

Games as education tools

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ABSTRACT

Objective: The aim of this study was evaluated effects of an intervention with the serious game “Perfect Bedroom: learn to sleep well” on the sleep habits of healthy children. **Methods:** Two groups were composed, experimental (EG) (n=8) and control (CG) (n=5), with health children. This study presented four stages: pre-intervention, intervention, post-intervention and follow-up. Parents responded questionnaires about sociodemographic data and sleep habits measured by UNESP Sleep Habits and Hygiene Scale Child version (USHS). Children responded strategies developed by researchers: “Set up your bedroom” and “Mapping activities before bedtime”. The intervention was performed with “Perfect Bedroom” twice a week and for three weeks in a row. Inferential analysis was accomplished for comparisons between groups (Mann-Whitney test) and intragroups (Wilcoxon signed-rank test and Friedman test for repeated measures). **Results:** Preliminary results indicated non-significant differences on the sleep habits reported by parents. Children’s responses indicated a reduction in the number of electronic objects in bedroom and actions with these devices to EG. **Discussion:** As far as we know, this is the first study that used a serious game to promote healthy sleep habits in children. In addition, they are actively included in the change process. Preliminary findings contribute to indicate the potential of this approach as an effective tool to promote healthy sleep habits in children.

Keywords: Children; Sleep Hygiene; Sleep; Interactive Learning; Games, Experimental.

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INTRODUCTION

Sleep problems, such as insufficient sleep duration, sleepiness and difficulty to falling asleep are common in childhood, becoming a public health problem^{1,2}. Empirical data demonstrated that sleep plays a critical role in physical, cognitive and psychological developmental process in children^{3,4}. In addition, sleep problems do not only impact the health and development of children, but can also affect other family members, increasing conflict and marital stress, sleep, mood, and daytime functioning of the parents⁵.

Numerous studies have shown that sleep is a strategic priority in public health and interventions to promote health sleep in childhood could help to mitigate the adverse effects of sleep problems. Recent research has identified only 15 published studies with sleep programs aimed at improving sleep in children and adolescents⁶. In Brazil, there are some similar initiatives^{7,8}. Sleep interventions have some common limitations. First, almost all of them present improvements in sleep knowledge, but they promote few changes in sleep behaviors⁶. Second, several interventions for children receive only information from parents, the children did not play an active role in the process of changes in sleep behavior. Third, sleep intervention presents difficulties to promote a motivational approach to optimize sleep habits and sleep parameters.

Sleep problems can be caused by various factors. However, in children, sleep problems are mostly related to sleep habits^{9,10}. Previous research indicated that school and pre-school children with television in their bedroom and without a consistent bedtime routine slept 18 to 60 minutes less per night, according parents report, indicating that poor sleep habits are associated with sleep alterations¹⁰. Sleep hygiene practices includes a set of behavioral and environmental recommendations on sleep environment, sleep routine and daytime activities intended to promote good sleep quality and sufficient sleep duration¹⁰.

Despite the benefits of sleep hygiene education recommendations, there is a gap in including a motivational approach that supports children's engagement and increases exposure to effective behavioral changes in sleep. In this view, serious game use can be a response, by including motivational aspects (e.g., fantasy and playful components), providing positive experiences, and increasing exposure to intervention. The serious game is an education game for developing social abilities, attitudes, knowledge and health¹¹.

Considering this, our research team developed a serious game based on recommendations of the Sleep Hygiene, named "Perfect Bedroom: learn to sleep well". The purpose of the current study is evaluated the effects of this game in the sleep habits and sleep parameters of health children. For this study, we define the following specific aims: (a) characterize children's sleep habits in pre-intervention, post-intervention and follow-up; (b) compare children's sleep habits in pre-intervention and post-intervention to assess immediate effects; (c) compare children's sleep habits in the stages of pre-intervention and follow-up to assess the maintenance of the effects. In this view, our

main hypothesis is that intervention with serious play will be useful to modify sleep hygiene related to inadequate sleep environment and pre-sleep activities of healthy children.

METHODS

This study present preliminary data from a study protocol recent published¹². It was expected sample size of 88 participants to each group, resulting in 176 healthy children, according to G*Power 3.1.9 analyses. Considering this, an initial sample of 13 healthy children comprised the experimental (EC) and control (GC) groups, as follows: EG (n=8; 5 boys, 3 girls) and control (CG) (n=5; 3 boys, 2 girls). Inclusion criteria for participation were as follows: (1) age between 7 and 8 years old; (2) not use of psychoactive drugs; (3) not diagnose of sleep disturbance or any health problems, such as neurological disorders, and psychiatric, cardiovascular or genetic diseases.

This research had four stages: pre-intervention, intervention, post-intervention and follow-up assessment, after four weeks. Assessment protocol included questionnaires, scales and strategies developed by researchers that were responded by parents/guardians and their children. The Research Ethics Committee of the Federal University of Rio Grande do Norte, Brazil (registration number 62016916.2.0000.5537) approved this study protocol. All participants (children and parents/guardians) were volunteers and signed the informed consent.

Measures

Parents responded a questionnaire about health and demographic characteristics from their family. To assessed family income was used socioeconomic status questionnaire responded by parents, which stratifies the population into six economic classes (A, B1, B2, C1, C2, D-E)¹³. In addition, parents answered Sleep Disturbance Scale for Children (SDSC) to evaluated presence of sleep disorders in children, such as: disorders of initiating and maintaining sleep, sleep breathing disorders, disorders of disturbance and nightmares, sleep wake transition disorders, sleepiness and sleep hyperhydrosis¹⁴.

Characteristics of the children's sleep habits were measured using the UNESP sleep habits and the version of the children's hygiene scale (USHS), answered by the parents at three different moments of the study: pre-intervention, immediate post-intervention and follow-up¹⁵. This scale has 16 items that have four indicators considered to sleep hygiene: sleep routine (activities performed before bed); physiological alertness (diurnal habits and discomfort near bedtime); cognitive/emotional aspects before bedtime (indicators of emotional regulation and well-being) and sleep environment (adequate sleep environment in terms of temperature, comfort and organization). Higher scores indicate worse sleep hygiene habits. This scale was empirically validated for use in Brazil.

The children participated actively in the stages of evaluation and characterization of sleep habits, using strategies developed by research team. In "Set up your bedroom" strategy each child received one kit with one sheet of paper A4 and seventeen

stickers that represent objects to set up your bedroom. In the second “Mapping activities before bedtime”, each participant received one kit with one sheet of paper A3 and fifteen stickers that represent activities to characterized actions that children usually did at night and before sleep¹². These strategies have been answered at three assessment moments.

Intervention

The intervention with experimental group was performed with the serious game “Perfect Room” and occurred for school children, twice a week (on Tuesdays and Thursdays), for three weeks in a row, starting at 2:00 p.m. and with a maximum duration of 50 minutes in each meeting. A previously trained researcher performed the intervention.

The serious game “Perfect Bedroom” was developed by our research team and it is currently in process of patenting, registration number BR 10 2015 032215 1, and their Study Protocol has been published¹². The game presents a series of behavioral and environmental recommendations on sleep hygiene in a playful way to learn about good sleep habits and to support changes in sleep behavior. (more details in reference 12). In this regard, participants were challenged to create the “perfect room” by applying sleep hygiene recommendations learned in the game.

Statistical Analysis

The initial analyses was performed to identified differences between experimental and control groups. The demographic data and sleep habits (according to children and parents responses) were investigated by inferential analysis

Variables exhibited an asymmetric distribution in Shapiro-Wilk normality test. In this regard, non parametric inferential analysis were conducted for identifying differences between experimental and control groups with Mann-Whitney test (U) for continuous variables and generalized Fisher test for categorical variables. Intragroup improvements were assessed through Wilcoxon (T) and Friedman test for repeated measures (χ^2).

In addition, the mapping strategy of bedroom responses was categorized into binary data (missing or present object in the room) and the total of inappropriate objects present was calculated and compared as well¹⁶. Moreover, the answers of the activities of mapping strategy before bed were analyzed in two ways: (1) categorized as binary data (absent or present activity) and (2) the last three activities of each participant were analyzed in order to characterize activities performed close to bedtime. Statistical was carried out using the software IBM SPSS (Statistical Package for the Social Sciences) version 22.0, assigning the 5% significance level for all statistical tests.

RESULTS

The results presented in this manuscript are preliminary. Groups were compared in terms of sociodemographic variables and sleep disorders screening. There were no significant differences between groups for these variables. According to parents’ responses and SDSC (Sleep Disturbance Scale for Children) screening, no participant had a diagnosis of sleep disorders. The

median ages was 7 years to experimental group (EC) and 8 years to control group (CG) (Table 1).

There were no differences between groups on parameters of the sleep habits measured by USHS in the pre-intervention evaluation, indicating that participants of both groups presented similar sleep habits related to sleep routine, physiological alert, cognitive/emotional aspects at bedtime and sleep environment (Table 1).

Findings from comparison between experimental and control groups in post intervention indicated lower scores for the experimental group on environmental sleep, physiological alert, cognitive/emotional parameters for the EG compared to CG (Table 2), although these results were not significant. Sleep environmental indicator are related to with how suitability is children’s bedroom (e.g. temperature and luminosity) and physiological alert with diurnal habits/activities realized before bedtime that could promote excitement or discomfort before bedtime. Looking this preliminary data and considering our sample size these findings could highlighted initial indications that intervention with the serious game could promote changes on sleep behaviors of children.

In the evaluation of amelioration for each group (intragroup analysis), non significant differences were found in the indicators of sleep hygiene for the EG, as follows: sleep routine ($\chi^2(2)=2.36, p=0.38$), physiological alert ($\chi^2(2)=0.54, p=0.88$), cognitive / emotional aspect ($\chi^2(2)=1.40, p=0.66$), sleep environment ($\chi^2(2)=2.0, p=1.00$) and for the total score ($\chi^2(2)=0.66, p=0.94$). In comparison between pre- and post-intervention to EG, an increase in the routine sleep indicator score (12,0 *versus* 14,0) was identified and a decreased in maximum value of this score was observed in post- intervention compared to pre-intervention (15,0 *versus* 21,0) (Table 3). Even if these differences were not significant, they could suggest some signals of the best sleep routine after intervention for EG, whereas higher scores in the USHS indicate worse sleep habits. The sleep routine involves activities performed before bedtime by children, such as the presence of nighttime relaxation activities (e.g. story telling, bath time) and the absence of electronic devices near bedtime (Table 3).

Of the children’s responses in the EG in the “Set Up Your Room” strategy, the number of electronic devices in the room (e.g., videogame and television) of 5 children after the intervention decreased, but this reduction was not significant ($T=9.5, p=0.23$).

Findings from the “Mapping activities before bedtime” strategy showed that school activities, riding and stories telling were more frequent in both groups at pre-intervention, followed by the use of electronic device for EG and personal hygiene to the CG. On the other hand, in the post-intervention it reduced the reports of use of electronic devices and increased the reports of games without use of the electronic games for EG, while increased the activities of personal hygiene for CG (Figure 1). In follow-up assessment was observed a decrease in activities related to school activities, riding and stories telling and an increase in use of electronic devices near bedtime to

Table 1. Sociodemographic characteristics, screening for sleep disorders and sleep habits of the experimental and control groups.

	EG N= 8	CG N = 5	<i>p</i>
Age (years)	Mdn	Mdn	
	7,0	8,0	0,16*
Gender	N	N	0,62**
Female	3	2	
Male	5	3	
Economic classes			1,00**
A1	0	0	
B1	1	0	
B2	1	0	
C1	2	2	
C2	3	3	
D-E	1	0	
SDSC	Mdn	Mdn	
DIMS	11,5	12	0,50*
SBD	4,5	5,0	0,49*
DDN	3,5	3,0	0,26*
SWTS	10,0	10,0	0,37*
DES	7,0	5,0	0,12*
SH	2,5	2,0	0,15*
USHS - Routine sleep	12,0	12,0	0,45*
Minimum	7,0	6,0	
Maximum	21,0	18,0	
USHS - Physiological alert	5,0	4,0	0,42*
Minimum	4,0	4,0	
Maximum	6,0	9,0	
USHS - Cognitive/emotional aspects	5,0	3,0	0,07*
Minimum	3,0	3,0	
Maximum	11,0	3,0	
USHS - Sleep environment	11,0	12,0	0,33*
Minimum	4,0	4,0	
Maximum	12,0	12,0	
USHS - Total	32,0	32,0	0,37*
Minimum	18,0	17,0	
Maximum	44,0	38,0	

EG=experimental group; CG=control group; SDSC=Sleep Disturbance Scale for Children; DIMS=disorders of initiating and maintaining sleep; SBD= sleep breathing disorders; DDN= disorders of disturbance and nightmares; SWTS=sleep wake transition disorders; DES=disorders of excessive sleepiness; SH= sleep hyperhydrosis; USHS=UNESP sleep habits and hygiene scale child version. **p* value refers to generalized Fisher test; ***p* refers to Mann-Whitney test; Mdn=median.

EC. Therefore, these findings point to some indications about the immediate effect of the game on the modification of the activities performed near the bedtime by the children, with the decrease of the use of electronic devices. However, after one month, these changes were not maintained, which indicated that the intervention was not long or intensive enough to sustain these changes.

DISCUSSION

This study is the first to assessing the effects of a serious game on the sleep habits of healthy children. According to parents' information about their children's sleep habits, the findings demonstrate small positive changes in the sleep routine

parameters after intervention in the experimental group, such as the inclusion of relaxing activities before bedtime (e.g. riding and stories telling) and reduction of exciting activities near bedtime (e.g. use of electronic devices).

Literature data has shown the potential bedtime routine on children's sleep behaviors⁹. The introduction of routines is to promote the same activities and in the same order, every night, before the lights are off, which helps and directs the children to sleep. Moreover, there are empirical evidences of the association between consistent bedtime routines (e.g. bath-time, massages, story-telling, giving a kiss/hug, softly singing) and improvements in children's sleep outcomes (e.g. sleep quality, sleep continuity, total sleep time)^{5,9}.

Table 2. Comparisons between groups on sleep hygiene parameters measured by UNESP sleep habits and hygiene scale child version (USHS) after intervention with the serious game "Perfect Bedroom".

	EG N=5 Mdn	CG N=5 Mdn	<i>p</i>
USHS - Routine sleep	14,0	13,0	0,35
Minimum	7,0	9,0	
Maximum	15,0	17,0	
USHS - Physiological alert	6,0	6,0	0,19
Minimum	4,0	4,0	
Maximum	8,0	6,0	
USHS - Cognitive/emotional aspects	5,0	3,0	0,08
Minimum	3,0	3,0	
Maximum	15,0	3,0	
USHS - Sleep environment	9,0	12,0	0,29
Minimum	4,0	4,0	
Maximum	12,0	4,0	
USHS - Total	33,0	30,0	0,23
Minimum	31,00	24,00	
Maximum	38,00	38,00	

EG=experimental group;CG=control group; **p*=statistical value ($p<0.05$); Mann-Whitney test.

On the other hand, accumulating evidences have highlighted the negative effects of media electronic use at bedtime on children's sleep, indicating that bedroom media presence and use of electronic devices by children are related to irregular sleep habits, poor sleep quality and shorter sleep time¹⁶. Findings from our research showed evidence of structural changes in children's bedroom organization with decrease in the use of electronic devices before bedtime for the experimental group, which was not sustained in the follow-up.

Although the changes are small, this amount of improvement may be clinically significant. Benefits acquiring knowledge about structural changes in the children's room and in routine participants' experimental group may be a starting point to enable individuals to understand the importance of the sleep and the implementation of the sleep hygiene recommendations over time, which could impact on health.

Overall, robust changes in sleep behaviors are a major challenge in this type of intervention and some hypotheses are highlighted^{17,18}. First, with the predominance of good practices of sleep hygiene or adequate duration of sleep, the effects of the intervention may be smaller since it is a group without sleep alterations. In this direction, the lack of significant improvements in the sleep parameters in the experimental group may be due to the good sleep hygiene parameters presented in the baseline¹⁹.

Another explanation about discrete changes in children's sleep habits observed in this study can be related to the necessity of parental engaging to promote effective improvements. For modification of some unhealthy sleep habits is necessary parent's involvement and assistance in promotion an appropriate sleep environment, as well as to acting in the resolution of emotional or health problems that may interfere in sleep. In our analysis, as expect, was not identified improvements in physiological alert, cognitive/emotional aspects and sleep environment indicators on sleep hygiene related by children's caregivers. Maybe, an association between interventions with parents and their child may be helpful to promote robust changes.

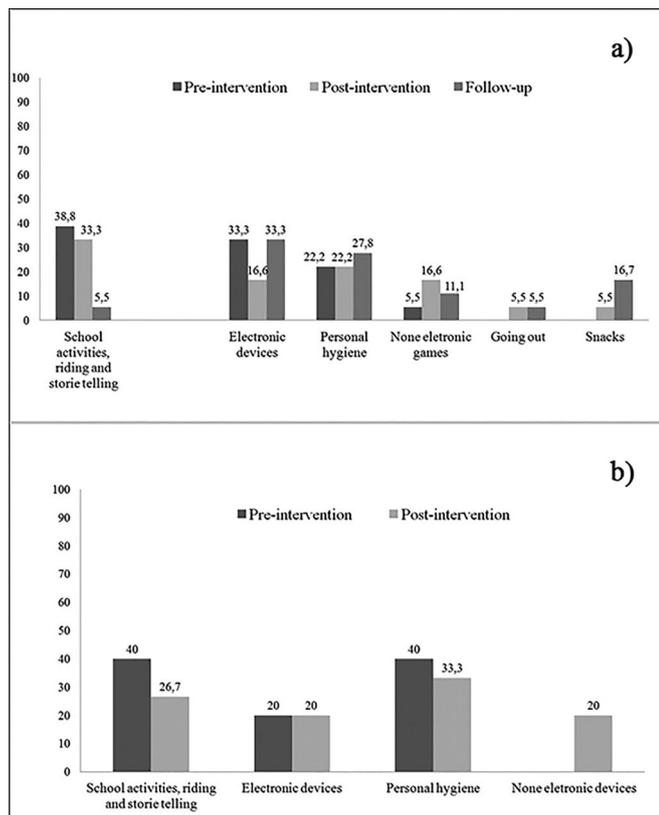
The results obtained in this study are preliminary and present some limitations that must be considered. First, a larger sample is needed to measure the actual effects of the serious game "Perfect Bedroom" in sleep habits (next step). Second, the

Table 3. Intragroups comparisons analysis of sleep hygiene parameters measured by UNESP sleep habits and hygiene scale child version (USHS).

	EG N=5			<i>p</i>	<i>p</i>	CG N=5		
	Pre Mdn	Post Mdn	Follow-up			Pre Mdn	Post Mdn	<i>p</i>
USHS - Routine sleep	12,0	14,0	15,5	0,38*	0,50**	12,0	13,0	0,46*
Minimum	7,0	7,0	14,0			6,0	9,0	
Maximum	21,0	15,0	17,0			18,0	17,0	
USHS - Physiological alert	5,0	6,0	5,0	0,88*	0,25**	4,0	6,0	0,62*
Minimum	4,0	4,0	4,0			4,0	4,0	
Maximum	6,0	8,0	7,0			9,0	6,0	
USHS - Cognitive/ emotional aspects	5,0	5,0	3,5	0,66*	0,62**	3,0	3,0	1,0*
Minimum	3,0	3,0	3,0			3,0	3,0	
Maximum	11,0	15,0	6,0			3,0	3,0	
USHS - Sleep environment	11,0	9,0	11,0	1,00*	0,50**	12,0	12,0	1,0*
Minimum	4,0	4,0	4,0			4,0	4,0	
Maximum	12,0	12,0	12,0			12,0	4,0	
USHS - Total	32,0	33,0	37,0	0,94*	0,37**	32,0	30,0	0,43*
Minimum	18,0	31,00	25,0			17,0	24,00	
Maximum	44,0	38,00	38,0			38,0	38,00	

EG=experimental group;CG=control group; **p*=statistical value ($p<0.05$); **p* value refers to Friedman test for repeated measures; ***p* refers to Wilcoxon signed-rank test.

Figure 1. Characterization of activities at night and before sleep according to strategy to "Mapping activities before bedtime": a) experimental group; b) control group.



subjective self-report of the parents is subject to social desirability and may lead to overestimation or underestimation of the report, which could influence the accuracy of the report²⁰. Third, a follow-up to evaluate the possible retention of sleep habits.

Despite the limitations, this study is the first to our knowledge to test serious game effects on the sleep habits of healthy children. This study provides an important contribution given initial support for the potential of a serious game "Perfect Bedroom" intervention to improve children's sleep habits immediately after the intervention, such as structural changes in environmental sleep (e.g. reduction of electronic devices in the bedroom) and at bedtime routine with decrease media consumption and increased relaxation activities before bedtime. While these positive effects have not been sustained in follow-up, suggesting the need for long-term follow-up to capture significant benefits and more intensive interventions that may include parents to help their children change behavior during sleep, there are signs of should be better explored.

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