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Journal
Paediatric Anaesthesia, 25(7)

ISSN
1155-5645

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Publication Date
2015-07-01

DOI
10.1111/pan.12678

HHS Public Access

Author manuscript

Paediatr Anaesth. Author manuscript; available in PMC 2016 July 01.

Published in final edited form as:

Paediatr Anaesth. 2015 July ; 25(7): 738–745. doi:10.1111/pan.12678.

Revisiting a Common Measure of Child Postoperative Recovery: Development of the Post Hospitalization Behavior Questionnaire for Ambulatory Surgery (PHBQ-AS)

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Abstract

Background—The Post Hospitalization Behavior Questionnaire (PHBQ) was designed for assessing children's post-hospitalization and postoperative new-onset behavioral changes. However, the psychometric properties of the scale have not been re-evaluated in the past five decades despite substantial changes in the practice of surgery. In this investigation, we examined the psychometric properties of the PHBQ to potentially increase the efficacy and relevance of the instrument in current perioperative settings.

Method—This study used principal components analysis, a panel of experts, Cronbach's alpha, and correlations to examine the current subscale structure of the PHBQ and eliminate items to create the Post Hospitalization Behavior Questionnaire for Ambulatory Surgery (PHBQ-AS). Data from previous investigations (N = 1064, M_{age} = 5.88) which utilized the PHBQ were combined for the purposes of this paper.

Results—A principal components analysis revealed that the original subscale structure of the PHBQ could not be replicated. Subsequently, a battery reduction, which utilized principal components analysis and a panel of experts, was used to eliminate the subscale structure of the scale and reduce the number of items from 27 to 11, creating the PHBQ-AS. The PHBQ-AS demonstrated good internal consistency reliability and concurrent validity with another measure of children's psychosocial and physical functioning.

Conclusion—Revising the former subscale structure and reducing the number of items in the PHBQ to create the PHBQ-AS may provide a means for reducing the burden of post-operative

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ETHICS

This manuscript did not require any ethical approvals.

DISCLOSURES

No authors have any conflicts to disclose.

behavioral assessment through decreasing time of administration and eliminating redundancy of items and allow for more accurate measurement of child postoperative behavioral changes.

Keywords

pediatric; postoperative; behavioral change; ambulatory surgery; measurement; modification

Background

Numerous studies have shown that hospitalizations, particularly those involving surgery have both short and long term psychological effects and behavioral consequences for children [1, 2]. In particular, anesthesia and surgery have been shown to be associated with new onset behavioral changes in children including increases in anxiety, nightmares, problems going to bed, and eating disturbances [3, 4]. Furthermore, if sleep disturbances and separation anxiety persist from six to twelve months post-surgery they may impact children's responses to subsequent medical care and may interfere with normal development, socialization, and adjustment to school [5]. Due to these consequences, it is important to accurately assess and treat new onset post-operative behavioral changes in children [1, 6].

In 1966, Vernon, Schulman, and Foley developed a parent-rated instrument, the Post Hospitalization Behavior Questionnaire (PHBQ), to quantify behavioral changes in children who undergo hospitalization due to surgery or illness [7]. Since then, the PHBQ has been used as a quantifiable method for assessing children's post-hospitalization as well as postoperative new onset behavioral changes [1, 4, 8]. However, this scale is less frequently used for research purposes possibly because some items are not applicable to specific contexts or populations, there is no consensus on how the scale should be scored, the scale may have never been properly evaluated, and the psychometric properties of the PHBQ have not been recently evaluated [1, 9, 10].

It is important to note that the PHBQ was originally developed to assess behavioral changes in children who underwent hospitalization due to anesthesia and surgery or illness. Given anesthesia and surgery have evolved significantly over the past 5 decades and most children currently undergo outpatient surgery, the relevance of the original scale in today's perioperative setting needs to be examined. We submit that reevaluating the psychometric properties of the scale for the perioperative setting may increase its relevance, efficacy, and efficiency by eliminating repeated nuances in the measure and focusing on behaviors more specific to surgical recovery. Therefore, the purpose of this paper was to examine the psychometric properties of the PHBQ in current perioperative settings using principal components analysis to potentially increase the efficacy of the instrument for future research in this area.

Method

Sample and Settings

The Center on Stress and Health at the University of California Irvine School of Medicine, which was located at Yale University until 2008 has conducted 17 studies [11-23] utilizing

the PHBQ over the past 15 years. The data used for this paper were derived from an integrated database of all participants (N = 1064, M_{age} = 5.88, SD_{age} = 2.32, $minimum_{age}$ = 1.97, $maximum_{age}$ = 12) in these studies. All participants were recruited from 2 major children's hospitals, one in the northeastern and one in the southwestern United States and underwent outpatient surgery with general anesthesia. Parents of child participants completed the PHBQ on post-surgery days one, two, and three, and weeks one and two. The analyses presented here utilize data from post-operative day two because this is the day when children are most likely to exhibit behavioral change and are home from surgery [13]. The majority of participants were male (56%) and non-Hispanic White (80%).

Measures

Post Hospitalization Behavior Questionnaire—The PHBQ is comprised of 27 items among six subscales (general anxiety and regression, separation anxiety, eating disturbance, aggression toward authority, apathy/withdrawal, anxiety about sleep; see Table 1). This parent-report measure assesses new onset maladaptive behaviors in children after stressful medical procedures and events, including surgery and hospitalization. Currently, the PHBQ is considered the criterion standard for postoperative behavioral assessment in children from one month to 16 years of age. For each item, parents are asked to compare their child's behavior before hospitalization to their current behavior (post-hospitalization) on a Likert-type scale using the following five response options: *much less than before* (1), *less than before* (2), *same as before* (3), *more than before* (4), and *much more than before* (5). Originally, the inclusive continuous scoring method was used for the analysis, which involves summing the responses from all 27 items with no transformation on any values. Thus, this method produces a possible range of scores from 27 - 135. More recent studies have used other scoring methodologies including assessing the frequency at which behavioral changes have occurred [8, 24].

Functional Disability Inventory—In this study, the Functional Disability Inventory (FDI) [25] was used as a measure to reflect concurrent validity of the revised PHBQ. The FDI is a 15-item instrument that assesses limitations in psychosocial and physical functioning as a function of children's physical health. The FDI can be completed by children ages 8 – 20 or can be administered to parents to report on child functioning. [26]. For each item, respondents are asked to rate the physical difficulty in completing each activity stated (e.g., eating regular meals, sleeping at night, doing chores at home, etc.). The items are scored on five different response options: *no trouble* (0), *a little trouble* (1), *some trouble* (2), *a lot of trouble* (3), and *impossible* (4) [25]. A total score is obtained by summing all 15 items, producing a possible range of scores from 0 – 60, with higher scores indicating increased functional disability. This measure was previously observed to have sound psychometric properties [26].

Statistical Method

Replication of Original Subscale Structure—A forced six factor principal components analysis with varimax rotation was conducted using all 27 items of the original PHBQ to determine if the items aligned as indicated in the original subscale structure analysis. If the items aligned with their original subscale structure, we sought to reduce

items within each subscale when possible. If the items did not align with their original subscale structure (this was the case and the following statistical methods reflect this), we sought to create one overall Post Hospitalization Behavior Questionnaire for Ambulatory Surgery (PHBQ-AS) with no subscales and fewer items.

Battery Reduction—We conducted a principal components analysis with no rotation and no forced number of factors to examine which items would be candidates for elimination based on empirical results. Then, a panel of experts, including a pediatric anesthesiologist, clinical child psychologist, and child psychiatrist reviewed the items and identified items necessary for retention based on content validity.

Reliability—Cronbach's alpha was used to examine the reliability among items of the PHBQ and PHBQ-AS. Cronbach's alpha reflects the internal consistency among items and can have a range from 0 to 1, with higher values indicating higher reliability. Cronbach's alphas were computed for the original 27 item PHBQ and the PHBQ-AS, and then compared. We used the Spearman-Brown Prophecy Formula [27] to predict the decrease in Cronbach's alpha when eliminating items. The Spearman-Brown Prophecy Formula estimates the resulting Cronbach's alpha of the reduced scale based on the original number of items and the reduced number of items in the scale. If the Cronbach's alpha for the PHBQ-AS was closer to the Cronbach's alpha of the original PHBQ than it was to the predicted Cronbach's alpha, the Cronbach's alpha of the PHBQ-AS was considered acceptable.

Concurrent Validity—To assess concurrent validity, we correlated the PHBQ and PHBQ-AS each with the FDI (only children aged 8 to 16 who had values on all three measures (N = 87) were used so as to account for the age limits of the scales and ensure the same subset of participants was used for each comparison). To examine possible changes in concurrent validity, the Pearson's product-moment correlation coefficients were compared [28].

Scoring of the Post Hospitalization Behavior Questionnaire for Ambulatory Surgery—Multiple imputation was used to impute scores for missing data by calculating the mean item value across all participants with complete data and using this mean to replace missing values[1]. Missing values were only replaced with the mean for participants who had only 10% or less of missing data. In this dataset, less than 2% of participants had missing data and, across all participants, less than 1% of data was missing for each item. Of the participants with missing data, 65% had 10% or less of missing data and thus, multiple imputation was used to replace their missing data. To ensure low levels of missing data, we suggest that future research follow the methods of Howard and colleagues by including an option of "not applicable" for each item of the measure and reporting the percentage of individuals selecting this option for each item [10]. Items responded to using this option should be given a value of 3 to indicate no behavioral change on the item. To score the PHBQ-AS, items were averaged by summing the items for each respondent and then dividing by the total number of items (this followed the methodology of Howard et al. [10]).

[1]When necessary, multiple imputation can be done separately for different groups (e.g., by condition (experimental vs. control) or by age (younger vs. older children).

The total PHBQ-AS score produces a continuous variable with higher values above 3 (the midpoint) indicating greater maladaptive behavioral changes, lower values below 3 indicating improvements in behavioral change, and values equal to 3 indicating no behavioral change.

Results

Replication of Original Subscale Structure

The results of the forced six factor principal components analysis with varimax rotation for the original 27 items failed to reproduce the original subscale structure developed in 1966 (see Table 1).

Battery Reduction

Because the factor analysis did not replicate the original factor structure of the PHBQ, a principal components analysis with no rotation and no forced number of factors was used to see if a single composite measure with fewer items could be created (Table 2). This analysis suggested that items 1, 4-8, 12-14, 16-23, and 25-27 (see Table 1 for content) should be eliminated. The panel of experts independently reviewed the remaining PHBQ items and determined that items 6, 14, 20, and 22 (see Table 1) had high content validity for the purpose of evaluating pediatric postoperative recovery, and should therefore be retained based on item content. Thus, items 2, 3, 6, 9, 10, 11, 14, 15, 20, 22, and 24 were retained to create the PHBQ-AS (see Table 3).

Reliability

The Cronbach's alpha coefficients for the PHBQ and for the PHBQ-AS were 0.82 and 0.80, respectively. The Spearman-Brown Prophecy formula estimated that 0.65 would have been the value of the Cronbach's alpha coefficients of the PHBQ-AS when the number of items in the scale was decreased from 27 to 11. Because the actual reliability was considerably higher than the estimated value and comparable to the reliability of the much longer PHBQ, we considered the Cronbach's alpha of the PHBQ-AS as adequate for group comparisons.

Concurrent Validity

There was a significant correlation between the PHBQ and the FDI (Pearson's r (87) = 0.48, $p < .001$). The correlation between the PHBQ-AS and FDI was also significant (Pearson's r (87) = 0.49, $p < 0.001$). These correlations were comparable ($z = -0.16$, $p = 0.88$), indicating no compromise in the validity of the shortened scale.

Conclusion

The purpose of the present study was to reevaluate the psychometric properties of the PHBQ using a large population of children undergoing surgery and general anesthesia. Under the conditions of the study, we found that the original subscale structure of the PHBQ, which was developed in 1966, could not be replicated. The shortened measure with no subscales and significantly fewer items could result in a more relevant, efficient, and valid means of assessing behavioral change in children undergoing outpatient surgery.

The lack of replication of the original subscales is possibly the result of the many changes that have occurred in the perioperative environment since the development of the PHBQ in 1966. Specifically, it is currently the norm that surgery is done on an outpatient basis (the population studied in this report reflects this), however, the original scale was constructed using a sample of hospitalized children undergoing surgery (and hospitalized children due to illness). Postoperative behavioral recovery could be expected to differ between children who undergo outpatient versus inpatient surgery and as a result, the original subscales may no longer be a valid form of measurement in the present surgical environment. Moreover, there are new innovations and methods of conducting simple and complex surgical procedures, which have altered how care is delivered and children's subsequent recovery at home. For example, anesthetic and analgesic agents have changed significantly over the past 50 years, which can impact behavioral recovery in children. It is because of these changes in the surgical environment that the newly developed PHBQ-AS is particularly relevant.

Although we have attempted to revise this measure using a large sample, there are still limitations in the conclusions that can be drawn due to methodological constraints of this study. Specifically, although we explain how changes in the surgical environment may have contributed to the lack of replication of the PHBQ with our sample, there are other cultural, social, scientific, and environmental factors that could explain this finding. However, it is difficult to conclude exactly which factors may have contributed to the differences in findings between the original development of the PHBQ and the current analysis because data on these factors is minimal.

Regardless of these limitations, significantly shortening the PHBQ will potentially reduce the time it takes to administer the measure, lessening parents' burden and increasing the potential use in clinical settings. Based on our experiences using this measure, each item takes a significant amount of time to administer when interviewing parents as parents must answer all 27 items. In addition, eliminating items that may be repeated and those that may be irrelevant to children undergoing outpatient surgery could yield in a more valid instrument when tested with longer term consequences of pre- and postoperative behavior changes.

Even though the PHBQ-AS represents a potentially more efficient and effective method of analyzing postoperative behavioral changes, the shortened measure needs to be further validated before it can be recommended for use in measuring post-operative behavior changes in children. Although we provide preliminary evidence of internal reliability and construct validity, the shortened measure will need to be fully evaluated in terms of its psychometric properties. However, once the PHBQ-AS has been extensively validated, the original PHBQ may still be a valid measure of child behavioral change after hospitalization due to illness or inpatient surgery.

We have also elaborated on the scoring of the PHBQ-AS. We state that missing data should be handled using multiple imputation and that scores should then be calculated by taking the average of the items. There is a great deal of inconsistency in the literature on the scoring of the PHBQ [9] and using these methods of handling missing data and calculating the scores will enable findings across studies to be compared. Additionally, scoring the PHBQ-AS

using an average will allow for an observance of improvements in behavioral change (as indicated by lower PHBQ-AS scores) . Often, studies track children over the course of a month after surgery and expect to see behavioral improvements towards the end of the month [10]. This scoring method will account for these changes.

In addition to recommendations for missing data and scoring, we suggested that researchers include a “not applicable option” for each item so that when parents are rating their child’s behavior they do not skip an item due to its lack of applicability. Inclusion of this option is important as applicability of each item of the PHBQ varies across surgery types and participant populations. For example, children who recover from tonsillectomies are unlikely to want to eat for the first few days after surgery leading parents to possibly answer yes to PHBQ item 24, “Does your child have poor appetite?” However, it is not truly the child’s lack of appetite but the pain associated with the surgery that may be causing the child to not want to eat. When using the PHBQ it is important for researchers to consider the types of surgeries their participants have experienced. In addition to the applicability of items to surgery type, there is also the question of applicability of items to population age ranges. Specifically, some items (e.g., item 7, “Does your child wet the bed at night?) are not relevant for older child populations such as adolescents. The age range of the population should also be taken into account when using the PHBQ. Although surgery type and participant population should be considered when using the PHBQ-AS, the addition of a “not applicable” option and the elimination of many of the PHBQ items (e.g., items 7 and 24; see Table 3) may alleviate some problems of applicability.

Although future research may be needed to address the issues noted above, our evaluation of the PHBQ in this paper is a step towards remediating some of the problems associated with the PHBQ. We have modified the PHBQ to create the PHBQ-AS by examining and then eliminating the original subscale structure of the measure, reducing the number of items from 27 to 11, and investigating the reliability and validity of the newly modified PHBQ-AS. This newly developed scale provides a means for reducing the burden of postoperative behavioral assessment through decreasing time of administration, eliminating redundancy of items, and increasing the relevance of the measure to the ambulatory surgery setting. Thus, the PHBQ-AS may result in the opportunity for more widespread assessment of behavioral changes in children after outpatient surgery.

Acknowledgments

FUNDING

This research was funded by National Institutes of Health grant numbers include: R01HD37007-01, R01HD37007-02, R01HD037007-04, 2R01HD037007-06, and R01HD048935-01A1.

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a. The Post Hospitalization Behavior Questionnaire (PHBQ) is used to evaluate children's post-hospitalization recovery but was developed over 50 years ago.

b. This article reevaluates the psychometric properties of the PHBQ to potentially increase the relevance of the instrument in the current perioperative setting.

c. This updated measure may be more appropriate for the current perioperative environment children experience.

Table 1

PHBQ Items, Subscales, Components, Communalities, and Eigen Values Based on a Forced 6 Factor Solution Principal Components Analysis with Varimax Rotation (N = 1035[a])

Item	Subscale	Components[b]						Communalities H-Squared Values[c]
		1	2	3	4	5	6	
4. Does your child need a pacifier?	General Anxiety	.388	.413	.216	−.246	.237	.295	.571
5. Does your child seem to be afraid of leaving the house with you?	General Anxiety	.360	.122	.098	−.234	.463	−.071	.428
6. Does your child seem uninterested in what goes on around him/her?	General Anxiety	.437	−.269	.158	.197	−.068	−.166	.359
8. Does your child bit his/her fingernails?	General Anxiety	.237	.559	.173	−.070	.098	.118	.427
12. Does your child seem to avoid or be afraid of new things?	General Anxiety	.456	.038	−.204	.129	.445	−.114	.479
13. Does your child have difficulty making up his/her mind?	General Anxiety	.514	−.026	.160	−.062	.216	−.419	.517
21. Does your child have irregular bowel movements?	General Anxiety	.208	−.170	.278	.038	−.021	.487	.389
27. Does your child suck his/her fingers or thumb?	General Anxiety	.338	.485	.184	−.104	.124	−.048	.411
9. Does your child get upset when you leave him/her alone for a few minutes?	Separation Anxiety	.627	−.038	−.421	−.174	.013	.030	.603
16. Does your child seem to get upset when someone mentions doctors or hospitals?	Separation Anxiety	.326	.175	.055	−.107	−.398	.079	.316
17. Does your child follow you everywhere around the house?	Separation Anxiety	.504	.048	−.585	−.154	−.041	−.081	.631
18. Does your child spend time trying to get or hold your attention?	Separation Anxiety	.487	.069	−.585	−.210	−.130	.104	.656
20. Does your child have bad dreams at night or wake up and cry?	Separation Anxiety	.379	.055	−.144	.040	−.155	.159	.218
2. Does your child make a fuss about eating?	Eating	.591	−.422	.213	.188	−.114	.003	.621
3. Does your child spend time just sitting or lying and doing nothing?	Eating	.578	−.464	.205	.017	.022	.132	.610
24. Does your child have a poor appetite?	Eating	.586	−.497	.222	.028	−.125	.072	.661
14. Does your child have temper tantrums?	Aggression	.443	.224	.088	.174	−.382	−.256	.496

Item	Subscale	Components[b] 1	2	3	4	5	6	Communalities H-Squared Values[c]
25. Does your child tend to disobey you?	Aggression	.350	.427	.025	.038	−.392	−.310	.557
7. Does your child wet the bed at night?	Apathy	.343	.404	.339	−.082	.022	.137	.422
10. Does your child need a lot of help doing things?	Apathy	.593	−.258	−.099	−.054	.006	.052	.434
11. Is it difficult to get your child interested in doing things (like playing games with toys)?	Apathy	.590	−.385	.101	−.002	.144	−.006	.527
15. Is it difficult to get your child to talk to you?	Apathy	.564	−.245	.109	.026	−.043	−.085	.400
23. Does your child seem to be shy around strangers?	Apathy	.468	.135	−.085	−.072	.177	−.177	.312
26. Does your child break toys or other objects?	Apathy	.411	.567	.293	−.043	−.176	−.064	.613
1. Does your child make a fuss about going to bed at night?	Sleep	.151	.352	−.097	.702	.116	.011	.662
19. Is your child afraid of the dark?	Sleep	.351	.197	−.206	.015	−.144	.464	.440
22. Does your child have trouble getting to sleep at night?	Sleep	.255	.229	−.204	.695	.179	.168	.702
Eigen value[d]		5.372	2.744	1.655	1.365	.1227	1.103	

Note: Highlighted values indicate which factor the item loaded onto. Values underlined in red indicate that the item had a split load.

[a] Principal components analysis deletes cases listwise so that participants with any missing data are removed from the analysis. Thus, 29 participants were not included in the analysis due to missing data.

[b] Component values of the six factors are listed for each item and represent the loading of each item onto each factor.

[c] Estimated Communalities (H-Squared Values) represent the variation that each item shared with the cluster of other variables in that factor. The total h squared value is the sum of the squared factor loadings.

[d] Eigen values for each factor measure the variance explained by all the variables included in that factor and is the sum of the squared factor loadings for all items in the factor.

Table 2

PHBQ Items, Subscales, Components, and Eigen Value for Factor 1 of a Principal Components Analysis (N = 1035[a])

Item	Subscale	Factor 1 Components[b]
4. Needs Pacifier	General Anxiety	.388
5. Afraid of Leaving	General Anxiety	.360
6. Uninterested in Surroundings	General Anxiety	.437
8. Bites Nails	General Anxiety	.237
12. Avoid New Things	General Anxiety	.456
13. Difficulty Making up Mind	General Anxiety	.514
21. Irregular Bowel Movements	General Anxiety	.208
27. Suck Thumb	General Anxiety	.338
9. Upset when Alone	Separation Anxiety	.627
16. Upset at Doctors/Hospitals	Separation Anxiety	.326
17. Follow You Everywhere	Separation Anxiety	.504
18. Wants Your Attention	Separation Anxiety	.487
20. Wakes Up and Cries	Separation Anxiety	.379
2. Fusses about Eating	Eating	.591
3. Does Nothing	Eating	.578
24. Poor Appetite	Eating	.586
14. Has Tantrums	Aggression	.443
25. Disobeys You	Aggression	.350
7. Wets the Bed	Apathy	.343
10. Needs a Lot of Help	Apathy	.593
11. Hard Getting Child Interested	Apathy	.590
15. Difficult to Talk to Child	Apathy	.564
23. Shy Around Strangers	Apathy	.468
26. Breaks Objects	Apathy	.411
1. Fussy at Night	Sleep	.151
19. Afraid of Dark	Sleep	.351
22. Trouble Getting to Sleep	Sleep	.255
Eigen Value[c]		5.372

Note: Highlighted items indicate those items that loaded onto factor 1.

[a] Principal components analysis deletes cases listwise so that participants with any missing data are removed from the analysis. Thus, 29 participants were not included in the analysis due to missing data.

[b] Component values of the single factor are listed for each item and represent the loading of each item onto each factor.

[c] The eigen value for the factor measures the variance explained by all the variables included in that factor and is the sum of the squared factor loadings for all items in the factor.

Table 3

Items Eliminated
1. Does your child make a fuss about going to bed at night?
4. Does your child need a pacifier?
5. Does your child seem to be afraid of leaving the house with you?
7. Does your child wet the bed at night?
8. Does your child bite his (or her) finger nails?
12. Does your child seem to avoid or be afraid of new things?
13. Does your child have difficulty making up his (or her) mind?
16. Does your child seem to get upset when someone mentions doctors or hospitals?
17. Does your child follow you everywhere around the house?
18. Does your child spend time trying to get or hold your attention?
19. Is your child afraid of the dark?
21. Does your child have irregular bowel movements?
23. Does your child seem to be shy around strangers?
25. Does your child tend to disobey you?
26. Does your child break toys or other objects?
27. Does your child suck his (or her) fingers or thumbs?
Items Retained
2. Does your child make a fuss about eating?
3. Does your child spend time just sitting or lying and doing nothing?
6. Is your child uninterested in what goes on around him (or her)?
9. Does your child get upset when you leave him (or her) alone for a few minutes?
10. Does your child need a lot of help doing things?
11. Is it difficult to get your child interested in doing things (like playing games with toys)?
14. Does your child have temper tantrums?
15. Is it difficult to get your child to talk to you?
20. Does your child have bad dreams at night or wake up and cry?
22. Does your child have trouble getting to sleep at night?
24. Does your child have a poor appetite?