

Parental behaviors and sleep/wake patterns of infants and toddlers in Hong Kong, China

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Background: To describe the sleep patterns of children below 36 months in Hong Kong, and evaluate the associations between parental behaviors and childhood sleep/wake patterns.

Methods: Parents of 1049 infants and toddlers completed an internet-based expanded version of the Brief Infant Sleep Questionnaire.

Results: Total sleep duration ($P<0.001$), frequency ($P<0.001$) and duration ($P<0.001$) of nocturnal awakenings decreased with age, whereas the longest sleep duration ($P<0.001$) and nocturnal sleep duration ($P<0.001$) increased with age. Children who room- or bed-shared with parents had later bedtimes ($P<0.001$), but similar sleep duration compared with those who had a separate sleep location. Falling asleep independently was associated with longer nocturnal sleep duration ($P<0.001$) and less sleep awakenings ($P<0.001$). Full-time employment of parents was associated with shorter total sleep duration of children ($P<0.001$). Although breastfeeding was associated with more nocturnal awakenings ($P<0.001$), no association was detected between breastfeeding and shorter sleep duration in children.

Conclusions: As infants and toddlers develop, their sleep consolidates. Falling asleep independently was associated with longer nocturnal sleep duration and fewer sleep awakenings, whereas sleep location was not. This is an important finding, especially for families with limited living space where parent/child room- or bed-sharing cannot be avoided.

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Key words: infant;
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Introduction

Childhood sleep/wake patterns evolve and consolidate rapidly during the early years of life. Changes include longer nocturnal sleep duration, fewer nocturnal awakenings, shorter daytime sleep duration, and shorter total 24-hour sleep duration.^[1,2] Sleep problems affect 20% to 30% of children during the first two years in life,^[3,4] which have been linked to daytime fatigue, suboptimal cognitive performance, and parental stress.^[5,6] Early sleep problems, such as difficulties in sleep initiation, excessive nighttime awakenings, and cry-fuss, may become entrenched and difficult to manage,^[7] and subsequently disturb childhood growth and cause long term problems including obesity, cardiovascular disease, and poor study performance.^[8-10]

Hong Kong has a childhood population with late bedtime, short nocturnal sleep duration, and more sleep problems than children in other Asian and Caucasian countries/regions.^[11] This has previously also been observed in older children,^[12] where sleep duration is much shorter than international recommendations. In older children, school start time and parental sleep patterns may contribute to short sleep duration,^[13] however the factors are less clear in infants and toddlers. This poses many challenges in clinical management and provides us with an opportunity to evaluate the associations between parental sleep-related behaviors and childhood sleep/wake patterns in a population where short sleep duration is prevalent even at a very young age. Sleep-related parental behaviors, including parental nocturnal involvement at sleep initiation and resumption, are associated with childhood sleep/wake patterns.^[14] However, it remains unclear which of these parental behaviors affect and to what extent they are associated with the perceived poor sleep of children. For example, while breastfeeding is common practice,

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and recommended for its advantages for growth and development, it has been found to be associated with more nocturnal awakenings, in view of the more easily digestible nature of breast milk leading to shorter feeding intervals.^[15] Another frequently studied factor is sleep location (independent location, or parental room- or bed-sharing). Sleeping in separate rooms has been recommended for better development of self-soothing ability and is believed to be associated with fewer sleep problems compared with room- or bed-sharing.^[16-18] In view of high population density and extremely high costs of housing, living space in Hong Kong is limited and thus parent/child room- and bed-sharing is prevalent^[12] and may be unavoidable. In a Chinese study of school-aged children, bed- and room-sharing was also common and associated with poorer sleep quality, reflected by association with sleep problems.^[16] Whether or not this relatively unmodifiable factor plays an important role in the observed short sleep duration amongst children in Hong Kong is unclear. Thus, although the association between sleep location and childhood sleep/wake patterns may be complex and bi-directional, it is nevertheless an important sleep-related practice to be investigated in relation to the establishment of healthy sleep/wake patterns and good sleep quality in children. Further analysis of the Hong Kong data may help suggest which potentially modifiable factors are associated with improved sleep duration for such a population of children with short sleep duration and constrained living spaces.

In this study, we aimed to 1) describe the sleep/wake patterns of infants and toddlers in Hong Kong; 2) evaluate the associations between parental sleep-related behaviors and children's sleep parameters (nocturnal sleep duration, number of awakenings, daytime sleep, and total sleep duration); and 3) compare the sleep outcomes within the context of parent/child room- and bed-sharing.

Methods

Participants

The present study was part of a cross-cultural study on the sleep/wake patterns and habits of infants and toddlers using an internet-based Brief Infant Sleep Questionnaire (BISQ).^[11] In Hong Kong, we invited parents to complete the online questionnaire about their children's sleep/wake patterns by email, utilizing mailing lists obtained from local marketing firms and online advertising at parenting websites. Recruitment took place from September to December of 2007. Data from 1049 Hong Kong children aged from 0 to 36 months were analyzed.

Procedures

Parent-completed BISQ included questions about infant daytime and nighttime sleep patterns during the

last two weeks, and sleep-related behaviors involving sleep arrangements (bed-sharing and room-sharing) and bedtime routines.^[16,19] The questionnaire was based on the BISQ and translated from English to Chinese and then back-translated by an independent person. The back translation was reviewed by the principal investigator and any discrepancies in meaning were corrected. The local population comprised highly literate adults who would have no problems understanding the language used. Questionnaire took 8-10 minutes to complete. Data were collected online via a free-standing website for the survey. The online version used pull-down menus with optional responses for each presented question. Completion of the questionnaire was voluntary and parents were not provided with any feedback. In addition to BISQ, demographic information including parental age, education, employment status and child's birth order was also obtained.

Statistical analysis

Demographics were presented as mean and standardized deviation for continuous variables and percentage for categorical variables. Although some of the measures were skewed, according to the central limit theorem, it was assumed that in large samples the mean is a good representation and that parametric tests are appropriate. The children were grouped into 7 age groups according to the following cutoffs: 0-2, 3-5, 6-8, 9-11, 12-17, 18-23, and 24-36 months old. Differences in means among study groups for continuous variables (sleep parameters of different age groups and at different sleep locations) were evaluated by using ANOVA with Duncan post hoc analysis. Categorical variables (percentage of parental behaviors) were tested using Chi-squared test. Results were considered significant when $P < 0.001$. The significance level of 0.001 was chosen to compensate for the multiple tests. The number of calculated statistics is close to 50 and so in order to decrease the false positive rate the usual significance level of 0.05 was reduced to 0.001. To assess the associations between parental behaviors/sleep ecology and sleep/wake patterns we performed stepwise linear regression analyses using sleep ecology and demographic variables as predictors for the most prominent sleep variables (nocturnal sleep duration, daytime nap duration, longest sleep episode, and the number of nocturnal awakenings). The predictors (independent variables) in each regression analysis included child demographic variables (age, sex, and birth order), parental demographic variables (age, education level, and employment status), parental involvement at sleep initiation (feeding method, rocking/holding, watching TV, and sleep location), and sleep resumption (holding or rocking to sleep, picking up-returning awake,

rubbing or patting in crib/bed, bottle/breast feeding back to sleep, giving pacifier, changing diaper, verbal comfort in crib, bringing child to parents' bed, letting child cry to fall asleep, waiting a few minutes, play until ready for sleep, watching TV or video, and singing to child). The parameter "falling asleep independently" referred to the ability to fall asleep without help by others, and reflects the child's ability to self-soothe and not whether the child is bed- or room-sharing. Given the cohort size of 1049 children, we set the level for entry into the regression model at $P<0.0001$ in order to control for type I errors.

Results

Development of children's sleep patterns and sleep-related parental behaviors

Sleep data of 1049 infants and toddlers aged from birth to 36 months (53.2 % boys) were analyzed (Table 1). Most respondents were mothers (94.09%), and 65.97% of them had full-time jobs. Significant age-related changes occurred both in children's sleep/wake patterns (Fig.) and parental involvement at sleep initiation and in response to nocturnal awakenings (Table 2). Total sleep duration, frequency (data not shown) and duration of nocturnal awakenings, the number of daytime naps, and nap duration decreased with age ($P<0.001$), whilst the longest sleep duration and nocturnal sleep duration increased with age ($P<0.001$).

Parental behaviors at sleep initiation, changed with the child's age. In response to night awakenings, parents

became less likely to breastfeed their children back to sleep, and more likely to rub or pat them back to sleep in the crib/bed (30.53% at 0-2 months vs. 61.59% at 24-36 months, $P<0.001$) or by verbal comfort (11.58%

Table 1. Demographic characteristics of study subjects

Variables	Number of subjects	Proportion (%)
Age (mon)		
0-2	95	9.4
3-5	125	12.3
6-8	144	13.5
9-11	143	13.7
12-17	222	21.0
18-23	156	14.3
24-36	164	15.7
Sex		
Boy	558	53.2
Girl	491	46.8
Birth order		
Only	559	53.3
Oldest	310	29.6
Middle/multiple	38	3.6
Youngest	142	13.5
Respondent		
Mother	987	94.1
Other	62	5.9
Respondent's employment status		
Full-time	692	66.0
Part-time	46	4.4
Home/student	311	29.6
Respondent's education		
High school or below	542	51.7
College	444	42.3
Postgraduate	58	5.5
Age of respondents, y		
21-24	10	1.0
25-29	45	4.3
30-34	218	20.8
35-39	464	44.2
40-44	272	25.9
>45	39	3.7

Table 2. Percentages of children in each age group using specific method to sleep and sleep location

Variables	Age group (mon)								Chi-square
	Total (n=1049)	0-2 (n=106)	3-5 (n=137)	6-8 (n=152)	9-11 (n=154)	12-17 (n=235)	18-23 (n=160)	24-36 (n=176)	
Sleep initiation methods									
Bottle-feeding	34.13	35.79	36.80	41.67	39.86	33.78	25.00	28.66	14.22
Breastfeeding	8.20	30.53	15.20	9.03	6.29	4.05	3.21	1.22	92.74*
Rocking	23.26	36.84	40.80	42.36	30.07	18.47	4.49	3.66	133.47*
Holding	29.46	43.16	48.00	43.75	27.27	24.77	19.23	12.80	75.83*
Watching TV	3.62	1.05	0.80	2.08	1.40	1.80	6.41	10.37	34.59*
In swing or stroller	6.67	11.58	18.40	9.03	6.99	4.05	2.56	0	50.98*
In crib/bed alone in the room	16.97	14.74	25.60	18.75	16.08	20.72	14.74	7.93	19.63†
In parents' bed alone	3.62	3.16	3.20	3.47	2.10	3.15	6.41	3.66	4.70
In crib/bed with parent present	14.68	10.53	14.40	9.03	15.38	16.67	17.31	16.46	7.02
In parents' bed with parent	27.17	8.42	12.00	15.28	27.27	27.48	41.67	45.73	86.84*
Resuming sleep									
Holding or rocking to sleep	34.51	48.42	38.40	45.83	46.85	30.63	26.28	15.85	58.19*
Picking up-returning awake	5.82	5.26	2.40	3.47	9.79	4.50	9.62	5.49	13.13
Rub or pat in crib/bed	47.38	30.53	36.00	39.58	48.25	51.35	52.56	61.59	37.23*
Giving a bottle	20.11	34.74	26.40	23.61	21.68	17.57	12.18	13.41	28.62*
Nurse back to sleep	7.24	25.26	12.80	8.33	6.29	2.70	2.49	1.22	69.52*
Pacifier	22.78	18.95	28.00	32.64	25.17	28.38	15.38	9.76	35.77*
Diaper	17.73	45.26	21.60	18.06	18.88	10.81	11.54	12.80	64.91*
Verbal comfort in crib	21.83	11.58	13.60	13.89	16.78	20.72	35.26	34.15	49.49*
Bring child to parents' bed	13.54	6.32	7.20	14.58	20.98	16.67	14.10	10.37	18.73†
Let cry to fall asleep	3.15	3.16	1.60	2.08	2.10	3.15	5.13	4.27	4.72
Wait a few minutes	26.12	24.21	28.00	24.31	23.78	26.13	28.85	26.83	1.70
Play until ready for sleep	0.76	1.05	1.60	0.69	0	0.45	1.28	0.61	3.26
Watch TV or video	0.76	1.05	0	0	0	0.45	2.56	1.22	10.70
Sing to child	9.72	9.47	8.80	11.11	6.99	11.26	7.05	12.20	4.67

*: $P<0.0001$; †: $P<0.001$.

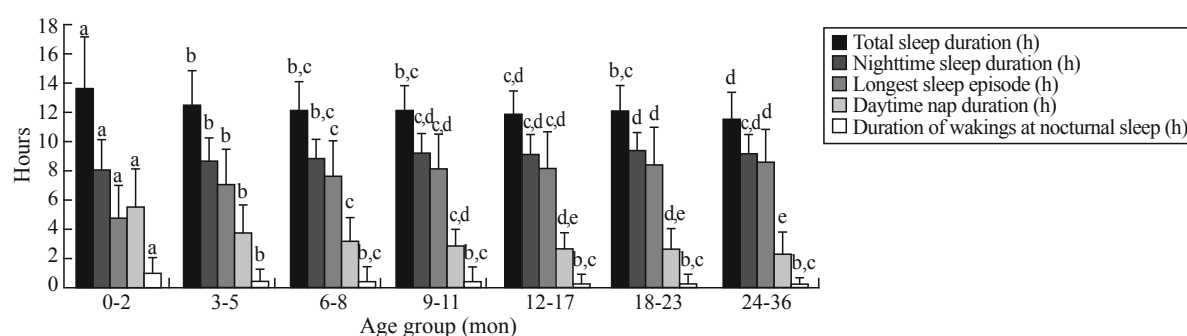


Fig. The differences of sleep variables between each age group tested by using Duncan post hoc analysis. Means were significantly different between different letters (e.g., "a" was different from "b").

Table 3. Percentage of overlapping between sleep initiation and sleep resumption techniques in parents

Variables	Hold/rock back to sleep	Pick up-return awake	Rub-pat back to sleep	Bottle-feed back to sleep	Nurse back to sleep
Bottle-feed to sleep at bedtime	44.13*	5.87	47.77	32.68*	3.35†
Nurse to sleep at bedtime	33.72	3.49	29.07†	13.95	70.93*
Hold/rock to sleep at bedtime	63.11*	5.74	45.08	25.00	11.07‡
Holding	57.93*	5.83	48.54	26.86†	10.68‡

*: $P<0.0001$; †: $P<0.001$; ‡: $P<0.01$.

Table 4. The differences in sleep variables across different sleep locations

Variables	Bed-share (n=289)	Room-share (n=430)	Separate room (n=258)	F^*
Bedtime (h)	22:47 ^a (1.03)	22:31 ^a (1.06)	22:05 ^b (1.16)	8.48†
Number of awakenings	1.14 (1.22)	1.09 (1.03)	1.04 (1.10)	2.74
Duration of awakenings (h)	0.39 (0.69)	0.50 (0.94)	0.44 (0.77)	0.09
Longest sleep (h)	8.07 (2.61)	7.65 (2.70)	7.80 (2.42)	1.15
Nocturnal sleep (h)	9.21 (1.43)	8.99 (1.47)	8.87 (1.43)	1.33
Number of naps	1.76 (0.96)	2.35 (1.12)	2.07 (1.07)	0.99
Daytime sleep (h)	2.89 (1.62)	3.29 (1.81)	3.12 (1.89)	1.95
Total sleep time (h)	12.09 (2.03)	12.28 (2.12)	11.99 (2.08)	2.49

Means were significantly different between different letters (e.g. "a" was different from "b"). *: adjusted for age; †: $P<0.0001$.

at 0-2 months vs. 34.15% at 24-36 months, $P<0.001$), when the children grew older.

Parental behaviors were similar at sleep initiation and sleep resumption (Table 3). About 70.93% of children who were nursed to sleep at bedtime were nursed back to sleep during the night ($P<0.001$), and 32.68% of children who were bottle-fed to sleep at bedtime were also bottle-fed back to sleep during the night ($P<0.001$). Parents who held or rocked children to sleep were more likely to do the same for children to resume sleep at night (63.11%, $P<0.001$).

Room- and bed-sharing

In Hong Kong, 44.0% of the children shared a room with parents in a separate bed or crib before 3 years old. 29.6% of children shared a bed with a parent, and 26.4% slept in a separate room. Table 4 lists the sleep/wake patterns of children with the different sleep locations. Children who slept in a separate room had an

Table 5. Stepwise linear regression analyses explaining sleep parameters using sleep ecologic and demographic variables

Variables	Beta	SE	Explained variance (%)	F
Total sleep duration				
Age	-0.23	0.03	0.05	50.50
Respondent's employment status	0.36	0.07	0.03	27.08
Daytime sleep duration				
Age	-0.40	0.03	17.97	228.34
Sex	0.34	0.10	0.88	11.46
Respondent's employment status	0.19	0.05	0.97	12.41
Nocturnal sleep duration				
Age	0.17	0.02	4.47	48.76
Falling asleep independently	0.41	0.12	1.11	12.19
Nocturnal awakenings				
Age	-0.06	0.02	1.07	11.83
Falling asleep independently	-0.50	0.09	2.70	28.91
Breastfeeding/nursing child back to sleep when child wakes up during the night	0.54	0.13	2.30	25.16
Longest sleep episode				
Age	0.48	0.04	11.53	135.75
Falling asleep independently	0.86	0.20	13.08	18.63

All entered variables met the criteria of $P<0.0001$. For sex, positive beta indicates the parameter increases for boys and a negative beta indicates that the parameter decreases for boys. Sex: 0=female, and 1=male; respondent's employment status: 0=employed full-time, 1=employed part-time, 2=on maternity leave, 3=homemaker/at-home parent, 4=student, and 5=unemployed/in-between jobs or other; fall asleep independently: 0=no, and 1=yes; breastfeeding/nursing child back to sleep when child wakes up: 0=no, and 1=yes. SE: standard error.

earlier bedtime (22:05, 1.16 hours) than those who slept in their parents' room (22:31, 1.06 hours, $P<0.001$) or shared a bed with their parents (22:47, 1.03 hours, $P<0.001$), respectively. However, no difference in other sleep outcomes was found among children with different sleep arrangements using univariate analysis.

Predictors of sleep patterns

Results of stepwise linear regression analysis are shown in Table 5. We found that age ($P<0.0001$) and sex ($P<0.0001$) were factors contributing most to children's sleep/wake patterns. Children whose mothers had a part-time job or were not employed had longer sleep duration with increased daytime sleep ($P<0.0001$). Longer nocturnal sleep duration, fewer nocturnal awakenings and longest sleep episode were associated with the child falling asleep independently after adjustment for demographic and behavioral factors ($P<0.0001$). Breastfeeding/nursing the child back to sleep when the child awoke at night was associated with more nocturnal awakenings ($P<0.0001$).

Discussion

We reported the sleep/wake patterns of infants and toddlers in Hong Kong. Our findings were consistent with previous cohorts showing that sleep develops with longer nocturnal sleep duration, fewer nocturnal awakenings, fewer daytime naps, and shorter total 24-hour sleep duration during the first few years of life.^[2,20,21] Of note, sleep location did not appear to have any impact on the sleep duration of the child, whereas allowing the child to fall asleep independently was associated with longer nocturnal sleep duration and fewer nocturnal awakenings. Although breastfeeding may disturb nocturnal sleep, we did not find evidence suggesting an association with shorter sleep duration. Infants and toddlers of mothers who were not employed or partially employed had longer naps and total sleep duration than those of full-time employed parents. This may be due to the flexible daily schedule of non-employed or partially employed parents.^[22,23] In addition, in Hong Kong, full-time employed parents may return home late, leading to later bedtimes in their children.

Behavioral recommendations have been made to parents for early and consistent bedtime and sleep routines.^[13,24] At night, parents are likely to be involved in children's sleep resumption after awakenings and parental behaviors were similar at sleep initiation and sleep resumption. This suggests that the development of self-soothing skills at sleep initiation may also help with sleep resumption. In Hong Kong, the most common parental behaviors at sleep initiation are bottle-feeding, rocking, holding, and putting children in bed with parents. There is a decrease in percentage of young children requiring feeding for sleep resumption with increasing age and it is possible that this decreasing trend is not only a result of maturation of the mechanisms controlling sleep, but also the satiety and hunger cycles.^[25,26]

Whether or not cultural differences affect the need for children to sleep in their own crib/bed in a separate room to reduce sleep-related problems is still unclear. In Western culture, parents are likely to use pacifiers, toys, or transitional objects to encourage infants to fall asleep by themselves, in order to engender independence and improve privacy for parents. However, in most Asian countries, such as China and Japan, room- and bed-sharing are much more common. In Hong Kong room- or bed-sharing may sometimes even be unavoidable due to the small living spaces that many families live in. Such sleeping arrangements may lead to prolonged interdependence between parent and child and the belief that separation at sleep produces distress and bed resistance. Prior studies in China,^[16] Italy,^[27,28] and United States,^[17,18] showed that bed-sharing reduced children's sleep quality and sleep quantity by impairing the child's development of the ability to self-soothe. Children who achieved independent sleep by one year after the first assessment had fewer sleep problems than those who continued to sleep with their parents.^[17] Compared with other ethnicities,^[29] we did not find such association between sleep locations and sleep outcomes in our population. Further, a case-control study by video recording found that although infants who sleep with parents had more frequent awakenings, they had less awakening duration than solitary sleeping infants, and hence no difference was detected in the total night wakefulness between the two groups.^[30] In our study, children who room-/bed-shared with their parents had later bedtimes. However sleep duration was not decreased and night awakenings were similar. It is possible that the presence of a parent throughout the night in room-/bed-sharing situations would increase the likelihood of reproduction of bedtime soothing behaviors to improve sleep resumption and more rapid transitioning to normal rapid eye movement/non-rapid eye movement sleep.^[31]

Our results are important to populations of families living in small spaces, where sleep location may not be a modifiable factor. Our data suggest that it is possible that whether or not the child develops sleep problems depends not so much as the sleep location, but the parental behavior at sleep initiation, with allowing the child to fall asleep independently being associated with longer night sleep duration in our population of children with short sleep duration.

Some limitations should be noted in this study. First, this internet-based survey may capture a population of respondents skewed towards higher education and socioeconomic status. A comparison with the Hong Kong census data revealed similar sex ratio (census data 2006 52.3% boys to 47.7% girls compared with

our study with 53.2% boys to 46.8% girls). Although further analysis according to the outcome measures was not possible due to the lack of corresponding census data, the similar sex ratio is reassuring that a large systematic bias was not present. However, the associations between the sleep-related behaviors and short sleep duration were statistically robust and unlikely to be chance or biased findings. Second, the sleep parameters were based on parental reporting, which is a subjective measure. However, although BISQ is based on parental reporting, it has previously been validated against other sleep measures such as sleep diary reports and actigraphy and have been shown to have high test-retest reliability ($r > 0.82$).^[19] In addition, objective sleep measurement methods would not have been feasible for a community-based study of this scale.

As infants and toddlers develop, their sleep consolidates. Our results suggest that rather than sleep location, it is whether the child falls asleep independently that is associated with longer nocturnal sleep duration and fewer sleep awakenings. Infants and toddlers of non-employed or partial employed parents had longer nap and total sleep duration than those of full-time employed parents, reflecting the potential importance of parental domestic scheduling on childhood sleep/wake patterns. Our findings highlight the importance of modifying parental sleep initiation and resumption behaviors over the childhood sleep location. This is of vital importance because while sleep initiation and resumption behaviors are potentially modifiable factors, in many Asian communities, room- and bed-sharing may be unavoidable.

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Ethical approval: Ethics approval for the overall international cross-cultural survey was obtained from Saint Joseph's University's Institutional Review Board for the Protection of Human Subjects in Research.

Competing interest: Mindell JA has received funding from Johnson & Johnson Consumer & Personal Products Worldwide, a division of Johnson & Johnson Consumer Companies, Inc. to conduct this study. For the remaining authors none were declared.

Contributors: Yu XT was responsible for analysis, manuscript draft and revision. Sadeh A was responsible for supervision of data collection and analysis, and contribution to study design. Lam HS was responsible for helping draft and critically review the manuscript. Mindell JA supervised the study and was responsible for critical review. Li AM was responsible for study design, manuscript revision and critical review. All authors have read and approved the final manuscript. Dedication: Professor Sadeh, a pioneer in the field of pediatric sleep and actigraphy, died on September 19, 2016. He was a licensed clinical psychologist with more than 25 years of clinical experience and

over 130 scientific publications in the field. He was a kind and caring man, trusted colleague and influential researcher. He will be missed by all in the sleep community.

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