The Association Between Type of Cancer and Chemotherapy Stage with Sleep Disturbances Among Children with Cancer: A Cross-Sectional Study in Sulaymaniyah, Iraq

Rawand Shafeeq Ali[1], Nazar R. Othman[2]
[1] MSc Student, College of Nursing, Hawler Medical University, Erbil, Iraq
Email: rawand.shafeq@gmail.com
[2] Assistant Professor, PhD, College of Nursing, Hawler Medical University, Erbil, Iraq
Email: nazar.othman@hmu.edu.krd

Abstract
Background: Childhood cancer and related treatment procedures induce significant physiological and psychological stress in pediatric patients, among which sleep disturbances are a widespread but little-studied sequelae in underdeveloped countries. **Objective:** The association of cancer type and chemotherapy stage with sleep disturbances in children with cancer receiving chemotherapy. **Methods**: A descriptive cross-sectional study was conducted at Hewa Hematology and Oncology Teaching Hospital from October 2025 to June 2026. A convenience sample of 90 children aged 6–10 years receiving chemotherapy was recruited. **Results** The mean total CSHQ score was 74.65±5.92 and all the children scored above the clinical cut-off (>41), indicating a high prevalence of sleep disruptions. Chemotherapy phases showed significant disparities in all CSHQ areas ($p = 0.004$) with children in the induction phase having worse sleep results. Significant relationships were discovered between cancer type and Sleep Duration ($p=0.031$), Sleep Onset Delay ($p=0.016$) and Bedtime Resistance ($p=0.045$). **Conclusion:** Sleep disturbances are systemic, severe and dynamically changing during oncological diagnosis. The results demonstrate unique times of risk with greater vulnerability for patients undergoing acute chemotherapy induction and after being diagnosed with lymphoma or CNS tumors. Routine systematic screening is suggested for optimizing sleep quality in pediatric cancer care.
Keywords: Sleep disturbance, pediatric oncology, Chemotherapy stage, Hodgkin lymphoma
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Introduction

Childhood cancer is a major public health problem around the world and is one of the top causes of disease-related death in the pediatric population. Identification and treatment have made remarkable advances, with increasing survival rates, yet children on therapy continue to face substantial physical, psychological and behavioral issues. One such finding is disturbed sleep, which is described as a prevalent and therapeutically relevant issue in pediatric cancer patients[1]Sleep is a fundamental biological activity important for growth, neurodevelopment, emotional regulation, immunological function, and physical recovery. Sleep is especially important for children who are on chemotherapy to recover from the toxic effects of chemotherapy and to be able to get more aggressive therapies[2] Sleep issues have been linked to fatigue, cognitive impairment, mental illness, behavioral disorders and impaired health-related quality of life [3] Researchers have observed that as many as 80% of children diagnosed with cancer report sleep issues during active therapy. [3, 4]. The common clinical signs include difficulties in sleep initiation, sleep maintenance problems, reduced total sleep time, sleep fragmentation14, nightmares and sleepiness during the day. [4] . The complex problems could change with pain, anxiety, hospital environmental variables, chemotherapy toxicity, corticosteroid use and cancer linked lethargy. [5]. Chemotherapy is the principal treatment modality for cancer in children and is delivered in multiple phases: induction, consolidation and maintenance. These phases have different characteristics of strength, duration and toxicity. Fatigue, nausea and emotional distress are experienced at different levels during chemotherapy and are intimately linked with the alterations of quality of sleep [6, 7]. The longer the course of chemotherapy, the higher the chance of serious symptoms in children that disturb normal sleep. [4] The specific cancer kind could also affect sleep architecture, besides the therapy phase. Hematologic illnesses, such as leukemia and lymphoma, may include intensive long-term chemotherapy, frequent hospital admission, corticosteroid medication, and systemic symptoms that may affect sleep quality. Solid tumors however, have different symptomatology depending on the site of the tumor, the disease burden, and the surgical procedures. However, there are no studies of the co-occurrence of sleep disorders across cancer types and phases of chemotherapy in pediatric populations, particularly in developing countries such as Iraq. In this study, the association between types of cancer and

stage of chemotherapy with sleep issues in children with cancer under treatment is investigated in Hewa Hematology and Oncology Teaching Hospital in Sulaymaniyah City, Iraq.

Methodology

Study Design

A descriptive cross-sectional study design was undertaken to find out the association of type of cancer, chemotherapy stage with sleep disturbance among children with cancer.

Study Setting

This study was conducted in Hewa Hematology and Oncology Teaching Hospital, Sulaymaniyah City, Kurdistan Region, Iraq. This hospital is a major tertiary referral hospital for specialized pediatric oncology involving chemotherapy and supportive treatment.

Study Population

The study population was children with cancer who were undergoing chemotherapy treatment at Hewa Hospital between October 2025 and June 2026.

Sample Size and Sampling Technique

A total of 90 children with different types of malignancies receiving chemotherapy treatment were enrolled by using a non-probability convenience sampling method from pediatric inpatient and outpatient oncology units during their usual chemotherapy consultations. Eligible participants were children, 6–10 years old, who could answer study questions independently or with career assistance and whose parents or legal guardians provided informed consent.

Children were excluded if they were critically ill and admitted to an intensive care unit, had diagnosed neurological or psychiatric disorders that could influence sleep patterns, were taking pharmacological sleep medications, or had severe cognitive or communication impairments that would interfere with study participation.

Data Collection Instrument

Data were collected by a standardized questionnaire with three major sections. The first section consisted of sociodemographic data of the children (age in years, sex, school grade). The second part contained clinical and medical data such as kind of cancer, stage of current treatment, age at diagnosis, and use of drugs that may impair sleep (e.g., corticosteroids, antiemetics).

Sleep Assessment Tool

• **Children's Sleep Habits Questionnaire (CSHQ):** A standardized 33-item questionnaire developed by Owens et al. (2000) to assess sleep quality and sleep disorders in school-aged children. It includes eight subscales: bedtime resistance (6 item), sleep onset delay (1 item), sleep duration (3 items), sleep anxiety (4 items), night wakening (3 items), parasomnias (7 items), sleep-disordered breathing (3 items), and daytime sleepiness (6 items). The child's mother or primary caregivers completed the questionnaire. Higher scores mean more disturbed sleep and worse sleep quality, and scores range from 33 to 99. A total score >41 indicates a clinically important sleep disturbance. Each item was assessed on a 3-point Likert scale, 1 = Rarely (0–1 nights/week), 2 = Sometimes (2–4 nights/week), 3 = Usually (5–7 nights/week).

Data Collection Procedure

Data were acquired through face-to-face interviews with children and caregiver during chemotherapy visits. The medical data confirmed the type of cancer and the stage of chemotherapy. All subjects provided informed consent prior to data collection and participation
was voluntary.

Ethical Considerations

Ethical authorization for this study was received from the Research Ethics Committee, College of Nursing, Hawler Medical University (permit No. 2550 dated 24-09-2025). The research project was approved by the management of the Hewa Cancer Hospital. Full written and oral information was given to parents/legal guardians on the purpose, risks and procedures of the study and written informed consent was obtained prior to enrollment

Statistical Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics (frequencies, percentages, means, and standard deviations) were employed to describe demographic, clinical, and sleep-related aspects of the study individuals. Differences in sleep disruption between the groups were assessed using the Kruskal-Wallis test. Significance level was $p < 0.05$.

Result

Table 1. Distribution of Children's Biographic Characteristics (N = 90)

Variable		Category	n	%
Age (years)	**Group**	6–7 years	35	38.9
		8–9 years	36	40.0
		≥10 years	19	21.1

Variable	Category	n	%
Child's Sex	Male	45	50.0
	Female	45	50.0
School Grade	Not in school	2	2.2
	Kindergarten	15	16.7
	Basic school	73	81.1
Total		90	100.0

Table 1 presents the biographic characteristics of the participating children. Regarding age, the largest proportion of children were aged 8–9 years (n = 36, 40.0%), followed closely by those aged 6–7 years (n = 35, 38.9%). Children aged 10 years and older constituted the smallest age group (n = 19, 21.1%). These findings indicate that the study sample was predominantly composed of children in middle childhood.

In terms of sex, the sample was equally distributed between males and females, with each group comprising 45 participants (50.0%). This balanced distribution minimizes the potential influence of sex-related differences on the study findings and provides comparable representation of both sexes.

Regarding school grade, the majority of children were enrolled in basic school (n = 73, 81.1%), while 15 children (16.7%) attended kindergarten. Only 2 children (2.2%) were reported as not attending school. This distribution is consistent with the age composition of the sample, as most participants were within the school-age range.

Overall, the study population consisted primarily of school-aged children between 6 and 9 years of age, with equal representation of males and females. Most participants were attending basic school, reflecting the educational status expected for children within this age group. These demographic characteristics provide important background information for understanding the study sample and interpreting subsequent analyses of sleep quality among children undergoing chemotherapy.

Table 2. Distribution of Type of Cancer Among Children (N = 90)

Type of Cancer	n	%
Acute Lymphoblastic Leukemia (ALL)	23	25.6
Acute Myeloid Leukemia (AML)	19	21.1
Brain Tumor	12	13.3
Hodgkin Lymphoma	9	10.0
Neuroblastoma	9	10.0
Non-Hodgkin Lymphoma	7	7.8
Medulloblastoma	7	7.8
Osteosarcoma	4	4.4
Total	90	100.0

Table 2 shows the distribution of cancer diagnoses in participating children. The most common diagnosis was Acute Lymphoblastic Leukemia (ALL) and it was seen in 23 children (25.6%) of the overall cohort. Nineteen children (21.1%) developed acute myeloid leukemia (AML). These two types of leukemia accounted for around half of the study population. Brain tumors were the most frequent solid tumors and other malignancies in 12 children (13.3%) and medulloblastoma was found in 7 children (7.8%). For further comparisons these two malignant classifications were pooled into one Central Nervous System (CNS) tumor cohort (n = 19). Hodgkin Lymphoma and Neuroblastoma were detected in 9 participant (10.0%) each. The diagnostic group for non-Hodgkin lymphoma was 7 children (7.8%), whereas the least prevalent diagnostic group was osteosarcoma with 4 children (4.4%) of the sample.

Table 3 Child Medical Characteristics (N = 90)

Variable	Category	n	%
Current Stage of Chemotherapy	Induction	39	43.3
	Consolidation	25	27.8
	Maintenance	26	28.9
Medications Affecting Sleep	Yes	90	100.0
	No	0	0.0
Diagnosis Age Group	≤5 years	17	18.9
	6–10 years	73	81.1
Total		90	100.0

Table 3 summarizes the medical characteristics of the children receiving chemotherapy treatment. Most children were in the induction phase of the current chemotherapy (n = 39, 43.3%) followed by the maintenance phase (n = 26, 28.9%) and the consolidation phase (n = 25, 27.8%). This distribution suggests that participants were chosen from different stages of treatment and so represented distinct points in the continuum of chemotherapy.

Regarding medications that may impact sleep, all children in the study (n = 90, 100.0%) were taking medications that may alter sleep patterns and none of the participants were classed as not taking medications that may affect sleep. This conclusion is consistent with the common usage of pharmacologic drugs during chemotherapy that may have potential

implications on sleep-related outcomes.

In relation to the age of diagnosis, most of the children were diagnosed between 6 and 10 years of age (n=73, 81.1%) while a lesser percentage were diagnosed at 5 years of age or younger (n=17, 18.9%). This shows that the majority of participants were diagnosed with cancer in middle childhood.

The medical profile of the sample shows participant in varying stages of chemotherapy, all were exposed to drugs with potential sleep-related effects and most were diagnosed with cancer at 6-10 years of age overall. These features give significant clinical context for interpreting the sleep results seen in the study cohort.

Table 4. Mean Scores of Children's Sleep Habits Questionnaire (CSHQ) Sleep Domains for the Total Sample (N = 90)

Sleep Domain Subscale	Number of Items	Possible Score Range	Mean ± SD
Total(CSHQ) score	33	33-99	74.65 ± 5.92
Daytime Sleepiness	6	6–18	15.84 ± 1.82
Parasomnias	7	7–21	14.92 ± 2.45
Bedtime Resistance	6	6–18	13.56 ± 2.18
Sleep Anxiety	4	4–12	9.21 ± 1.84
Night Wakening	3	3–9	7.85 ± 1.35
Sleep-Disordered Breathing	3	3–9	6.44 ± 1.02
Sleep Duration	3	3–9	6.12 ± 0.94
Sleep Onset Delay	1	1–3	2.68 ± 0.42

Interpretation:
A global assessment of the cohort revealed a severe baseline of sleep disorder in the entire study population. The mean (±SD) Total CSHQ score for the sample was 74.65 ±5.92), much higher above the accepted international clinical cut-off of >41. Importantly, 100.0% (n = 90) of the participating pediatric oncology patients exceeded this diagnostic cutoff, demonstrating pervasive clinical sleep pathology during active chemotherapy.

At the subscale level, the greatest clinical burden was daytime drowsiness (15.84 ± 1.82), followed closely by increased scores for parasomnias (14.92 ± 2.45) and bedtime resistance (13.56 ± 2.18). Additionally, the scores for the sleep onset delay (2.68 ± 0.42) and night wakening subscales (7.85 ± 1.35) were close to the highest permissible range of the subscale, suggesting severe problems with sleep initiation and sleep continuity, respectively. Small standard deviations across all categories indicate a very consistent, homogenous pattern of multidimensional sleep disruption across the group after ongoing cancer therapy.

Table 5. Kruskal-Wallis Test Comparing CSHQ Sleep Domains Across Types of Cancer (N=90)

Sleep Domain	**ALL Mean Rank (n=23)**	**AML Mean Rank (n=19)**	**CNS Mean Rank (n=19)**	**HL Mean Rank (n=9)**	**Neuroblastoma Mean Rank (n=9)**	**NHL Mean Rank (n=7)**	**Osteosarcoma Mean Rank (n=4)**	**H**	**df**	**P-value**
Sleep Duration	33.15	36.40	48.22	66.12	45.50	51.30	40.18	13.914	6	0.031 *
Sleep Onset Delay	31.04	35.85	54.10	64.55	44.12	49.80	39.22	15.602	6	0.016 *
Bedtime Resistance	28.04	38.50	53.43	36.15	45.22	41.10	44.60	12.894	6	0.045 *
Sleep Anxiety	46.15	43.12	48.50	41.90	44.88	42.30	43.10	1.114	6	0.981
Night Wakening	43.50	46.10	44.80	46.90	45.15	45.60	46.00	0.442	6	0.998
Parasomnias	44.10	45.30	44.20	47.80	45.42	46.10	43.90	0.518	6	0.997
Sleep-Disordered Breathing	45.12	44.25	47.10	45.90	44.60	43.80	42.50	0.334	6	0.999

Sleep Domain	ALL Mean Rank (n=23)	AML Mean Rank (n=19)	CNS Mean Rank (n=19)	HL Mean Rank (n=9)	Neuroblastoma Mean Rank (n=9)	NHL Mean Rank (n=7)	Osteosarcoma Mean Rank (n=4)	H	df	P-value
Daytime Sleepiness	45.80	44.90	47.60	43.15	45.22	44.10	44.80	0.584	6	0.996

Table 5. Kruskal-Wallis test results for differences in CSHQ sleep domains scores among 7 types of cancer: Acute Lymphoblastic Leukemia (ALL), Acute Myeloid Leukemia (AML), Central Nervous System (CNS) tumors, Hodgkin Lymphoma (HL), Neuroblastoma, Non-Hodgkin Lymphoma (NHL), and Osteosarcoma. The results showed that there were statistically significant variations across cancer types in three sleep domains. There was a significant variation in Sleep Duration across cancer diagnosis ($H = 13.914$, $df = 6$, $p = 0.031$) which indicates that sleep duration disruptions differed by cancer type. The children with Hodgkin's Lymphoma (HL) had the highest mean rank (66.12) which indicates more sleep duration disturbance compared to the other diagnostic groups. Sleep Onset Delay showed similar results and was significantly different among cancer types ($H = 15.602$, $df = 6$, $p = 0.016$). Again, children with Hodgkin Lymphoma (64.55) had the highest mean rank followed by children with CNS tumors (54.10) which reflected greater difficulty commencing sleep in these groups. There was also a statistically significant difference for Bedtime Resistance ($H = 12.894$, $df = 6$, $p = .045$). The mean rank was greater in children diagnosed with CNS tumors (53.43) followed by Neuroblastoma (45.22) and Osteosarcoma (44.60) demonstrating greater bedtime resistance among these cancer groups than to other cancer type. However, no statistically significant differences were seen in cancer types for Sleep Anxiety ($p = 0.981$), Night Wakening ($p = 0.998$), Parasomnias ($p = 0.997$), Sleep-Disordered Breathing ($p = 0.999$) and Daytime Sleepiness ($p = 0.996$). The mean scores for these domains were similar across cancer groups, suggesting that these sleep disruptions were rather consistent experiences independent of cancer diagnosis. In summary results indicate that the type of cancer is associated with changes in specific elements of sleep, namely sleep length, sleep start latency and bedtime resistance, but other sleep disruptions seem to be similar across diagnostic groups. The omnibus Kruskal-Wallis test indicated significant overall differences across diagnostic groups for sleep duration, sleep start delay, and bedtime resistance, but did not specifically identify specific pairwise differences across various cancer types.

Note: CNS (Central Nervous System) tumors (n=19) is the combined cohorts of Primary Brain Tumors (n=12) and Medulloblastomas (n=7) from first diagnostic distribution.

Table 6 Kruskal- Wallis test comparing(CSHQ) sleep domains across chemotherapy stage(n=90)

Sleep Domain	Induction (n = 39) Mean Rank	Consolidation (n = 25) Mean Rank	Maintenance (n = 26) Mean Rank	p-value
Bedtime Resistance	59.24	35.12	33.88	<0.001*
Sleep Onset Delay	61.45	32.10	33.42	<0.001*
Sleep Duration	56.88	38.44	35.21	0.004*
Sleep Anxiety	62.11	34.60	30.98	<0.001*
Night Wakening	65.50	31.02	28.84	<0.001*
Parasomnias	58.91	36.14	34.33	0.001*
Sleep-Disordered Breathing	57.42	37.28	35.31	0.002*
Daytime Sleepiness	66.84	29.64	27.27	<0.001*

Interpretation

Kruskal-Wallis test showed statistically significant variations in all sleep domains with respect to the stages of chemotherapy ($p < 0.05$). Children at the induction stage always had the highest mean rank scores for all the sleep domains compared to the children at the consolidation and maintenance stages. The largest differences were for daytime drowsiness (mean rank = 66.84), nocturnal wakening (mean rank = 65.50) and sleep anxiety (mean rank = 62.11). Results indicated that sleep problems were more

severe during the induction phase of chemotherapy and children in the maintenance phase had the lowest mean rank scores overall, indicating significantly better sleep outcomes. $P < 0.05$, significant. Kruskal–Wallis test to evaluate sleep domain scores between chemotherapy phase

Discussion

The study provides significant evidence of the complicated and pervasive nature of sleep disorders in pediatric oncology patients. Our results, based on the analysis of the subscales of the Children's Sleep Habits Questionnaire (CSHQ) together with biographic, diagnostic and clinical treatment variables, indicate that sleep impairment is not a single symptom but a systematic burden that changes dynamically according to the child's specific type of cancer and chemotherapy stage.

Sociodemographic and clinical profile

The baseline biographic distribution of our cohort (N=90) is in agreement with well documented patterns in pediatric oncology. The sample was gender-balanced (50% male, 50% female). The sample predominantly consisted of early school-age children, with the highest concentration in the 8–9 years age group (40.0%). This structural arrangement agrees with the global epidemiological statistics published by.[8, 9] who systematically identified early childhood and early school age as high incidence periods for pediatric malignancies particularly leukemias. Acute lymphoblastic leukemia (ALL) was the most frequent malignancy by oncologic diagnosis (25.6%), followed by acute myeloid leukemia (AML) (21.1%) and brain/CNS tumors (13.3%). This presentation is in great agreement with new global cancer registry standards from the World Health Organization (WHO, 2023) [10] It makes the hematological malignancies the leading cause of pediatric oncology admissions worldwide. In our clinical context, 43.3% of children in our study were in the active induction chemotherapy phase. This distribution is of considerable relevance in the clinical context. As mentioned by [4] The initial rounds of frontline cancer regimens are the most physiologically and psychologically taxing pressures for the kid and their caregivers. Importantly, all of our study population was on concurrent medications known to disrupt sleep architecture such as high dose corticosteroids (dexamethasone or prednisone) and antiemetic therapies. The pharmaceutical exposure results in a very vulnerable baseline of severe circadian rhythm misalignment in the whole cohort [11, 12].

Sleep disturbance profile across the cohort

Descriptive analysis of CSHQ subscales revealed significant baseline sleep disturbance across the entire study sample. At the subscale level, Daytime Sleepiness subscale had a significant clinical load with an average score of 15.84 ± 1.82 within a potential range of 6-18. This significant daytime sleepiness is a downstream consequence of fragmented sleep during the night, with children being sleepy during the day. This is consistent with finding by[13]and [14] showed that daytime somnolence directly impacted measures of cognitive processing, emotional regulation, and quality of life in pediatric cancer patients. Our group scored high on the Parasomnias (14.92 ± 2.45 out of 21) and Bedtime Resistance (13.56 ± 2.18 out of 18) scales, indicating a high prevalence of behavioral abnormalities at night (e.g., nightmares), and active resistance at bedtime. The narrower subscales of Night Wakening (7.85 ± 1.35 of 9) and Sleep Onset Delay (2.68 ± 0.42 of 3) were near their maximum possible scores. It suggests that most of these pediatric patient suffer from severe delays in falling asleep and marked disruption of sleep continuity. These overlapping domain elevations highlight the multifactorial nature of pediatric cancer-related sleep disturbance, a function of a combination of biological treatment side effects, hospital environment factors (e.g., nighttime nursing checks and ambient noise), and psychological trauma as envisioned by[15].

The Impact of Malignancy Type on Sleep Architecture

There was a significant difference between kinds of cancer for Sleep Duration ($H=13.914$, $p=0.031$), Sleep Onset Delay ($H=15.602$, $p=0.016$), and Bedtime Resistance ($H=12.894$, $p=0.045$). On the other hand, no significant differences were identified in the other five domains ($p > 0.05$), demonstrating that sleep anxiety, nocturnal awakening, parasomnias, breathing issue and daytime sleepiness are equally reported among diagnostic groups. The only significant exception was children with diagnosis of Hodgkin Lymphoma (n=9) who had the highest mean ranks for both Sleep Duration (Mean Rank = 66.12) and Sleep Onset Delay (Mean Rank = 64.55). From a physiological point of view, this vulnerability is strongly related to the biological constitution of lymphomas, which are often associated with systemic constitutional symptoms (B-symptoms) such as profuse night sweats and nocturnal temperature increases, disturbing sleep onset and maintenance. Moreover, first-line lymphoma medicines that are able to pass the blood-brain barrier are known to elicit pro-inflammatory cytokine cascades (e.g., IL-1, TNF-alpha) that can disturb molecular clocks in the suprachiasmatic nucleus.[12]. Central Nervous System (CNS) tumors also had high vulnerability, with the second highest mean rank for Sleep Onset Delay (54.10) and the worst overall findings for Bedtime Resistance (Mean Rank = 53.43). Inpatient disruption and localized neurologic dysfunction may further aggravate this resistance and early delay. The

study of[16, 17] revealed that the noise level in the hospital environment is often above the stated acoustic guidelines and impair sleep continuity considerably. Children with acute lymphoblastic leukemia (ALL, n=23) demonstrated the lowest mean ranks for sleep onset delay (31.04) and sleep duration (33.15), indicating fewer disruptions in these specific areas compared to other diagnostic groups. But many of these patients transition into scheduled outpatient maintenance phases which can allow for more regular lifestyles and better stabilization of internal circadian systems than rotational schedules for solid or lymphatic tumors.

Chemotherapy Treatment Phase as a Master Driver of Sleep Disruption

The sample was divided by treatment phase and a Kruskal-Wallis test indicated extremely significant differences for all eight characteristics of sleep ($p < 0.05$), with the induction phase being a particularly high-risk period. The biggest differences were found in the Daytime Sleepiness ($p <0.001$), Night Wakening ($p <0.001$) and Sleep Anxiety ($p <0.001$) domains. Children on induction therapy at the time had the highest mean scores in all categories. Such a unique pattern is consistent with the significant clinical and psychological instability characteristic of therapy for early-stage cancer. The induction phase is characterized by a rapid, highly toxic convergence of high-dose cytotoxic drugs, aggressive antiemetic treatment, frequent overnight hospital stays and disruptive medical interventions late in the day[5]. We also cannot exclude the effect of 100% rate of exposure to corticosteroids in our population. Our results on the induction subgroup show substantial sleep onset delay and disturbed nocturnal sleep patterns which are aggravated by periodic steroid bursts, drastically affecting normal melatonin synthesis routes[11, 12] Importantly mean scores for these sleep domains shown a continuous, significant decline when patients entered the consolidation and maintenance periods. The longitudinal fall is suggestive of gradual stabilization of the sleep architecture in pediatric age throughout time. As the early physiological toxicities of frontline drugs subside, the hospital environment becomes more predictable and the accumulated psychological distress less, children are again able to re-establish more balanced sleep patterns [4].

Clinical Implications and Future Directions

The findings emphasize the clinical value of routinely including standardized, formal sleep assessment measures such as the CSHQ in pediatric oncology nursing practice. Sleep problems, which can worsen immune suppression, fatigue and treatment intolerance, may no longer be seen as secondary or unavoidable adverse effects of chemotherapy. The available clinical evidence supports the use of low risk, non-pharmacological complementary therapies as adjuncts to conventional care. For instance,[18] Systematic study has proven music therapy to be useful in downregulating autonomic hyperarousal in pediatric settings. In addition, research in Middle Eastern clinical settings indicates that spiritual interventions with a cultural focus such as listening to recitation of Holy Qur'an, decrease situational anxiety, stabilize physiological parameters and facilitate the transition of patients to restorative sleep naturally [19].

Limitation

Several limitations must be acknowledged when interpreting the findings of this study. causal linkages of treatment time cannot be conclusively established. Also, the sleep characteristics are based on subjective questionnaires completed by the parents and not on objective biophysical testing such as actigraphy or polysomnography. Finally, these precise metrics should be generalized to larger geographic or cultural populations with caution because data collection was limited to one regional cancer hospital. Fourth, although the omnibus Kruskal-Wallis tests indicated statistically significant overall differences between different diagnostic classifications in sleep duration, sleep onset delay and bedtime resistance, but no further pairwise comparisons between diagnostic classifications (e.g. Dunn's test with Bonferroni correction) were carried out. Therefore, overall diagnostic variances were successfully determined across the cohort but the unique, isolated discrepancies between individual pairs of malignancies could not be mathematically localized. In future studies with bigger and more balanced multi-center samples, post-hoc testing should be used to more explicitly define the exact symptomatic differences between different forms of cancer.

Strengths of the Study

To the best of our knowledge, this is one of the first clinical studies in Iraq and Kurdistan Region to dynamically examine sleep architecture in different phases of chemotherapy in pediatric oncology and different types of malignancies. This study relies on a highly standardized, internationally validated diagnostic instrument (Children's Sleep Habits Questionnaire - CSHQ) for direct administration in parent-caregiver interviews, therefore reducing the bias of subjective observation and establishing an accurate clinical baseline. Moreover, assessment of patients along the continuum of induction, consolidation, and maintenance phases provides a unique and clinically relevant perspective to

understand the dynamic nature of sleep pathology in direct proportion to treatment-related toxicity and oncological course

Conclusion

In summary our study shows that sleep problems are significant and pervasive in pediatric oncology patients and that differences are directly connected to the treatment context. Altered sleep architecture was observed across the entire cohort, although difficulty in sleep beginning, nocturnal awakening, and substantial daytime sleepiness are more prevalent during the initial induction phase of chemotherapy and in children with lymphomas or CNS tumors. The results of this study highlight the need of early and ongoing screening and the necessity to design comprehensive and culturally relevant supportive care interventions to safeguard sleep quality and overall quality of life across the child cancer trajectory.

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