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Article

The Associations between Screen Time and Sleep Duration, and Body Mass Index (BMI) in under Five-Year-Old Children

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Abstract: Today, due to recent developments in technology, children devote plenty of time for screen viewing. However, its harmful effects are not yet clear. The purpose of present study was to examine the associations among screen viewing and sleep duration, and body mass index (BMI) in under-five years old children. This cross-sectional study was conducted with 322 under-five healthy children that were selected using multistage stratified cluster sampling method in 2017. The data that were gathered by time-use diary method were analyzed using Kolmogorov-Smirnov test, Spearman correlation tests, multiple linear regression analysis, one-way ANCOVA, two-way ANCOVA. There was a negative correlation between screen time and sleep duration ($rs = -0.42$, $p = 0.00$), positive correlation between screen time and BMI ($rs = 0.38$, $p = 0.00$) and sleep duration negatively correlated with BMI ($rs = -0.22$, $p = 0.00$). screen viewing was a predictive factor for both sleep duration ($\beta = -0.26$, $p = 0.00$) and BMI ($\beta = -0.26$, $p = 0.00$). screen viewing had a significant impact on sleep duration ($4, 314) = 5.02$, $P = 0.001$) and BMI ($F (4, 314) = 1.16$, $P=0.298$). Results of this study indicated that screen viewing is related to sleep duration and BMI in under-five children. furthermore, screen time has an impact on sleep duration and BMI scores of children. findings of our study suggest that sleep duration negatively is associated with BMI in under-five-year-old children.

Keywords: screen time; sleep duration; body mass index (BMI); time use

1. Introduction

In the shadow of the dramatic technological advances, the diversity and availability of media and its impacts on lives of children are expanding [1-3]. Furthermore, electronic screen use including media use and exposure such as TV viewing, mobile media use, and video games have increased markedly amongst infants and young children despite the recommendations of the American Academy of Pediatrics that children under 18 months should have no media use other than video-chatting and caregivers should limit media use of young children 2- 5 years of age to 1 hour per day

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[3-5]. The existing data suggest that early and excessive media exposure and use is associated with sleep problems [6], overweight and obesity [7], and child developmental delay including cognitive, language, and social/emotional delays [8-10]. sleep is an active neurophysiological process and the preliminary function of the developing nervous system [11,12].

Research widely indicate that sleep is crucial for optimal cognitive performance, physiological processes, emotional regulation, and quality of life [11,13]. The optimal quantity and quality of sleep are essential for physical and psychosocial health that is difficult to achieve in this modern life [14,15]. Shorter sleep durations are related to a broad range of harmful health and educational outcomes such as obesity and increased weight status, inflammation, impaired glucose regulation, inappropriate appetite, and energy expenditure as well as problems with memory consolidation and attention in children [11,15-17].

According to the World Health Organization (WHO), "overweight and obesity are defined as abnormal or excessive fat accumulation that may affect health" [18]. Childhood overweight and obesity prevalence appear to be rising rapidly in developing countries, while Until a while ago overweight and obesity were considered as problems only in high-income developed countries. In particular, in the past 3 decades, obesity prevalence among Iranian children has more than doubled [19,20]. Obesity and overweight in childhood have a considerable impact on either physical or psychological health and children with obesity and overweight are at risk for various conditions, such as cardiovascular diseases and type 2 diabetes mellitus, Hyperlipidemia, hypertension, abnormal glucose tolerance, and depression [19,21,22]. Furthermore, in the future, they will often become obese and overweight adolescents and adults [19,23].

Although Various studies demonstrate the associations between of screen time and sleep in children and adolescents, In most research, the target populations were adolescents and school-aged children [24-29], and There is limited evidence for the relationships between media use and exposure, and sleep duration in under-five-years old children [6,29]. In the same way, while various analytical studies have shown the associations between screen time and BMI in late childhood [30-35], evidence about infants, young children, and preschool children are not conclusive [36,37].

Moreover, although some studies indicate that the duration of media use is associated with sleep duration and BMI, most researchers have concentrated on particular types of the screen viewing devices such as TV and portable video device [38-40], while children in real life are in touch with a variety of screen viewing devices. Therefore, in this study, screen viewing time has been investigated based on all media devices. Regarding the fact that lifestyle-related variables are usually culture-dependent [41], research in the field of screen viewing, sleep, and BMI should be conducted separately for each community. Nonetheless, to the best of our knowledge, no other study examined the relationship between screen time and both sleep duration and BMI in Iranian children under the age of five years. The main objectives of the present study were to explore the associations between screen viewing and sleep duration in under-five years old children, to explore the associations between screen viewing and BMI in under-five years old children and to explore the associations between sleep duration and BMI in under-five years old children

2. Materials and Methods

2.1. Study type, Population, and Sampling Method

The present cross-sectional study was conducted in the Takestan county, an area in the Qazvin province of Iran, from May to December 2017.

Using multistage stratified cluster sampling 322 Takestan county under-five years old healthy children included in the study, while children with severe mental or physical illness that needing hostelry special care services in Institutes (The children living in the institution) were excluded from the research process.

Participants have been selected from all cities and villages of the county. In the first stage from similar socio-economic regions of urban and rural areas, representative areas were selected. At the next stage, seven rural health centers and three urban health centers were selected from urban and rural areas which incorporate sixteen rural health centers and eight urban health centers.

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Subsequently, equal number of girls and boys were selected from various health houses of rural centers and various health posts of urban centers based on the population load of children under five years of age and commensurate with the number of children per each seven age groups (under one months, 2-3 months, 4-6 months, 7-12 months, 1-2 years, and 3-5 years).

We obtained written informed consent from parents before participation and an approval for the study was obtained from the Social Welfare and Rehabilitation Sciences University.

2.2. Instrument and procedures

The version of the time-use diary that was applied to this research had four main open-ended questions that asked the primary activity when it began and ended, and whether any other activities took place, where and with whom that activity takes place.

The time-use diary which was either interviewer-administered or self-reported asked about the child's flow of activities over a 24-Hour period of a weekday. time-use diary in the present study designed as an open-response category, and open-interval via per 3 hours. Yesterday or tomorrow methods of time use diaries were utilized in line with the desire and conditions of the participants. Yesterday diaries were completed based on face to face interview (and additional telephone-based interview as need as necessary) and tomorrow diaries were left behind to main caregivers after a preparative interview.

All data gathered by Three professionally trained staff that participated workshops about time use mythology, administration of time use diary and interview method of assessment.

2.2.1. Screen time

Screening viewing time was calculated based on the sum of media use as either a primary or a secondary activity on the weekday, including time use estimates (minutes) of TV viewing, video game, and use the personal computer, laptop, or tablet that were measured by yesterday and tomorrow time use diaries.

2.2.2. Sleep duration

Total sleep duration was calculated by Summation of day-time sleep and night-time sleep time estimates that were measured by yesterday and tomorrow time use diaries.

2.2.3. BMI

Anthropometric data including height and weight were measured according to a standard program using calibrated devices by a trained staff of health-care systems. The BMI was calculated by dividing the weight in kilograms by the square of the height in meters [42,43]. Overweight and Obesity status was determined based on BMI z-scores that were calculated by using World Health Organization gender-specific BMI-for-age growth charts [18].

2.3. analysis

2.3.1. qualitative analysis:

Different from previous time use studies, in this study, the tomorrow and yesterday diaries estimates of time use were investigated based on eight areas of occupations, which are classified based on the third version of occupational therapy practice framework, domain and process (OTPF3) [44]. Other indicators that were compared in this research are included frequency of verbatim, occupational repertoire, co-occupations time estimates and concurrent occupations time estimates. The interpretation of the diary was done in several steps. In the first stage, verbatim was extracted and the number and duration of each of them were determined. In the next step, the frequency and duration of the tasks, activities, and occupations of daily life were determined according to the OTPF3, and in the next stage, the time allocated to each of the areas of occupations was determined based on the OFPF3; in addition, the number of occupations in occupational repertoire, the time allocated to

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the concurrent occupations, the time devoted to the childcare activities (interactive and physical childcare) are specified.

2.3.2. Statistical analysis:

Statistical analyses were performed by using SPSS (IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY, USA; IBM Corp.), and The level of significance was set at $p < 0.05$.

Means and SDs were calculated for the descriptive statistics, and frequencies and percentages were calculated for categorical variables and the data were analyzed using Kolmogorov-Smirnov test for testing normality. Spearman Rho correlation tests for analysis of relationship and the Multiple linear regression analyses were used to evaluate the impacts of selected predict variables (screen time, sleep duration and age) on the sleep duration and the BMI as dependent variables. One-way analyses of covariance (ANCOVA) were used to examine how screen time was related to five categories of sleep duration with a covariate of age, and the differences in BMI scores were assessed by two-way ANCOVA (5 screen time × 5 sleep duration) with adjustment for the covariate of age.

2.4. Ethics approval

This study was approved by the Ethics Committee of the University of Social Welfare and Rehabilitation Sciences on 3 October 2016 under the ethics code IR.USWR.REC.1395.193.

3. Results

Table 1 presents Descriptive statistics including the mean and standard deviation of screen time, sleep duration, and BMI by age categories and gender. In general, the mean screen time, sleep duration, and BMI were 97.75 min/day, 668.35 min/day, and 16.58 among of our participants. It is noteworthy that there is no significant difference in any of the variables between girls and boys.

Table 1. Descriptive statistics of screen time, sleep duration and BMI by age categories and gender

Variable		Screen time Mean (SD)	Sleep duration Mean (SD)	BMI Mean (SD)	N
Age categories	0-1 m	13.33 (23.01)	759.72 (143.94)	13.95 (1.05)	18
	2-3 m	20.75 (27.83)	806.75 (135.23)	16.22 (1.49)	20
	4-6 m	34.25 (60.88)	722.75 (98.82)	16.76 (2.00)	20
	7-12 m	59.16 (66.85)	691.86 (86.73)	16.97 (1.94)	43
	13-24 m	82.36 (73.74)	643.48 (106.2)	17.01 (1.89)	69
	25-60 m	144.13 (96.56)	636.17(96.56)	16.61 (1.77)	149
Gender	Girl	98.69 (84.30)	675.31 (102.91)	16.50 (1.89)	160
	Boy	97.75 (92.76)	661.44 (124.83)	16.66 (1.92)	159
Total		97.75 (92.76)	668.35 (114.39)	16.58 (1.90)	319

As presented in table 2, approximately 63.9 percent of participants spend excessive screen time according to the American Academy of Pediatrics, 12.4 percent of participants had short sleep duration and in total 14.1 percent of children were overweight or obese.

Table 2. The frequencies and percentages of participants with excessive screen time, short sleep, overweight and obesity by age groups

Variable	Age categories						Total
	0-1 m	2-3 m	4-6 m	7-12 m	13-24 m	25-60 m	
Excessive screen time Frequency (percent)	5 (27.78%)	8 (40.00%)	10 (50.00%)	26 (59.09%)	51 (73.91%)	104 (69.80)	204 (63.95)

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Short sleep Frequency (percent)	2 (11.11%)	2 (10.00%)	2 (10.00%)	6 (13.64%)	13 (18.57%)	15 (10.00%)	40 (12.42%)
Overweight Frequency (percent)	0 (0.00%)	0 (0.00%)	3 (15.00%)	4 (9.30%)	5 (7.25%)	11(7.38%)	23 (7.21%)
Obesity Frequency (percent)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (2.33%)	8 (11.59%)	13 (8.72%)	22 (6.90)

Table 3 shows the results of the Spearman's Rho Correlation test carried out to examine the association among screen time, sleep duration, BMI, and age. Screen time was significantly, and positively correlated with BMI (rs = 0.38, p = 0.00) and age (rs = 0.60, p = 0.00), while was significantly negatively correlated with sleep duration (rs = -0.42, p = 0.00). sleep duration was significantly, and negatively correlated with BMI (rs = -0.22, p = 0.00) and age (rs = -0.40, p = 0.00) and finally BMI was significantly positively correlated with age (rs = 0.133, p = 0.00).

Table 3. The association among screen time, sleep duration, BMI and age

Variable	**Screen time**		**Sleep duration**		**BMI**		**Age**	
	r_s	p	r_s	p	r_s	p	r_s	p
Screen time	1	0.000	-0.417	0.000	0.380	0.000	0.597	0.000
Sleep duration	-0.417	0.000	1	-	-0.218	0.000	-0.397	0.000
BMI	-0.218	0.000	0.380	0.000	1	-	0.133	0.000
Age	0.597	0.000	-0.397	0.000	0.133	0.000	1	-

The Screen time (β = -0.26, p = 0.00) and the age (β = -0.20, p = 0.00) were significant predictors of sleep duration (table 4).

Table 4. Multiple linear regression model examining the association between screen time and age, and sleep duration

Variable	**Sleep duration**					
	B	SE	β	R^2	Adjusted R^2	P
Screen time	-0.317	0.076	-0.257	0.189	0.184	0.000
Age	-1.551	0.41	-0.234			0.000

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As shown in Table 5, the multiple linear regression model shows a direct association between BMI and screen time (β = 0.44, p = 0.00), and age (β = -0.17, p = 0.00), and screen time had more contribution to BMI. While sleep duration (β = -0.09, p = 0.12) was not significant predictor of BMI (table 6). The multiple regression that is presented in Table 7 indicated the significant predictive role of sleep duration in BMI scores.

Table 5. Multiple linear regression model examining the association between screen time, sleep duration and age, and BMI

	BMI					
Variable	B	SE	B	R^2	Adjusted R^2	P
Screen time	0.009	0.001	0.440	0.164	0.156	0.000
Sleep duration	-0.002	0.001	-0.09			0.117
Age	-0.019	0.007	-0.170			0.000

Table 6. Multiple linear regression model examining the association between sleep duration and age, and BMI

Variable	**BMI**					
	B	SE	B	R^2	adjusted R2	P
sleep duration	-0.003	0.001	-0.183	0.042	0.0360	0.002
age	0.005	0.007	0.049			0.415

The one-way ANCOVA (screen time categories x sleep duration with age as a covariate) indicated a significant impact of screen time (F (4, 314) = 5.02, P = 0.001) on the sleep duration (table 8).

Table 7. Summary of covariance analysis to evaluate the effect of screen time on the sleep duration (covariate: age)

Source of variation	**Sum-of-squares**	**df**	**Mean square**	**F**	**Sig.**
Age	131151.761	1	131151.761	12.273	0.001
Screen time	214390.353	4	53597.588	5.015	0.001
Error	3344889.927	313	10686.549	-	-

Two-way ANCOVA with factors of screen time (five categories) and sleep duration (five categories), and age as a covariate found no significant interaction between screen time and sleep duration categories (F (4, 314) = 1.16, P=0.298), While fund a significant main effect of the screen time categories (F (4, 314) = 9.25, p=0.000) and sleep duration categories (F (4, 314) = 4.18, p=0.000) that summarized in table 9.

Table 8. Summary of two-way ANCOVA to evaluate the effect of screen time and sleep duration on the BMI (covariate: age)

Source of variation	**Sum-of-squares**	**df**	**Mean square**	**F**	**Sig.**
Age	17.474	1	17.47	5.799	0.017
Screen time	111.507	4	27.877	9.252	0.000
Sleep duration	50.334	4	12.583	4.176	0.003
Screen * sleep	56.011	16	3.501	1.162	0.298
Error	879.816	292	3.013	-	-

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4. Discussion

The aim of this study was to investigate associations among screen time, and sleep duration and BMI of under-five-year-old children.

We found that children who had more screen time use had less sleep duration. In other word screen time as a predictor have a significant impact on sleep duration. The findings of the present study support the recommendations of the American Academy of Pediatrics in terms of an appropriate limitations screen time for under-five years old children [3,4]. This finding is consistent with some previous studies that found that screen time is adversely associated with sleep outcomes. For instance, the findings of a cohort study (2014) on Australian children (4-5 years of age at baseline) showed that total media use at 4 years of age was significantly associated with sleep duration at 6 years of age [45]. In most studies, the relationship between time spent watching TV, using computers or other screen devices, and sleep-related variables including sleep duration has also been evaluated separately [46]. Mak et al (2014) in their baseline survey study on adolescents in Hong Kong obtained heterogeneous results and indicated that Television and computer viewing were not correlated with sleep duration, while mobile phone viewing was correlated with sleep duration [47]. It is noteworthy that the content type [6], and temporal and physical location of screen viewing [6,24] are two compelling factors influencing the sleep duration.

The findings of the present study showed that BMI scores of under-five children was positively associated with screen viewing time and negatively associated with sleep duration. Also, the results of this study indicate that screen time could predict BMI scores, however, the sleep duration could not predict the BMI of under-five children in presence of screen time as an independent variable. Furthermore, both screen time and sleep duration had an impact on under-five children's BMI scores. The results of our study could be supported by the unconscious eating mechanism, in which children have a tendency to eat more energy-dense snack foods. When they eat during the TV viewing, they will be unaware of the amount of food they eat. [48,49]. Moreover, the more screen time is associated with more sedentary behavior time and less physical activity Which in turn can cause overweight or obesity [50,51].

Our finding is in good agreement some previous research suggested the relationship between screen viewing aspects and BMI, overweight, or obesity. Kuriyan et al (2007) identified TV viewing as one of the significant factors that contribute to overweight in 6-16-year-old children [52]. In another study, Bickham et al (2013) showed that attention to TV is a key element of media use that is associated with increased BMI in young adolescents [53].

This study has not confirmed a meta-analysis of prospective studies published in 2018 revealed that shorter sleep duration is a risk factor for obesity in infants, children, and adolescents [54]. The disparity of findings may be attributed to the role of screen time as an independent variable; in such a way that irrespective of screen time as an independent variable, sleep duration could predict BMI as presented in table 7.

The main limitation of the study was its cross-sectional design, which restrains causal inference. Besides, the data collection method for screen time and sleep duration which was based on self-reporting time use diary might have caused a bias in recall bias. Future research on this topic could address the limitations of this study and a prospective cohort study would be more appropriate design to examine the long-term impacts of screen time on sleep duration and BMI of under-five children.

The strength of this study was our sampling strategy and its attempt to control extraneous variables especially for age, gender, and the socioeconomic status of households.

5. Conclusions

In summary, findings of the present study suggest that screen viewing is associated with sleep duration and BMI in under-five children. Moreover, screen time is a predictive factor on sleep duration and BMI scores of children. Our findings suggest that sleep duration negatively is related to BMI in under-five-Year-Old children. Based on the evidence from this study, it is recommended to

focus research on Predictors of screen viewing time on Iranian children, and finally, we purpose to plan health-related and psycho-social early intervention program in order to control the duration of media use.

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