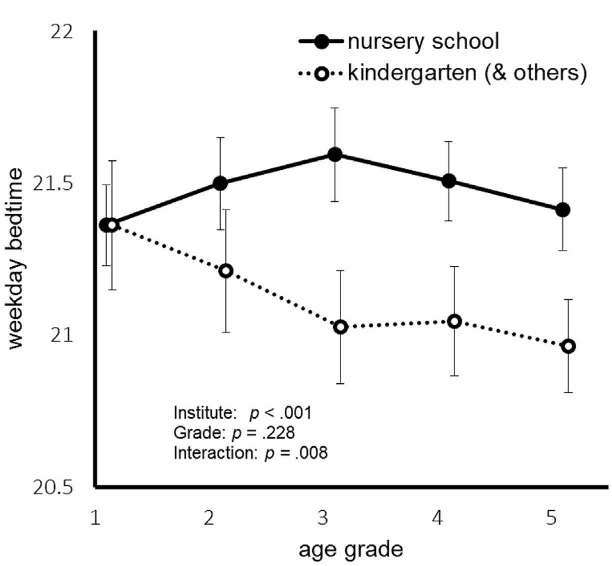

Fig. 1. Weekday bedtime for nursery school children and others (kindergartners and children staying at home) in each age grade. Error bars indicate the 95% confidence interval.

We conducted a one-way ANOVA for bedtime of children by age group, separately in each institute group. Levene's test for equality of variance showed no significant difference in variance in both groups (for the nursery school children: $p = 0.518$, for the kindergartners: $p = 0.148$). The one-way ANOVA found no significant differences for the nursery school children group, $F(4, 475) = 1.574$, $p = 0.180$, but significant differences for the kindergartners, $F(4, 472) = 2.963$, $p = 0.019$, $\eta^2 = 0.024$). In the Kindergarten Group, the group of Age Grade 1 significantly slept later than groups of Age Grade 03, 04, and 05 (LSD, $p = 0.012$, $p = 0.018$, and $p = 0.003$, respectively). ANOVA is known to be relatively robust against violations of normality of the residuals. We also checked the residual normality using the Kolmogorov–Smirnov test. This test revealed that the data were not normally distributed. Thus, we applied the Kruskal–Wallis test on this data. There was no significant difference in the kindergartners, $H(4) = 4.596$, $p = 0.331$, while there was a significant difference in the nursery school childrens weekday bedtime, $H(4) = 9.865$, $p = 0.043$.

3.2. Classification of lifestyle

The two-step cluster analysis revealed five groups of families with different lifestyles (Fig. 2).

Levene's test for equality of variance revealed no difference in variances of the variables of weekday and weekend suppertime ($p = 0.129$, $p = 0.506$, respectively); however, there were significant differences in variances of the variables of weekday wake time, bedtime, and breakfast time ($p < 0.001$, $p = 0.005$, and $p < 0.001$, respectively) and of weekend wake time, bedtime, and breakfast time ($p = 0.002$, $p = 0.026$, and $p = 0.001$, respectively). We applied Welch's ANOVA to these variables. There are significant differences in all variables: weekday wake time: $F(4, 405.180) = 21.425$, $p < 0.001$, $\eta^2 = 0.097$, weekday bedtime: $F(4, 398.026) = 31.490$, $p < 0.001$, $\eta^2 = 0.133$, weekday breakfast time: $F(4, 403.116) = 16.635$, $p < 0.001$, $\eta^2 = 0.082$, weekday suppertime: $F(4, 400.115) = 11.797$, $p < 0.001$, $\eta^2 = 0.052$. Weekend wake time: $F(4, 395.220) = 36.644$, $p < 0.001$, $\eta^2 = 0.156$, weekend bedtime: $F(4, 397.901) = 43.916$, $p < 0.001$, $\eta^2 = 0.177$, weekend breakfast time: $F(4, 398.266) = 48.898$, $p < 0.001$, $\eta^2 = 0.193$, weekend suppertime: $F(4, 398.311) = 14.061$, $p < 0.001$, $\eta^2 = 0.063$. In addition, we checked the residual normality using the Kolmogorov–Smirnov test. The test revealed the data were not normally distributed. Thus, we applied the Kruskal–Wallis test to the same data. All eight variables showed significant differences among five clusters (weekday wake time: $H[4] = 84.974$, $p < 0.001$; weekday bedtime: $H[4] = 110.505$, $p < 0.001$; weekday breakfast time: $H[4] = 63.037$, $p < 0.001$; weekday supper time: $H[4] = 43.431$, $p < 0.001$; weekend wake time: $H[4] = 132.952$, $p < 0.001$; weekend bedtime: $H[4] = 151.730$, $p < 0.001$; weekend breakfast time: $H[4] = 182.161$, $p < 0.001$; weekend supper time: $H[4] = 56.452$, $p < 0.001$).

We compared the percentages of the children with irregular habits of wake time, bedtime, time of breakfast, and time of supper (Fig. 3). There are significant differences between the five clusters concerning these four variables both on weekdays and weekdays (Weekdays; wake time: $\chi^2 = 235.918$, $df = 4$, $p < 0.001$, bedtime: $\chi^2 = 386.847$, $df = 4$, $p < 0.001$, time of breakfast: $\chi^2 = 565.233$, $df = 4$, $p < 0.001$, time of supper: $\chi^2 = 249.115$, $df = 4$, $p < 0.001$, Weekend; wake time: $\chi^2 = 565.233$, $df = 4$, $p < 0.001$, bedtime: $\chi^2 = 474.745$, $df = 4$, $p < 0.001$, Time of breakfast: $\chi^2 = 767.956$, $df = 4$, $p < 0.001$, Time of supper: $\chi^2 = 520.537$, $df = 4$, $p < 0.001$). Cluster 1 was the most irregular concerning all four variables on both weekday and

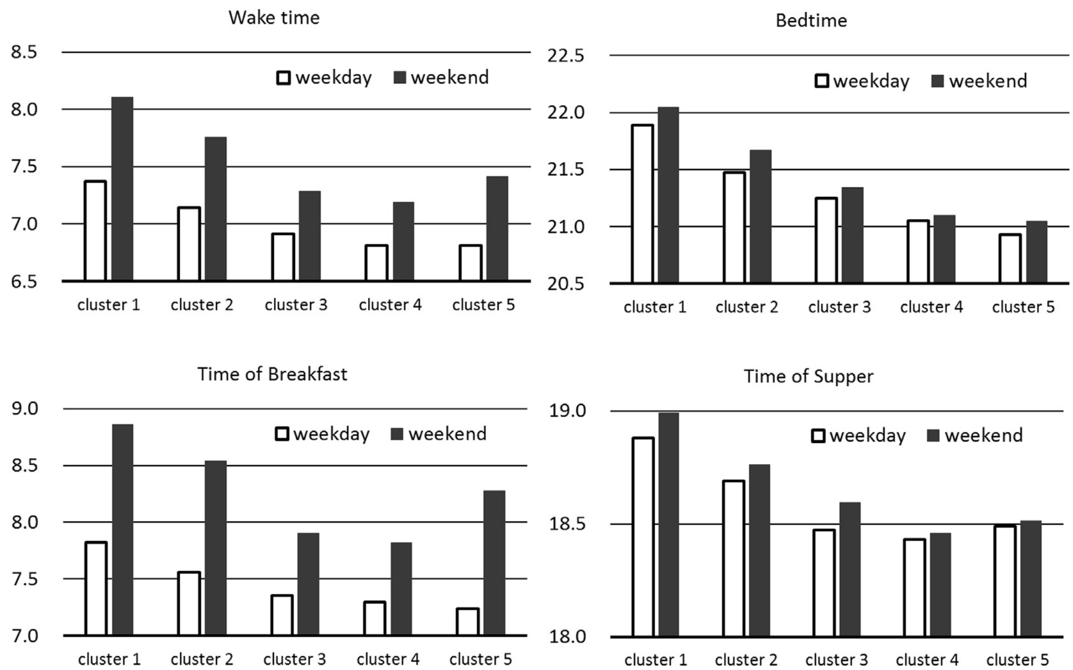

Fig. 2. Mean values of wake time, bedtime, time of breakfast, and time of supper in the five clusters.

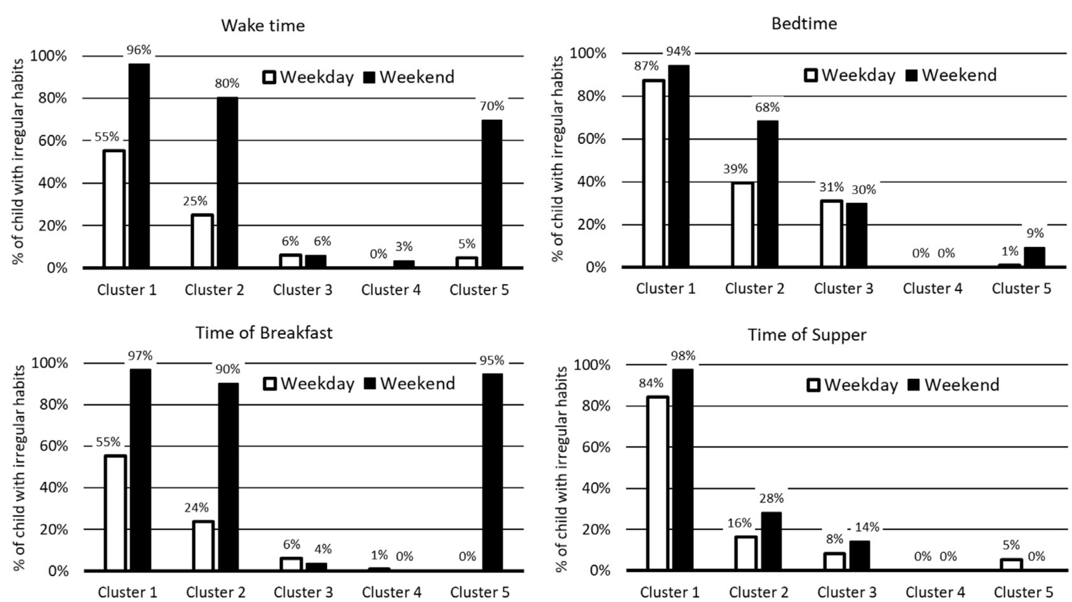

Fig. 3. Percentage of children with irregular wake time, bedtime, time of breakfast, and time of supper in the five clusters.

weekend. Cluster 2 was the second most irregular with these variables. Cluster 3 was not so irregular. Cluster 4 showed the most regular habits with all the four variables both on weekday and weekend. Cluster 5 was quite regular on weekday, but very irregular on weekends, especially with wake and breakfast time.

This analysis was conducted to show the characteristics of the 5 clusters using the variables with which we conducted the cluster analysis. We additionally conducted one-way ANOVAs with several demographic variables (ie, children's age in months, mothers' age, fathers' age, mothers' BMI, and children's corrected BMI). The ANOVAs revealed significant differences in mothers' BMI, $F(4, 911) = 3.416$, $p = 0.009$, $\eta^2 = 0.015$) between the five clusters. Levene's test showed a significant difference in the variance of mothers' BMI ($p = 0.020$). We re-calculated Welch's ANOVA on mothers' BMI and found there were significant difference between the five clusters, $F(4, 391.976) = 3.445$, $p = 0.009$. Post hoc comparisons (Games-Howell) revealed significant differences between Cluster 2 and 4 ($p = 0.018$), and between 2 and 5 ($p = 0.030$). The mothers of Cluster 2 weighed more than the mothers of Cluster 4 and 5.

3.3. *Weekday routine*

The weekday wake time, bedtime, breakfast time, and suppertime of Cluster 1 were significantly later than almost all the other clusters (Games-Howell, wake time: $p = 0.041$, bedtime: $p < 0.001$, and breakfast time: $p = 0.020$), but suppertime showed no significant difference with Cluster 2 ($p = 0.115$). Almost all the time variables of Cluster 2 were significantly later than those of Clusters 3, 4, and 5 (wake time: $p = 0.002$, $p < 0.001$, $p < 0.001$, respectively; bedtime: $p = 0.023$, $p < 0.001$, and $p < 0.001$, respectively; breakfast time: $p = 0.005$, $p < 0.001$, $p < 0.001$, respectively; supper time: $p = 0.018$, $p < 0.001$, $p = 0.029$, respectively), but earlier than those of Cluster 1 (wake time: $p = 0.041$; bedtime: $p < 0.001$; breakfast time: $p = 0.020$; supper time: $p = 0.115$). The weekday bedtime of Cluster 3 was significantly later than that of Cluster 5 ($p = 0.001$), but earlier than that of Clusters 1 and 2 ($p < 0.001$, $p = 0.023$, respectively). The weekday wake time, breakfast time, and suppertime of Cluster 3 were significantly earlier than those of Clusters 1 and 2 (wake time: $p < 0.001$, $p = 0.002$; breakfast time: $p < 0.001$, $p < 0.001$; supper time: $p < 0.001$, $p = 0.018$, respectively), but were not significantly different from Clusters 4 and 5 (wake time: $p = 0.382$, $p = 0.374$; breakfast time: $p = 0.846$, $p = 0.311$; supper time: $p = 0.968$, $p = 1.000$, respectively). The weekday wake time, breakfast time, suppertime, and bedtime of Cluster 4 were significantly earlier than those of Clusters 1 and 2 (wake time: $p < 0.001$, $p < 0.001$; breakfast time: $p < 0.001$, $p < 0.001$; supper time: $p < 0.001$, $p < 0.001$, bedtime: $p < 0.001$, $p < 0.001$, respectively), but had no significant differences from Clusters 3 and 5 (wake time: $p = 0.382$, $p > 0.999$; breakfast time: $p = 0.846$, $p = 0.893$; supper time: $p = 0.968$, $p = 0.905$, bedtime: $p = 0.092$, $p = 0.499$, respectively). The weekday wake time, breakfast time, and suppertime of Cluster 5 were significantly earlier than those of Clusters 1 and 2 (wake time: $p < 0.001$, $p < 0.001$; breakfast time: $p < 0.001$, $p < 0.001$; supper time: $p < 0.001$, $p = 0.029$, respectively), but were not significantly different from Clusters 3 and 4 (wake time: $p = 0.374$, $p = 1.000$; breakfast time: $p = 0.311$, $p = 0.893$; supper time: $p = 1.000$, $p = 0.905$, respectively). The weekday bedtime of Cluster 5 was earlier than that of Clusters 1, 2, and 3 ($p < 0.001$, $p < 0.001$, $p = 0.001$, respectively), but had no significant difference from Cluster 4 ($p = 0.499$). These results are summarized in Table 2.

3.4. Weekend routine

The weekend wake time, bedtime, breakfast, and suppertime of Cluster 1 were significantly later than those in the other four clusters (Games-Howell, wake time: $p = 0.003$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively; breakfast time: $p = 0.018$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively; supper time: $p = 0.049$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively; bedtime: $p = 0.001$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively). Almost all the time variables of Cluster 2 were significantly later than those of Clusters 3, 4, and 5 (wake time: $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively; breakfast time: $p < 0.001$, $p < 0.001$, $p = 0.008$, respectively; bedtime: $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively), but earlier than those of Cluster 1 (wake time: $p = 0.003$; breakfast time: $p = 0.018$; bedtime: $p = 0.001$), with the exception being that weekend suppertime was not different from that of Cluster 3 ($p = 0.118$). The weekend wake time of Cluster 3 was significantly earlier than that of Clusters 1 and 2 ($p < 0.001$, $p < 0.001$, respectively), but was not significantly different from Clusters 4 and 5 ($p = 0.627$, $p = 0.554$, respectively). The weekend bedtime of Cluster 3 was significantly earlier than that of Clusters 1 and 2 but later than that of Clusters 4 and 5 ($p < 0.001$, $p < 0.001$, $p = 0.008$, $p = 0.002$, respectively). The weekend breakfast time of Cluster 3 was significantly earlier than Cluster 1, 2, and 5, but was not significantly different from Cluster 4 ($p < 0.001$, $p < 0.001$, $p < 0.001$, $p = 0.798$, respectively). The weekend suppertime of Cluster 3 was significantly earlier than Cluster 1, but was not significantly different from other clusters ($p < 0.001$, $p = 0.118$, $p = 0.256$, $p = 0.856$, respectively). The weekend wake time and breakfast time of Cluster 4 were significantly earlier than that of Clusters 1, 2, and 5 (wake time: $p < 0.001$, $p < 0.001$, $p = 0.032$, respectively; breakfast time: $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively), but was not significantly different from Cluster 3 (wake time: $p = 0.627$; breakfast time: $p = 0.798$). The weekend bedtime of Cluster 4 was significantly earlier than that of Clusters 1, 2, and 3 ($p < 0.001$, $p < 0.001$, $p = 0.008$, respectively), but was not significantly different from Cluster 5 ($p = 0.957$). The weekend suppertime of Cluster 4 was significantly earlier than Clusters 1 and 2 ($p < 0.001$, $p < 0.001$, respectively), but was not significantly different from that of Clusters 3 and 5 ($p = 0.256$, $p = 0.930$, respectively). The weekend wake time of Cluster 5 was significantly earlier than that of Clusters 1 and 2 and later than that of Cluster 4 ($p < 0.001$, $p < 0.001$, $p = 0.032$, respectively), but was not significantly different from that of Cluster 3 ($p = 0.554$). The weekend bedtime of Cluster 5 was significantly earlier than that of Clusters 1, 2, and 3 ($p < 0.001$, $p < 0.001$, $p = 0.002$, respectively), but was not significantly different from Cluster 4 ($p = 0.957$). The weekend breakfast time of Cluster 5 was significantly earlier than that of Clusters 1 and 2 and later than that of Clusters 3 and 4 ($p < 0.001$, $p = 0.008$, $p < 0.001$, $p < 0.001$, respectively). The weekend supper time of Cluster 5 was significantly earlier than that of Clusters 1 and 2 ($p < 0.001$, $p = 0.010$, respectively), but was not significantly different from Clusters 3 and 4 ($p = 0.856$, $p = 0.930$, respectively). These results are summarized in Table 2.

Table 2
Number of children in each institute.

Nursery school	480
Kindergarten and other institutes:	477
Kindergarten:	255
United nursery and kindergarten:	9
Baby sitter:	1
Other institutes:	7
Staying at home:	205

3.5. Comparison between weekday and weekend routines

We conducted a repeated-measures ANOVA for the weekday and weekend factors in the five clusters. Weekday and weekend meal and sleep routines were found to differed significantly. Rise time, bedtime, breakfast and supper were later on the weekends than on the weekdays: rise time, $F(1, 911) = 807.191$, $p < 0.001$, $\eta^2_p = 0.446$; bedtime: $F(1, 911) = 58.462$, $p < 0.001$, $\eta^2_p = 0.055$; breakfast: $F(1, 911) = 1178.006$, $p < 0.001$, $\eta^2_p = 0.532$; supper: $F(1, 911) = 21.938$, $p < 0.001$, $\eta^2_p = 0.024$).

3.6. Lifestyle of each cluster

Thus, each of the five clusters showed different lifestyle patterns and irregularities with regard to meal and sleep times. Cluster 1 was characterized by children's extremely late meal and sleep times and highest irregularities on weekdays and weekends. Cluster 2 was similar to cluster 1 but not as late and not as irregular. Cluster 3 was the “mildly late” and relatively regular lifestyle group. Cluster 4 was an “early bird” group wherein the children had an early meal and early sleep times on both weekdays and weekends and highly regular lifestyle. Cluster 5 resembled the “early bird” group on weekdays, but the children had “fairly late and irregular meal and sleep times on weekends” especially with regard to their wake time and time of breakfast.

Cluster 1 (Extremely Late and Irregular) consisted of 14% of participants ($n = 127$). Cluster 2 (Very Late and Irregular) consisted of about a quarter of participants (25%, $n = 233$). Cluster 3 (Mildly

Late) consisted of about one-fifth of participants (18%, $n = 168$). Cluster 4 (Early Bird and Regular) consisted of about a quarter of participants (28%, $n = 259$). Cluster 5 (Late and Irregular on Weekends) consisted of 14% of participants ($n = 129$).

3.7. The clusters and type of institutes

As bedtime is known to be delayed by the long afternoon naps employed by nursery schools in Japan, we investigated the ratio of nursery school children in each cluster. Fig. 4 shows the percentage of children attending nursery schools, kindergartens, or were raised at home. The distributions of these three groups were not different among the five clusters ($\chi^2 = 4.981$, $df = 8$, $p = 0.760$). As the number of children not attending nursery school, kindergarten, or not staying at home was very small ($n = 17$ children), we only included data from children who were in nursery school, kindergarten, or staying at home in this analysis.

3.8. The clusters and other demographic variables

We conducted multinomial logistic regression with the family and child characteristics that may have been confounded with the clusters. We applied the following variables: mothers' age, fathers' age, children's age in months, children's sex, type of institutes. There were no significant variables (Table 3).

3.9. The clusters and problematic symptoms in children

To investigate the relationship between children's lifestyle and their problematic physical and mental symptoms, we compared the children's symptoms between the five lifestyle clusters as shown in Table 4.

Among these symptoms, only one (a fear of novelty) showed no significant difference: (poor health tendency, $F(4, 911) = 3.548$, $p = 0.007$, $\eta^2_p = 0.015$; morning moodiness, $F(4, 911) = 27.973$, $p < 0.001$, $\eta^2_p = 0.109$; tendency to catch cold, $F(4, 911) = 4.680$, $p = 0.001$, $\eta^2_p = 0.020$; fear of novelty, $F(4, 911) = 1.514$, $p = 0.196$, $\eta^2_p = 0.007$; attention deficit, $F(4, 911) = 9.640$, $p < 0.001$, $\eta^2_p = 0.041$; mental stability, $F(4, 911) = 3.521$, $p = 0.007$, $\eta^2_p = 0.015$; fear of new food, $F(4, 911) = 3.621$, $p = 0.006$, $\eta^2_p = 0.016$; restlessness during meals, $F(4, 911) = 12.121$, $p < 0.001$, $\eta^2_p = 0.051$. Levene's test for equality of variance revealed no difference in variances of these variables between the 6 clusters (poor health tendency: $p = 0.112$, morning moodiness: $p = 0.470$, tendency to catch a cold: $p = 0.314$, fear of novelty: $p = 0.757$, attention deficit: $p = 0.326$, mental stability: $p = 0.103$, fear of new food: $p = 0.286$, restlessness during meals: $p = 0.142$). We also checked the residual normality using the Kolmogorov–Smirnov test. The test revealed almost all of the data were not normally distributed. Thus, we applied the Kruskal–Wallis test to the same data. All eight variables showed significant differences among five clusters (poor health tendency: H[4] = 14.729, $p = 0.005$; morning moodiness: H[4] = 103.757, $p < 0.001$; tendency to catch cold: H[4] = 18.487, $p = 0.001$;. fear of novelty: H[4] = 5.173, $p = 0.270$; attention deficit: H[4] = 33.287, $p < 0.001$; mental stability: H[4] = 20.932, $p < 0.001$; fear of new food: H[4] = 14.334, $p = 0.006$; restlessness during meals: H[4] = 51.273, $p < 0.001$). All but one variable, a fear of novelty, showed significant differences between the clusters.

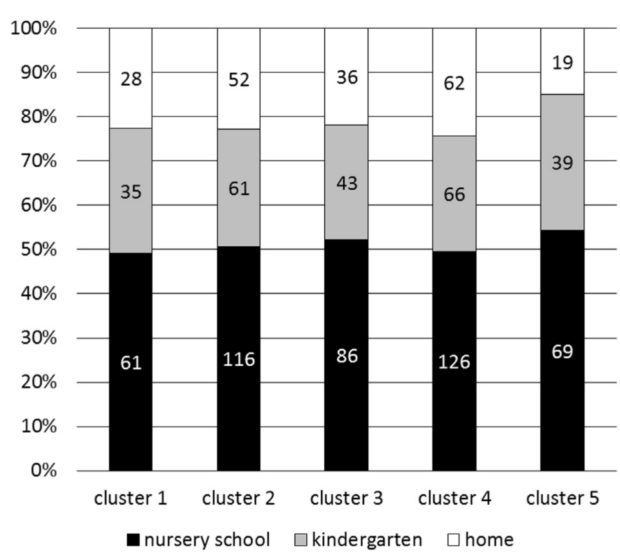

Fig. 4. The five lifestyle clusters and the different types of institutes. There were no significant correlations ($\chi^2 = 4.981$, $df = 8$, $p = 0.760$). The number shown in each category is the number of children in the group.

The symptoms of "morning moodiness," "tendency to a catch cold," "attention deficit," and "restlessness during meals" in Cluster 1 were significantly worse than those in Clusters 2, 3, 4, and 5 (LSD, morning moodiness: $p = 0.012$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively; tendency to catch cold: $p = 0.044$, $p = 0.002$, $p < 0.001$, $p = 0.041$, respectively; attention deficit: $p < 0.001$, $p < 0.001$, $p < 0.001$, $p < 0.001$, $p = 0.014$, respectively; restlessness during meals: $p = 0.005$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively). The symptoms of "poor health tendency" and "fear of new food" in Cluster 1 were significantly worse than those in Clusters 3, 4, and 5 (poor health tendency: $p = 0.005$, $p = 0.002$, $p = 0.004$, respectively; fear of new food: $p = 0.031$, $p = 0.001$, $p = 0.045$, respectively), but there was no significant difference with Cluster 2 (poor health tendency: $p = 0.128$; fear of new food: $p = 0.268$). The symptom of "mental stability" was significantly worse in Cluster 1 than in Clusters 4 and 5 ($p < 0.001$, $p = 0.043$, respectively) (see Table 5).

The symptoms of "morning moodiness" and "restlessness during meals" in Cluster 2 were significantly better than that reported in Cluster 1 and worse than that reported in Clusters 3, 4, and 5 (morning moodiness: $p = 0.012$, $p < 0.001$, $p < 0.001$, $p < 0.001$, respectively; restlessness during meals: $p = 0.005$, $p = 0.039$, $p < 0.001$, $p = 0.002$, respectively). The symptoms of "tendency to catch a cold" and "attention deficit" in Cluster 2 were significantly better than that in Cluster 1 and worse than that in Cluster 4 (tendency to catch a cold: $p = 0.044$, $p = 0.016$, respectively; attention deficit: $p < 0.001$, $p = 0.014$, respectively). The symptoms of "fear of new food" and "mental stability" in Cluster 2 were significantly worse than that reported in cluster 4 (fear of new food: $p = 0.006$; mental stability: $p = 0.032$).

The symptoms of "morning moodiness" and "restlessness during meals" in Cluster 3 were significantly better than in Clusters 1 and 2 (morning moodiness: $p < 0.001$, $p < 0.001$, respectively; restlessness during meals: $p < 0.001$, $p = 0.039$, respectively). The symptoms of "poor health tendency," "tendency to catch a cold," "attention deficit," and "fear of new food" in Cluster 3 were significantly better than in Cluster 1 ($p = 0.005$, $p = 0.002$, $p < 0.001$, $p = 0.031$, respectively).

The symptoms of "morning moodiness" and "attention deficit" in Cluster 4 were significantly better than those in Clusters 1, 2, and 5 (morning moodiness: $p < 0.001$, $p < 0.001$, $p = 0.008$, respectively; attention deficit: $p < 0.001$, $p = 0.014$, $p = 0.002$, respectively). The symptoms of "tendency to catch a cold," "mental stability," "fear of new food" and "restlessness during meals" in Cluster 4 were significantly better than in Clusters 1 and 2 (tendency to catch a cold: $p < 0.001$, $p = 0.016$, respectively; mental stability: $p < 0.001$, $p = 0.032$, respectively; fear of new food: $p = 0.001$, $p = 0.006$,

Table 3
Characteristics of wake time, bedtime, time of breakfast, and time of supper in the five clusters.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
	$n = 127$	$n = 233$	$n = 168$	$n = 259$	$n = 129$
	Extremely Late & Irregular	Very Late & Irregular	Mildly Late	Early Bird & Regular	Late & Irregular on Weekend
Weekday					
Wake time	7:22[a]	7:09[b]	6:55[c]	6:49[c]	6:49[c]
Bedtime	21:53[a]	21:28[b]	21:15[c]	21:03[cd]	20:56[d]
Breakfast	7:50[a]	7:33[b]	7:21[c]	7:18[c]	7:14[c]
Supper	18:53[a]	18:41[a]	18:28[b]	18:26[b]	18:29[b]
Weekend					
Wake time	8:06[a]	7:46[b]	7:17[cd]	7:11[c]	7:25[d]
Bedtime	22:03[a]	21:40[b]	21:20[c]	21:06[d]	21:03[d]
Breakfast	8:51[a]	8:32[b]	7:54[c]	7:49[c]	8:17[e]
Supper	18:59[a]	18:46[b]	18:36[bc]	18:27[c]	18:31[c]

Note. Values with different superscript letters were significantly different from one another. Games-Howell was used for post hoc comparisons.

Table 4
Results of multinomial logistic regression with demographic variables of parents and children (parameter estimates): Relative risk ratio of each variable.

Clusters based on sleep and meal time[a]	p	Exp (β)	95%CI
Cluster 2			
Mother Age (in Years)	0.334	0.033	(0.967–1.104)
Father Age (in Years)	0.451	0.020	(0.969–1.073)
Child Age (in Months)	0.806	0.998	(0.985–1.012)
Children's Gender	0.411	1.201	(0.776–1.857)
Institute (Nursery School)	0.749	1.074	(0.695–1.660)
Cluster 3			
Mother Age (in Years)	0.084	1.065	(0.991–1.145)
Father Age (in Years)	0.137	0.958	(0.905–1.014)
Child Age (in Months)	0.358	0.993	(0.979–1.008)
Children's Gender	0.390	0.815	(0.511–1.299)
Institute (Nursery School)	0.659	1.110	(0.697–1.768)
Cluster 4			
Mother Age (in Years)	0.207	1.043	(0.977–1.114)
Father Age (in Years)	0.487	0.982	(0.933–1.033)
Child Age (in Months)	0.348	0.994	(0.981–1.007)
Children's Gender	0.628	0.900	(0.587–1.379)
Institute (Nursery School)	0.892	1.030	(0.672–1.579)
Cluster 5			
Mother Age (in Years)	0.920	1.004	(0.931–1.082)
Father Age (in Years)	0.781	1.008	(0.952–1.068)
Child Age (in Months)	0.280	1.008	(0.993–1.024)
Children's Gender	0.627	1.130	(0.690–1.853)
Institute (Nursery School)	0.390	1.242	(0.758–2.035)

[a] The reference category is: 1 (Cluster 1).

respectively; restlessness during meals: $p < 0.001$, $p < 0.001$, respectively). The symptoms of "poor health tendency" in Cluster 4 were significantly better than in Cluster 1 ($p = 0.002$).

The later their meal and sleep times, the worse the children's physical and mental conditions became. For almost all the reported symptoms, Cluster 1 (Extremely Late and Irregular) and Cluster 2 (Very Late and Irregular) showed more severe symptoms than was reported in the other clusters. Cluster 4 (Early Bird and Regular) showed the lowest scores for all the symptoms. However, even if the meal and sleep times were early and regular on weekdays, getting up and having breakfast late and irregularly on weekends (Cluster 5, Late and Irregular on Weekends) was associated with an increase in problematic physical and mental symptoms in children. A post hoc comparison showed that Cluster 5 was significantly worse than Cluster 4 for the symptoms of "morning moodiness" ($p = 0.008$) and "attention deficit" ($p = 0.002$).

4. Discussion

4.1. Overview of findings

We investigated the meal and sleep times and several behavioral symptoms in preschool children. Our previous articles reported that bedtime was delayed by the compulsory nap routine in Japanese nursery schools. These compulsory naps could be one of the reasons why children stay up late at night. However, children's bedtime is not only determined by diurnal naps but also by a number of other factors, including family lifestyle. We found that a delayed lifestyle (ie, delayed bedtime, wake time, and mealtimes) was closely correlated with physical and mental symptoms in children. Moreover, we found a group of families whose lifestyle on weekdays is early and regular; however, who wake up and have breakfast much later and irregularly on weekends than on weekdays (Cluster 5: Late and Irregular on Weekends). Their weekday lifestyle is quite similar to that of the early lifestyle group (Cluster 4: Early Bird and Regular) with the difference being limited to the weekends. However, there were significant differences with regard to the symptoms reported in these two groups. In fact, Cluster 4 (Early Bird and Regular) showed the best conditions in seven out of

Table 5
Psychological and physical symptoms in children across the five lifestyle clusters.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Poor Health Tendency	6.20 (5.78–6.63)[a]	5.80 (5.49–6.12)[ab]	5.40 (5.09–5.71)[b]	5.40 (4.99–5.70)[b]	5.34 (5.45–5.76)[b]
Morning Moodiness	8.09 (7.63–8.56)[a]	7.40 (7.07–7.74)[b]	6.01 (5.63–6.39)[cde]	5.71 (5.41–6.01)[c]	6.43 (6.01–6.84)[d]
Tendency to Catch Cold	7.84 (7.35–8.34)[a]	7.24 (6.89–7.58)[b]	6.84 (6.40–7.28)[bc]	6.64 (6.31–6.98)[ce]	7.15 (6.71–7.58)[bc]
Fear of Novelty	9.75 (9.24–10.25)[a]	9.58 (9.22–9.93)[a]	9.43 (8.99–9.88)[a]	9.11 (8.78–9.44)[a]	9.57 (9.11–10.04)[a]
Attention Deficit	23.30 (22.54–24.06)[a]	21.52 (20.97–22.07)[b]	21.05 (20.40–21.70)[bc]	20.58 (20.04–21.12)[c]	21.99 (21.35–22.64)[b]
Mental Stability	15.87 (15.55–16.19)[a]	16.30 (16.02–16.59)[ab]	16.35 (16.01–16.69)[abc]	16.72 (16.45–17.00)[ce]	16.41 (16.06–16.76)[bc]
Fear of New Food	15.88 (15.09–16.68)[a]	15.33 (14.77–15.90)[ab]	14.74 (13.99–15.49)[bc]	14.23 (13.70–14.76)[ce]	14.76 (14.01–15.51)[bc]
Restlessness during Meals	13.60 (13.02–14.18)[a]	12.41 (11.01–12.22)[b]	11.61 (10.57–11.55)[c]	11.06 (10.45–11.77)[de]	11.11 (11.61–12.12)[cd]

Note. Values with different superscript letters were significantly different from one another Mean and the 95% confidence interval are presented. There were no significant differences among the clusters on the variable "Fear of Novelty." Only on the variable "Mental Stability," did smaller values indicate "worse" symptoms Least Significant Difference (LSD) was used for post hoc comparisons.

eight symptoms, while Cluster 5 showed the second or third worst condition in five out of the eight symptoms (Table 4). These results suggest that a delayed lifestyle is not straightforwardly important; the gap or irregularity in their lifestyle between weekdays and weekends should be considered when identifying a preferable lifestyle for young children.

Social jet lag research (eg, a lifestyle gap between school [work] days and free days) has been receiving attention in recent research due to its adverse effects on physical and mental well-being [27,28]. Indeed, social jet lag is usually used for school-aged children or working adults, however, as we showed in Fig. 4, about 80% of Japanese young children attend preschools, and they showed later wake time on the weekend (Fig. 2). Differences shown between weekday and weekend is much larger in wake time than in bedtime, resulting in shorter sleep time on weekdays. We think this might cause ‘quasi’ social jet lag for the children in these age groups. A delayed lifestyle and an irregular schedule might individually influence children's welfare. A restricted meal regimen has been found to influence the circadian clock of metabolic tissues but not SCN in animal studies [29]. Recently, a similar phenomenon was confirmed in an experiment with humans [21]. These findings suggest that delayed mealtimes cause internal desynchronization between the SCN and several other internal clock systems. A mealtime before which the fasting time is longer is influential for the phase shift of internal clocks. Usually, the time before breakfast, approximately the length of nocturnal sleep, is the longest period of fasting. Thus, the timing of breakfast might be the key variable for the phase shift of some internal clocks, causing internal desynchronizations. Parents in Cluster 5 might intentionally delay their own and their children's wake times on weekends to have the opportunity to sleep longer, thinking that the compensation for sleep loss on weekdays would be good for their health. Based on these findings, their tactics for their sleep and wake regimen appear to be ineffective for improving their own and their children's physical and mental wellbeing. Interventions with families with a very delayed wake time and time of breakfast on weekends, to encourage them to keep their sleep-wake cycle as regular as possible, may benefit families with large gaps in life patterns between weekdays and weekends.

Sleep patterns are closely related to physical and mental health [5–7], and people generally understand that having a good night's sleep is an important component of a healthy lifestyle; however, they may be unaware of the aspects of sleep that are crucial for good health. Moreover, people are typically less willing to change their habitual lifestyle, even when they know what the best choices are. These factors can make it difficult to develop interventions that might prolong weekday sleep length. High compliance for lengthening sleep would be unexpected. A recent study [30] revealed the effects of sleep education are limited; however, it may be more pragmatic to encourage people to maintain a consistent lifestyle, rather than going to bed earlier. Intervention methods should be selected based on the target family's lifestyle. An intervention study with families who have a large gap in their weekdays and weekends sleep patterns, as well as large gaps in their daily behaviors that targets developing a consistent lifestyle, may be promising.

4.2. Strengths and limitations

This study was carried out using relatively large samples of families throughout Japan. However, the sample was not selected using rigid random sampling rules; rather, it was from a database offered by a network survey company. This might cause some bias in the results of the study. Moreover, Japan is well known as a nation of late bedtimes and short sleep. Japan also has an obligatory nap routine for young children, which is different from other countries. Whether the findings we obtained here are universal or not remains unclear. The categorization of children's lifestyles using cluster analysis is likely to show overly simplified results from these groupings. In one cluster, there are actual families whose lifestyles vary from the typical pattern as a matter of course. Thus, we have to be cautious about interpreting these simplified results. Furthermore, since this study was conducted as a survey and the data we obtained is observational, we could not argue causal relationships between variables, which is the most important limitation of this study. Future intervention research is needed to clarify the causality of the variables.

Compliance with ethical standards

All procedures performed in the study involving human participants were in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all participants included in the study.

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Conflict of interest

The authors have no potential conflicts of interest concerning the research, authorship, and publication of this article.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2019.03.023.

Appendix

Children's symptoms were estimated by the mothers with the following statements to indicate how much the statements applicable to their child by selecting the choices (ie, Choice type A: Always, Often, Sometimes, Rarely, and Never; Choice type B: Applicable, Relatively applicable, Hardly applicable, and Never applicable). Reverse worded items are indicated by capital letter R at the end of the sentences.

Poor health tendency (choice type A) Cronbach's $\alpha = 0.711$.
My child feels dull.
My child gets tired easily.
My child has eczema and/or an allergy to something.

Morning moodiness (choice type A) Cronbach's $\alpha = 0.792$.
My child is grumpy in the morning.
My child is lethargic and sluggish in the morning.
Even if I get my child up, he/she does not really wake up.

The tendency to catch a cold (choice type A) Cronbach's $\alpha = 0.808$.
My child catches a cold easily.
My child gets a fever easily.
My child gets a running nose easily.

Fear of novelty (choice type B) Cronbach's $\alpha = 0.766$.
My child cowers when he/she goes to an unfamiliar place.
My child dislikes being with strangers.
My child can try to do something for the first time after encouragement from a parent.

My child quickly gets accustomed to a new place when he/she goes there for the first time (R).

Attention deficit (choice type B) Cronbach's $\alpha = 0.749$.

My child becomes distracted at the slightest thing while he/she plays.

My child breaks off doing something because he is preoccupied with something else.

My child fails to do something because he/she cannot listen until the end of instructions.

My child's interests change continually in a short time.

My child is distracted from doing something when he/she hears another unrelated sound.

My child interrupts someone talking with another person.

My child uses other children's things without permission.

My child cannot stop crying even if I try to calm his/her feelings.

My child easily cries over little things.

Mental stability (choice type B) Cronbach's $\alpha = 0.590$.

My child looks relieved after I talk to him/her when he/she feels anxious or nervous.

My child can do unfamiliar things comfortably when I stay with him/her.

My child is usually smiling.

My child can wait for his/her turn when he/she plays on a swing or slide.

My child cuddles me.

Fear of new food (choice type A) Cronbach's $\alpha = 0.844$.

My child eats only familiar food.

My child is picky with food/My child has preferences regarding food.

My child hesitates to eat something even when the taste of familiar food changes a little.

My child easily eats new food after a few times (R).

My child eats unfamiliar food without any encouragement (R).

Restlessness during meals (choice type A) Cronbach's $\alpha = 0.807$.

My child leaves the dining table in the middle of a meal.

My child cannot finish eating while sitting in one place.

My child cannot concentrate on eating because he/she is disturbed by little things.

My child is reluctant to finish food but continues to eat grudgingly.

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