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CLINICAL REVIEW

The assessment of sleep in pediatric chronic pain sufferers

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SUMMARY

The aim of this study is to review the options available for assessing sleep in pediatric chronic pain populations. One subjective measure of sleep (questionnaires) and two objective measures (polysomnography and actigraphy) were reviewed. The following databases were searched from their inception to June 2011: PsycINFO, ERIC, FRANCIS, MEDLINE, PsycARTICLES, Global health, Inspec, Health and Psychosocial Instruments, CINAHL, Scopus and ProQuest Dissertations and Theses databases. A total of nine sleep questionnaires were identified, two of which proved to be reliable and valid when used with pediatric chronic pain patients and, according to evidence-based assessment criteria, can be regarded as "well-established" instruments. Objective measures have been used less frequently. Both polysomnography (PSG) and actigraphy (ACT) have been used in five different studies. PSG is a reliable method for assessing sleep stage problems but is costly and intrusive. Actigraphy is cheaper, more ecological and easier to use than PSG but it deals only with the objective dimension of sleep (total sleep time, sleep efficiency, etc).

In order to improve the reliability and validity of the assessment of sleep, a multi-level and multi-method approach is suggested: sleep measurement should be extended to include both objective and subjective assessment.

Introduction

Sleep is one of the most essential physiological needs for human beings. Good sleep is fundamental to adequate rest, proper functioning and health. It is often disturbed or deteriorated in children and adolescents with health problems, and particularly if they have chronic medical conditions.[2] Defining good rest or sleep quality is not easy. For example, the subjective sense of being refreshed, the number of hours slept, the number of awakenings and the sleep onset latency, among other factors, have all been related to proper rest, but the term "sleep quality" has not been rigorously defined.[3] Buysse et al.[4] suggested the following conceptualization: "*Sleep quality includes quantitative aspects of sleep, such as sleep duration, sleep latency, or number of arousals, as well as more purely subjective aspects, such as depth or restfulness of sleep*." They also went on to state that "*the exact elements that compose sleep quality, and their relative importance, may vary between individuals. Furthermore, because sleep quality is largely subjective, sleep laboratory measures may correlate with perceived sleep quality, but they cannot define it*." Buysse et al.'s statement has been used by most subsequent studies and publications on sleep quality.

The relationship between chronic pain and sleep problems in adults is well documented. A recent survey in Europe showed that 65% of respondents with chronic pain reported that they were unable to sleep or had difficulties falling asleep.[5] Adult pain sufferers have reported scores on sleep disturbance scales that double those of healthy counterparts[6] and it has been proved that there is a direct positive relationship between improving the pain and the quality of sleep in adults with chronic pain.[7]

Although not much information is available on young people with chronic pain, the reports that have been published also show that sleep is deteriorated: children report that they have difficulties sleeping,[8] the risk of insomnia increases by as much as six times[9] and there is a significant prospective association of sleep duration with following day pain, namely, longer sleep duration and increased wake time after sleep onset (WASO) is associated with higher pain.[10]

Sleep is crucial for chronic pain patients, and absolutely critical in children and adolescents. For example, it is one of the core

Abbreviations: ACT, actigraphy; APA, American Psychological Association; ASHS, adolescent sleep hygiene scale; ASWS, adolescent sleep wake scale; CSHQ, children's sleep habits questionnaire; EBA, evidence-based assessment; PSG, polysomnography; WASO, wake time after sleep onset.

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Table 1
Pediatric sleep questionnaires used in chronic pain research.

Name	Author and year	Number of items	Languages	Age and respondent	Sleep quality criteria	Psychometric properties	Pain problem	Psychometric properties in pain	EBA criteria[a]
Sleep disturbance scale for children SDSC[29]	Bruni et al. (1996)	26	Italian English[29] [b]Brazilian Portuguese[30] [b] Dutch[31]	6.5–15.3 (parent)	- Disorders of initiating and maintaining sleep - Sleep breathing disorders - Disorders of arousal - Sleep-wake transition disorders - Disorders of excessive somnolence - Sleep hyperhydrosis	- Factors: 6 - Sensitivity: (.89) - Specificity: (.74) - Internal consistency: ($\acute{a}$ = .71–.79) - Test-retest reliability: (Spearman = .71)	Polyarticular juvenile rheumatoid arthritis[32] Headache[33]	Not assessed Not assessed	It doesn't meet the criteria to be used in pediatric chronic pain
Pediatric sleep questionnaire PSQ[34]	Chervin et al. (2000)	22	English[34] [b] Spanish[35]	2–18 (parent)	- Snoring - Sleepiness - Behavior - Sleep-related breathing disorders	- Factors: 4 - Test-retest reliability (Spearman = .66–.92) - Internal consistency ($\acute{a}$ = .66–.89) - Validity: association between SRBD scale and diagnosis (AUC = .95)	Limb pain[36] Migraine[37] Chest pain[38]	Not assessed Not assessed Not assessed	It doesn't meet the criteria to be used in pediatric chronic pain
Adolescent sleep hygiene scale ASHS[17,18]	LeBourgeois et al. (2005)	28	English[17,18] Italian[17,18] [b] Dutch[39]	12–17 (self administrated)	- Physiological - Cognitive - Emotional - Sleep environment - Daytime sleep - Substances - Bedtime routine - Sleep stability - Bed sharing	- Internal consistency ($\acute{a}$ = .80)	Chronic pain[40] Chronic pain[9]	Internal consistency ($\acute{a}$ = .81) Internal consistency ($\acute{a}$ = .81)	Well-established criteria to be used in pediatric chronic pain
Adolescent sleep wake scale ASWS [17,18]	LeBourgeois et al. (2005)	28	English[17,18] Italian[17,18]	12–17 (self administered)	- Going to bed - Falling asleep - Maintaining sleep - Reinitiating sleep - Returning to wakefulness	- Internal consistency ($\acute{a}$ = .80–.86)	Chronic pain[41] Chronic pain[9] Chronic pain[40]	Correlation with actigraphy (r = .37) Internal consistency ($\acute{a}$ = .70) Internal consistency ($\acute{a}$ = .70)	Well-established to be used in pediatric chronic pain
Children's sleep habits questionnaire (school ages) CSHQ[16 c]	Owens et al. (2000)	56	English[16,42] Dutch[43] [b] Chinese[44] [b] Hebrew[45]	4–10 years	- Bedtime resistance - Sleep onset delay - Sleep duration - Sleep anxiety - Night wakings - Parasomnias - Disordered breathing - Daytime sleepiness	- Sensitivity: (.80) - Specificity: (.72) - Internal consistency ($\acute{a}$ = .68–.78) - Test-retest reliability (Pearson = .4–.79)	Chronic pain[46] Juvenile rheumatic arthritis[47] Migraine[48] Migraine[49] Juvenile idiopathic arthritis[50] Sickle cell disease[51] Migraine[37]	Reliability ($\acute{a}$ = .86) Good correlation with SSR Not assessed Not assessed Not assessed á = Consistent with original validation sample Not assessed	Well-established criteria to be used in pediatric chronic pain
Sleep self-report (child form) SSR[52]	Owens et al. (2000)	26	English[52] Finnish[53] [b] Dutch[54]	7–12 years (self)	- Sleep habits - Sleep onset delay - Sleep duration - Night wakings - Daytime sleepiness	- Internal consistency ($\acute{a}$ = .71) - Convergent validity with CSHQ	Juvenile rheumatic arthritis[47] Juvenile rheumatic arthritis[55] Inflammatory bowel disease[53]	Good correlation with CSHQ Not assessed Not assessed	Approaching well-established criteria to be used in pediatric chronic pain

Sleep habits questionnaire[56]	Sadeh et al. (2000)	20	Hebrew[56]	7.2–12.7 (parent, self)	- Sleepiness - Sleep habits - Fatigue	- Convergent validity with actigraphy and sleep logs - Internal consistency (ά = .72–.82)	Headache[57] Abdominal pain[58]	Not assessed Not assessed	It doesn't meet the criteria to be used in pediatric chronic pain
Sleep questionnaire by Simonds and Parraga[59]	Simonds et al. (1982)	23	English[59]	5–18 (parent)	- Poor-quality or non-restorative sleep - Anxieties about sleep - Parasomnias - Disordered breathing - Early waking	- Face validity - Content validity - Test-retest reliability (Spearman .83)	Neurofibromatosis [60]	Not assessed	It doesn't meet the criteria to be used in pediatric chronic pain
School sleep habits survey SSHS[60,61] Modification by Bruni[63]	Wolfson et al. (1998) Bruni et al. (2008)	63 34 + some open questions	English[60,61] Italian[62] Hebrew[64]	13–19 8–15 (self)	- Sleepiness scale - Sleep-wake behavior problems scale - Depressive mood scale - Sleep habits question - Sleepiness scale - Sleep-wake problem behavior scale - Morningness/ eveningness questionnaire	- Internal consistency (ά = .70–.75) - Convergent validity with actigraphy and sleep logs - Internal consistency (ά = .62–.68)	Headache[65] Chronic pain[66] Musculoskeletal pain[67] Headache[63]	Not assessed Not assessed Not assessed Not assessed	It doesn't meet the criteria to be used in pediatric chronic pain

Abbreviations: CSHQ, children's sleep habits questionnaire; SRBD, sleep-related breathing disorder; AUC, area under the ROC curve.
[a] APA Division 54 assessment task force steering committee criteria.[1]
[b] Questionnaire version not used in pain research.
[c] CSHQ also has a preschool and toddler version that has not been used with pediatric chronic pain populations. This version is only available in English.

outcome domains recommended for consideration in clinical trials of pediatric chronic and recurrent pain.[11] It is central to research into the effects of treatment programs for pediatric chronic pain. Having a valid and reliable assessment procedure that can provide significant information on sleep quality has become a priority for clinicians and researchers.[12]

The aim of this study is a) to review the three assessment procedures that are most commonly used in pediatric chronic pain studies[11]: one subjective measure (questionnaires) and two objective measures (polysomnography and actigraphy); and b) to analyze future avenues for research.

Methods

Search strategy and identification of studies

In order to maximize the number of papers retrieved we adopted a two-stage search strategy, similar to that implemented by Palermo et al.[13] First, PsycINFO, ERIC, FRANCIS, MEDLINE, PsycARTICLES, Global health, Inspec, Health and Psychosocial Instruments, CINAHL, Scopus and ProQuest Dissertations and Theses were all electronically searched from their inception to June 2011. Second, reference lists of relevant retrieved papers[14,15] were checked to identify additional published works not found in the computerized database searches. Once our results had been filtered, a total of 33 papers were identified, of which five studied polysomnography, five actigraphy and 23 questionnaires used in pain research.

The following key words and strategies were implemented in the search engines to find the questionnaires: "Sleep" AND (infant* OR child* OR adolescent*) AND (questionnaire* OR instrument* OR scale* OR checklist* OR assessment* OR record* OR report* OR interview* OR test* OR measure*) AND "pain". The following key words were used to search for polysomnography studies: (child* OR adolescent* OR infant*) AND "polysomnography" AND "pain". Finally, in order to find papers related to actigraphy, the following key words were implemented: "Sleep" AND (child* OR adolescent* OR infant*) AND "actigraphy" AND "pain".

Selection criteria

An article was eligible if it met all of the following criteria: 1) it had been published in a peer reviewed journal; 2) the participants were 18 years old or less; 3) the study population suffered from chronic pain; and 4) the article had been published in a full report. An article was excluded if: 1) the tool (questionnaire, actigraphy or polysomnography) did not assess sleep quality or sleep habits (for example, the questionnaire focused on sleepiness, sleep breathing disorders, cognitions about sleep, dream content or circadian rhythms; or the actigraphy device was used to assess physical activity); 2) the questionnaire was part of a multidimensional scale (for example a fibromyalgia inventory); 3) the questionnaire was originally designed to be used in an adult population; or 4) the article dealt with cancer-related pain.

Results

Questionnaires

The initial list of questionnaires retrieved was filtered and we kept only those questionnaires that had been used in pediatric chronic pain-related research and for which psychometric characteristics were available. In the present paper we report on the nine questionnaires that satisfy these criteria. Table 1 summarizes the findings. We also report on the evidence-based assessment

(EBA) criteria produced by the American Psychological Association (APA) Division 54 assessment task force steering committee.[1] The EBA criteria make it possible to classify the questionnaires as a) well-established, b) approaching well-established, and c) promising. Well-established measures must have been presented in at least two peer-reviewed articles by different researchers or research teams. Enough details about the measure are provided to allow critical evaluation and replication of the study. Detailed information is provided (e.g., statistical data) and validity and reliability are shown to be good in at least one peer-reviewed article. Approaching well-established measures must have been presented in at least two peer-reviewed articles by the same researcher or research team. Enough details about the measure are provided to allow critical evaluation and replication of the study. Information is provided on the validity and reliability, either in vague terms (e.g., no statistics are presented) or the values are moderate. Promising measures must have been presented in at least one peer-reviewed article. Enough details about the measure are provided to allow critical evaluation and replication of the study. Information is provided on the validity and reliability, either in vague terms (e.g., no statistics are presented) or the values are moderate.

As can be seen in Table 1, most questionnaires were first published and made available in English, although there are now other language versions. Most questionnaires contain a long list of items; they range from 22 to 63, with a mean of 33 items. The published questionnaires can be used in a wide age range (2–19 years), but there are fewer questionnaires for the ages at the extremes of this range. Each questionnaire has its own sleep quality conceptualization: sleepiness is considered in six questionnaires, but fatigue in only one. Although all questionnaires reported good psychometric properties, the psychometric assessment was poor in most instances when they were used with chronic pain populations: 18 studies did not report any psychometric characteristics, four informed only of the internal consistency, three showed the correlation with only one other measure and one reported on the reliability of the questionnaire. Headaches and juvenile arthritis are the two most commonly investigated pain problems, and seven studies did not specify the chronic pain problem.

On the basis of the EBA criteria,[1] three questionnaires can be considered to be well-established tools, and one other can be judged as approaching well established. The remaining questionnaires do not reach the standards required for use in pediatric chronic pain populations (none of the questionnaires reviewed meet the "promising" criteria). The questionnaires that have been rated as well-established measures in pediatric pain research are the "children's sleep habits questionnaire" (CSHQ),[16] which has been used in six chronic pain-related studies; the "adolescent sleep wake scale" (ASWS),[17,18] which has been used in three chronic pain-related studies; and the "adolescent sleep hygiene scale" (ASHS),[16,17] which has been used in two chronic pain-related studies. This last study only deals with sleep hygiene.

Polysomnography

Polysomnography is regarded as "the gold standard" for assessing sleep[4,11] but it has been used in only seven studies (see Table 2). Polysomnography assesses such biophysiological variables as brain function, heart rate, eye movement and muscle activation while the subject is sleeping.[15] It also provides information on total sleep time, sleep disordered breathing, sleep stages and their distribution, and other parameters.[3] These data have to be collected in a sleep unit, a special room equipped to monitor all these variables using various kinds of sensors: electrodes (for electroencephalography, electro-oculography, electromyography and electrocardiography), thermistors and microphones (to assess air flow and breathing), piezoelectric strain gauges (for thoracic movements), finger oximeters (for oximetry), etc. All of this is a considerable burden for the patient. Table 2 summarizes the results.

The first publication using polysomnography in pediatric chronic pain research appeared in the year 1998. In most of the subsequent studies, the samples consist of a clinical group with an age- and sex-matched control group. The sample sizes are as low as 12 people and as high as 90, with a mean of 42. The studies were conducted with young patients (study samples range from 6 to 15 years; one study was conducted with newborns). Most of the studies report two nights of recordings: a night of sleep laboratory habituation and a night of evaluation. The pain problem in which polysomnography has been most used is juvenile arthritis. To the best of our knowledge, to date no study has looked into the validity and/or reliability of polysomnography (PSG) in pediatric chronic pain populations. A total of three studies used self-report instruments and PSG to assess the quality of sleep of a group suffering from chronic pain and a group with no chronic pain, but no attempt was made to relate both measures. Of these three studies, one[55] reported no differences between groups in self-reported sleep but differences were shown by PSG. The other two studies,[32,73] however, showed exactly the opposite: that is to say, there were no intergroup PSG differences but there were in self-reported sleep.

Table 2
Polysomnography and pediatric chronic pain research.

Authors	Sample size	Sample age	Number of nights assessed	Pain problem	Validity
Axelin et al. (2010)[68]	18 pain sufferers	Newborns	30 h	Pain in preterms	Not assessed
Lopes et al. (2008)[69]	12 pain sufferers 12 healthy controls	12.5 ± 2.4 13.1 ± 2.0	1 (after a night of sleep laboratory habituation)	Chronic arthritis	Not assessed
Passarelli et al. (2006)[32]	21 pain sufferers 20 healthy controls	13.0 ± 2.0 13.0 ± 2.0	1 (after a night of sleep laboratory habituation)	Juvenile rheumatoid arthritis	Not assessed
Vendrame et al. (2008)[72]	90 pain sufferers	11.0 (5–19)	1	Mixed sample of headache sufferers: migraine and tension headaches	Not assessed
Ward et al. (2008)[55]	32 inactive JRA 38 active JRA	8.1 ± 1.8 8.9 ± 2.0	1 (after a night of sleep laboratory habituation)	Juvenile rheumatoid arthritis	Not assessed
Ward et al. (2010)[70 a]	32 inactive JIA 37 active JIA	8.1 ± 1.8 8.9 ± 2.0	1 (after a night of sleep laboratory habituation)	Juvenile rheumatoid arthritis	Not assessed
Zamir et al. (1998)[73]	16 pain sufferers 9 healthy controls	12.0 ± 4.0 11.0 ± 3.0	1	Juvenile rheumatoid arthritis	Not assessed

Abbreviations: JRA, juvenile rheumatoid arthritis; JIA, juvenile idiopathic arthritis.
[a] In this study Ward et al. worked with the same sample as in the study of 2008.

Actigraphy

Used to assess sleep in chronic pain populations since 2004, actigraphy employs a watch-like device that contains an actimetry sensor to record movements. It provides useful objective measures for assessing sleep patterns.[15] This tool has been shown to report sleep data consistently with polysomnography,[19,23] sleep diaries,[20,21] and parental reports.[22] Table 3 summarizes information from the seven studies that used actigraphy to assess sleep quality in pediatric chronic pain studies. As is the case with polysomnography, in most cases the samples used consisted of a clinical group with an age- and sex-matched control group. Sample size ranged between 15 and 39 people. The age of the participants was between 8 and 16 years. Most of the studies reported one week of measurements. A total of three studies dealt with various chronic pain problems: one dealt with recurrent abdominal pain, two with headache and one with chronic musculoskeletal pain (additional information about the characteristics of the pain and the location in the body is provided in Table 3). Like polysomnography, the validity and reliability of actigraphy (ACT) in pediatric pain populations is not well established. Only two papers, using the same sample of participants, reported on the relationship between actigraphy and the adolescent sleep wake scale, and the authors found a moderate correlation between both measures.[40,41] Two other studies found group discrepancies in sleep complaints but not in ACT reports.[10,58]

Discussion

Our work reviewed the three assessment procedures that are used in most pediatric chronic pain studies[11]: one subjective measure (questionnaires) and two objective measures (polysomnography and actigraphy). The review has shown that only a handful of questionnaires have been assessed with pediatric chronic pain populations. When the psychometric properties of questionnaires have been studied, the samples used were mostly healthy subjects. Of all the questionnaires reported in the literature, only three can be regarded as well-established tools: the "children's sleep habits questionnaire" (CSHQ),[16] the "adolescent sleep wake scale" (ASWS)[17,18] and the "adolescent sleep hygiene scale" (ASHS).[16,17] These measures are very similar in terms of their psychometric properties so whether one or another is used depends largely on the age of the study population and even the language in which the assessment is to occur. Nevertheless, since these questionnaires assess different aspects of sleep, clinicians must be cautious about identifying the specific instrument that is most suited to their purposes. The ASWS and the ASHS could be used together as complementary tools. However, using them together can be a problem if they are part of a protocol for evaluating children in pain because they lengthen the evaluation quite considerably. The same can be said of the CSHQ, which has 56 items and takes a long time to answer.

Polysomnography is a valid and reliable tool for use in the general population but, even so, little effort has been made to assess its validity and reliability when used in pediatric chronic pain research. It assesses many sleep quality-related variables, some of which may also be evaluated with questionnaires and actigraphy, but polysomnography is the only alternative that can assess sleep stages. Even though polysomnography has a certain appeal for research purposes, it does have some drawbacks when it is used in clinical practice. First of all, it is an expensive procedure due to the complexity of the appliances. Second, the staff that use it need to be thoroughly trained. Third, it is not an ecological measure; information has to be collected in very special sleep units in very special environments, quite different from what the child is used to. One final problem is that it does not take into account the subjective aspects of sleeping; in fact there seem to be no differences in the polysomnographic records of patients who complain about the quality of their sleep and those of people who judge their sleep quality to be "good".[24]

Actigraphy has some positive characteristics. It is easy to use and comfortable for the user; it is an ecological measure that allows data to be collected over quite long periods of time.[3] It also seems to be a cost-effective method for objectively assessing certain sleep parameters.[25] Nevertheless, the recording period must be long enough to gather information on all the significant events, it is much more expensive than any questionnaire and it requires trained staff to analyze the data collected with the proper software. Actigraphy focuses on the objective dimension of sleep so it is not

Table 3
Actigraphy and pediatric chronic pain research.

Authors	Sample size	Sample age	Number of nights assessed	Pain problem	Validity
Bruni et al. (2004)[74]	18 pain sufferers 17 healthy controls	9.8 ± 1.21 9.6 ± .99	14 7	Migraine without aura	Not assessed
Bursztein et al. (2006)[57]	28 pain sufferers 108 healthy controls	10.39 ± 2.02 10.28 ± 1.62	5	Headache	Not assessed
Haim et al. (2004)[58]	15 pain sufferers 25 healthy controls	13.7 ± 2.7 age matched	7	Functional recurrent abdominal pain	Not assessed
Lewandowski et al. (2010)[10]	39 pain sufferers 58 healthy controls	15.3 ± 1.5 14.6 ± 1.8	10	Mixed sample: headache (48.7%), abdominal pain (20.5%), back pain (15.4%), and other musculoskeletal pain (15.4%)	Not assessed
Palermo et al. (2007)[40]	20 pain sufferers 20 healthy controls	14.6 ± 1.9 15.5 ± 1.4	7	Mixed sample: chronic headaches (40%), functional abdominal pain (10%), myofascial pain (40%), and complex regional pain syndrome (10%)	Correlation with ASWS in sleep efficiency ($r = .37$) and wake bouts ($r = -.34$)
Palermo et al. (2008)[41] [a]	20 pain sufferers 20 healthy controls	15.0 ± 1.4 14.6 ± 2.0	7	Mixed sample: chronic headaches (40%), functional abdominal pain (10%), myofascial pain (40%), and complex regional pain syndrome (10%)	Correlation with total sleep quality on the ASWS ($r = .37$)
Tsai et al. (2007)[71]	19 pain sufferers (girls only)	14.9 ± 2.0	7	Chronic musculoskeletal pain	Not assessed

Abbreviation: ASWS, adolescent sleep wake scale.[17,18]
[a] In this study Palermo et al. worked with the same sample as in the study of 2007.

appropriate for providing a full description of sleep quality; for example, it cannot report on the nature of behavioral sleep disturbances like bedtime resistance or insomnia. It only gathers information on movement, not sleep per se. Thus, as is also the case with polysomnography, actigraphy has not been extensively validated for use in pediatric pain populations and it cannot be the only technique used to assess sleep quality.

The role that sleep problems play in pain processes, or the relationship between sleep and pediatric chronic pain, is still poorly understood and has seldom been explored.[26] It is evident, though, that both pain and sleep problems significantly deteriorate the patient's quality of life. In spite of the methodological difficulties of assessing sleep in pediatric chronic pain populations, the literature suggests that there is a clear, reciprocal relationship between pain and sleep.[7,10,27] Furthermore, sleep disturbance is one of the most important and prevalent complaints of pediatric chronic pain patients. Little is known about how to effectively manage sleep problems in this population.[9] Nevertheless, some reports have shown that certain interventions (e.g., cognitive-behavioral therapy[28]) lead to significant improvements in both sleep quality and pain.

There is a pressing need to use reliable, valid and sensitive measures to assess sleep[28] and to include sleep assessment and treatment in all pediatric chronic pain management programs.[2] Using reliable, valid and change-sensitive measures of sleep would help to improve our understanding of how sleep problems and pain processes interact and influence each other. It would also help us to design specific treatment protocols tailored to the internal and external personal characteristics of the patients.

The analysis of sleep requires a multi-level and multi-method approach to assessment, in which the various procedures are efficiently combined to provide an exhaustive analysis of the multiple levels and units in which sleep can be decomposed and studied. A combination of both subjective measures (questionnaires) and objective measures (actigraphy and polysomnography) would help to overcome the limitations inherent to each procedure and provide detailed, valid and reliable information.

Practice points

- Sleep is one of the outcome domains that professionals dealing with pediatric chronic pain should assess.
- There are three main tools for assessing sleep in pediatric chronic pain: questionnaires, polysomnography and actigraphy. Each has its advantages and disadvantages.
- The psychometric properties of questionnaires are well documented in the original paper in which they were first reported.
- Three "well-established" questionnaires are used in pediatric pain populations: the adolescent sleep hygiene questionnaire,[17,18] the adolescent sleep wake scale[17,18] and the children's sleep habit questionnaire.[16]
- The validity and reliability of actigraphy and polysomnography in pediatric chronic pain patients has yet to be determined.
- The age of patients, the kind of illness, and their social and economic resources all need to be taken into account if the most appropriate measure is to be chosen for particular individuals in particular circumstances.
- The three "well-established" questionnaires aside, the psychometric properties of the questionnaires used with chronic pediatric pain populations are poorly assessed.

Research agenda

- The lack of a widely accepted definition of "sleep quality" suggests that it could be worthwhile to hold a sleep experts meeting to reach a consensus.
- Future studies should provide numerical data on the psychometric properties of questionnaires so that informed decisions on whether they are valid or reliable for specific purposes can be made.
- An additional area for further research and development is to create shorter questionnaires, or shorter versions of existing questionnaires, in order to minimize the burden on patients when they are undergoing extensive multidimensional pain assessments.
- The age range of children using polysomnography and actigraphy is very narrow. Future studies are needed to try out these devices on younger patients so that their reliability can be assessed.
- International multi-center studies are needed to develop universally validated tools, which can subsequently be adopted to study sleep in chronic pediatric pain populations. This would also help to develop appropriate treatment protocols.
- Longitudinal studies need to be carried out with larger samples to provide adequate data for developing effective treatments.
- Studies need to be made of the relationship between the various assessment alternatives so that the agreement between them can be determined. The correspondence between measures has yet to be studied in depth.

Conflict of interest statement

None to be reported.

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