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Impact of Corticosteroid Therapy on Children with Nephrotic Syndrome

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ABSTRACT

Nephrotic syndrome is a condition that causes the kidneys to leak large amounts of protein into the urine. This can lead to a range of problems, including swelling of body tissues and a greater chance of catching infections. Although nephrotic syndrome can affect people of any age, it's usually first diagnosed in children aged between 1 and 6 years old. It tends to be more common in those with an Asian background although the reason is unknown.

Keywords: Nephrotic Syndrome, Corticosteroid, Ocular complications, Bone mineral density, obesity

INTRODUCTION

Nephrotic syndrome (NS) is primarily a pediatric disease characterized by nephrotic-range proteinuria, widespread edema, hypoalbuminemia, and hyperlipidemia in the presence of normal renal function. The etiology of NS can be classified into primary and secondary. The primary nephrotic syndrome often called idiopathic nephrotic syndrome (INS), is a group of illnesses affecting the glomeruli of the kidney that are unrelated to systemic causes. Nephrotic syndrome is typically a relapsing illness in children in two-thirds of cases that require repeated courses of glucocorticoids (GCs). All children presenting with their first episode of nephrotic syndrome should be admitted to the hospital for diagnostic assessment, nursing, and medical management, and parental education.[1]

Background of the Study

In the United States, the reported annual incidence rate of nephrotic syndrome is 2-7 cases per 100,000 children younger than 16 years. The cumulative prevalence rate is approximately 16 cases per 100,000 individuals.[2] Childhood nephrotic syndrome has an incidence of 90–100 per million population of India.[3]

Corticosteroids should be the first-line agent, with cyclophosphamide or cyclosporine as backup for steroid-resistant cases. Mycophenolate and rituximab have also been used in treating focal glomerulosclerosis. Although corticosteroids effectively treat nephrotic syndrome in many children, using these medicines for long periods of time can cause side effects, such as impaired growth, obesity, high blood pressure, eye problems, and bone loss. Other common side effects include anxiety, depression, and aggressive behavior. Treatment with glucocorticoids in children with nephrotic syndrome can be the cause of developmental disorders of the

masticatory organ and bone or teeth abnormalities.[4]

Objectives: The primary aim of this review is to identify the various effects of the treatment modalities on children diagnosed and treated with Nephrotic Syndrome

MATERIALS & METHODS

A review was conducted by searching Pub Med, Sage Journals, Web of Science, Science Direct, and Google Scholar for studies using the key words Nephrotic Syndrome, Steroid therapy, effects of steroid therapy, ophthalmic problems, behavioral problems, obesity.

RESULTS

The use of corticosteroid medicine has been associated with several problems in the body's systems. When glucocorticoids are administered to children with nephrotic syndrome, they can cause anomalies in the development of the masticatory organs, abnormalities in the bone or teeth, obesity, problems with their eyes, and an increased risk of infections. Nephrotic Syndrome (NS) patients who use corticosteroids for an extended period of time may experience ocular complications such as glaucoma, ptosis, mydriasis, increased intraocular pressure, keratitis, corneal and sclera thinning, and recurrent hordeolum exacerbations.

1. OCULAR COMPLICATIONS

A comparative study undertaken to identify ocular abnormalities in children with Nephrotic syndrome and their correlation with steroid dose and duration. The study included 100 patients with Nephrotic syndrome aged 2 to 18 years who had no signs of any systemic disease. Group I included 66 individuals who received the normal steroid regimen for their first episode of NS. Group II included 34 individuals who used steroids impulsively (on a daily basis for an extended period of time) rather than following the conventional protocol. Steroid-induced ocular problems were compared in both groups following a thorough ophthalmological examination. The findings of the study revealed that ocular abnormalities were found to be 18% and 47% from Group 1 and 2. Out of 12 patients of Group I who had ocular problems, three had myopic astigmatism, eight patients had PSC and one had temporal disc pallor. While in Group II, out of 16 patients who had ocular complications, two patients had raised intra ocular pressure and two patients had myopic astigmatism and 12 patients had posterior sub capsular cataract. The study concluded that ocular complications were more common in patients with irrationally steroid intake and cumulative steroid dose intake was also significantly higher in same patients.[5]

According to certain data, children receiving steroid medication may experience a number of ocular problems. In children receiving long-term corticosteroid treatment, steroid-induced posterior subcapsular cataract and steroid-induced ocular hypertension are frequent coexisting problems that often manifest within the first and sixth months, respectively. Individuals who suffer from Steroid-Induced Ocular Hypertension are more likely to develop cataracts.[6]

A cross-sectional study was conducted to evaluate the corneal and lens densitometry values of children with Nephrotic Syndrome (NS) and healthy persons. Pentacam HR was used to measure corneal topography as well as corneal and lens densities. Densitometry measurements in various layers were examined and compared among groups. Correlations between steroid cumulative dose, age at diagnosis, length of disease, number of relapses, and patients' densitometries values were studied. The study found significant differences ($p < 0.05$) in keratometry, horizontal white-to-white, and iridocorneal angle measurements between groups. Additionally, Nephrotic syndrome children had considerably higher values for 0-2 mm and 2-6 mm anterior corneal densitometry. ($p = 0.009$; $p = 0.033$). The study concluded that changes in corneal and lens densitometry occur in the

eyes of Nephrotic Syndrome patients in relation to disease duration, number of attacks, and cumulative steroid dose. Significant density alterations were identified, particularly in the anterior cornea and central 0-6 mm area.[7]

A cohort study was carried out to assess the incidence and predictive risk factors for ophthalmological complications in children with nephrotic syndrome receiving long-term oral corticosteroids. Recruiting children aged 4-18 years with idiopathic nephrotic syndrome who had received long-term oral steroids for more than 6 months attending the paediatric nephrology clinic between January 2019 and January 2021. The findings of the study revealed that incidence of cataract was 18.1% (20 of 110 cases). Visual acuity was impaired in seven (35%) of the children with cataract. Children with cataract were younger as compared to those without cataract (p=0.03)]. Children with cataract also had higher cumulative dose of prednisolone intake (p<0.01)] and greater cumulative duration of prednisolone intake (p<0.01). The incidence of raised IOP was 9.1% (10 of 110 cases) concluding The incidence of cataract and raised IOP was high. The risk factors for the development of cataract were age at onset of nephrotic syndrome, cumulative dose and cumulative duration of steroid intake. The findings of the study concluded that the incidence and predictive risk factors for ophthalmological complications among children with nephrotic syndrome who has taken long term steroid therapy have increase incidence of cataract and raised increase ocular pressure, children with cataract were younger as compared to those without cataract age at onset of nephrotic syndrome The risk factors for the development of cataract were : age at onset of nephrotic syndrome, cumulative dose and cumulative duration of steroid intake.[8]

A cross-sectional study was undertaken to estimate the burden of ocular complications such as raised intraocular pressure (IOP) and posterior subcapsular cataract (PSCC) in children with nephrotic syndrome receiving long-term oral steroids. Additionally, the duration and cumulative dosage of steroid consumption were evaluated in relation to these ocular complications. The study included children with nephrotic syndrome aged 4 to 18 who had received steroids for a minimum of six months. From case files, demographic, clinical, and therapeutic information was gathered. A thorough examination of the eyes was done to assess Increased Ocular pressure and look for Posterior subcapsular cataract. According to the study's findings, 1 in 4 and 1 in 9 of the children with nephrotic syndrome exhibited elevated increased ocular pressure and Posterior subcapsular cataract. Nevertheless, there was no significant correlation seen between posterior subcapsular cataract or elevated ocular pressure and the total dose and duration of steroid therapy. This study highlights the importance of routine eye examination and investigates other potential causes of steroid-induced ocular problems.[9]

A cross-sectional study was carried out to investigate the ocular complications arising from nephrotic syndrome and its treatments in children. A total of 31 pediatric patients with nephrotic syndrome were studied. Comprehensive ophthalmic assessments on best-corrected visual acuity, intraocular pressure, slit-lamp and fundus examination were being taken along with information on the histological diagnosis of nephrotic syndrome and its treatment regimen in each patients. The data were reviewed and analyzed which showed that Bilateral posterior subcapsular cataracts were detected in 10.3% who had received steroid therapy, 9.7% had isolated asymptomatic fundal findings of tortuous and dilated retinal vessels. Hypertensive retinopathy was found in 3.2% of the subjects. No steroid-induced glaucoma, uveitis, ocular infection, or other eye complications related to the use of steroids or other immunosuppressive agents were noted. Thus, the study concluded that children with nephrotic syndrome often require

prolonged, intermittent high dose of systemic corticosteroid Therapy which appears to have a higher risk when steroid therapy is used in very young patients. [10]

Based on data from multiple articles, the most frequent ocular side effects caused by steroids are: PSC (Posterior Subcapsular Cataract), glaucoma, higher intraocular pressure, ptosis, mydriasis, skin atrophy of the eyelid, keratitis, corneal and sclera thinning, recurrent hordeolum exacerbations, myopic astigmatism, temporal disc pallor, and other eye conditions associated with the use of steroids or other immunosuppressive drugs.

2. COMPLICATIONS ON THE BONES AND TEETH

Childhood, particularly adolescence, is a critical time for the accrual of bone mass. Any chronic childhood illness or treatment interferes with the acquisition of normal bone mineral content may compromise the achievement of an individual's genetically programmed peak bone mineral content. This may increase their risk of developing osteoporotic fractures in adulthood. Osteoporosis and increased fracture risk have long been recognized as complications of long-term treatment with oral corticosteroids in adults. Corticosteroids are known to have multiple effects on bone, including direct effects resulting in diminished bone formation and enhanced resorption, reduction of the lifespan of osteoblasts and osteocytes, and promotion of osteoclast survival. Of potential specific importance to children is the impact of these agents on the synthesis and activity of a variety of cytokines and growth factors, including the insulin-like growth factors (IGF-I and IGF-II) and their binding proteins (IGFBP-3, -4, and -5). Corticosteroids additionally induce reduced intestinal calcium absorption and increased urinary calcium excretion. Corticosteroid-induced osteoporosis has a predilection for the axial rather than the appendicular skeleton and affects trabecular more than cortical bone. A retrospective study showed that the long-term impact of prednisone on increasing doses of Glucocorticoids were significantly associated with lower height and BMD Z-scores. Adult survivors of childhood Minimal Change Nephrotic Syndrome have a significant reduction in forearm trabecular bone mineral density, placing them at increased fracture risk at this site.[11]

Glucocorticosteroids (GCs) are the first-line treatment for idiopathic nephrotic syndrome (NS), but prolonged administration interferes with growth and bone mineralization. Steroids can cause osteoporosis in children and have a negative impact on bone mineral content (BMC) and bone mineral density (BMD). A retrospective was carried out to examine the long-term impact of prednisone on growth and bone mineral density (BMD) in children with Nephrotic Syndrome. Data were collected from children diagnosed with Nephrotic Syndrome for 10 years. Height and spine bone mineral density values were converted to Z-scores The mean cumulative dose of Glucocorticoids were analyzed and correlated to patient's growth and spine bone mineral density. Samples consisted of 30 patients diagnosed at 3.7 years and followed over 9.8 years respectively. The one half of Nephrotic syndrome patients was steroid sensitive and one half dependent or resistant. Growth and spine Bone Mineral Density were both negatively associated with the cumulative dose of Glucocorticoids (P=0.001 and P=0.037, respectively). Final height Z-scores were significantly lower in patients receiving >0.2 mg/kg/day GCs (P=0.001). The study concluded that the increasing doses of Glucocorticosteroids were significantly associated with lower height and BMD Z-scores. [12]

A cross-sectional study was carried out to ascertain the bone mineral density of children with idiopathic nephrotic syndrome (INS) with corticosteroids therapy which included 90 patients on corticosteroids therapy and 50 apparently healthy and sex-matched children served as a control group. Renal functions, bone biochemistry, and parathyroid hormone (PTH) were tested

among the patients and controls. BMD was measured at the lumbar spinal region (L2–L4) using Dual-energy X-ray absorptiometry (DEXA) scan in both patients and controls groups. Serum PTH, phosphorous, and alkaline phosphatase levels were found to be higher in patients compared to the control group. There was a statistically significant reduction in blood calcium levels in patients compared to controls. Osteopenia was detected by DEXA scan in 24 and osteoporosis in 12 patients. There was a statistically significant decline in BMD-z score, BMD, and BMC in patients compared to the healthy group. There is a lower BMD in patients treated with INS on corticosteroids than in the population at large. Pediatric Idiopathic nephrotic syndrome patients had a high prevalence of osteopenia and osteoporosis as measured by DEXA. Steroid therapy has a deleterious impact on bone mineralization in children with INS. **[13]**

Additionally, another study was done on the bone mineral density of 26 kids with idiopathic nephrotic syndrome and healthy controls who were age and sex matched. Peripheral quantitative computed tomography was used to quantify BMD in trabecular (TBD), cortical (CBD), and total bone (BD) in a targeted manner. Patients' levels of TBD, CBD, and BD decreased, and these levels were inversely connected with the total amount of steroid treatment. Sixteen of the 26 patients who had received large cumulative dosages of steroids also received cyclophosphamide treatment. Comparing the children in this group with a modest cumulative steroid dose alone, there was a substantial decrease in both cortical and bone mineral density. For every subgroup, there were notable drops in bone density, cortical bone density and trabecular bone density .**[14]**

In children with remission of steroid sensitive nephrotic syndrome, a study has been conducted to investigate bone mineral density and levels of D.25 hydroxyvitamins in the urine. In this study, 32 patients with Steroid Sensitive Nephrotic Syndrome who did not receive Glucocorticoid therapy in the last six months and a control group of 20 normal children were included. Bone mineral density was determined in the lumbar spinal region using dual-energy X-ray absorptiometry (DEXA). Serum 25-(OH) D levels were lower in the steroid sensitive nephrotic syndrome patients than in the healthy children ($P < 0.05$), with 22 patients (68.8%) having Z-scores <-1. The Z-scores were positively correlated with 25-(OH) D levels ($r = 0.424$, $P < 0.05$). Parathyroid hormones levels were higher in patients with osteoporosis than in patients with Z-scores ≥-1 ($P < 0.05$). Bone mineral content and bone mineral density were positively correlated with the age of diagnosis ($P < 0.01$). Receiver-operating characteristic curve analysis showed that the cutoff value of 25-(OH) D levels for predicting low bone mineral density was 14.67 ng/mL with a sensitivity of 90% and a specificity of 64%. The area under the curve (AUC ± standard error) was 0.868 ± 0.064 (95% confidence interval: 0.742-0.994, $P = 0.001$). Decreased 25-(OH)D levels and the negative effects of long-term Glucocorticoid treatment on Bone mineral density persist in Steroid sensitive nephrotic syndrome remission phase. Levels of 25-(OH) D <14.67 ng/mL could predict abnormal DEXA scans in children with Steroid sensitive nephrotic syndrome remission phase. The study concluded that among patients with nephrotic syndrome serum 25(OH) D was significantly lower as compared to other groups. Steroid resistant nephrotic syndrome (SRNS) patient group showed the highest drop .**[15]**

A cross sectional study was performed on children with nephrotic syndrome to assess the effect of steroid therapy on growth hormone in children with nephrotic syndrome, where the findings of the study have revealed majority of children with nephrotic syndrome have a height deficiency. Children with nephrotic syndrome may have growth retardation as a result of chronic steroid therapy. In most instances of nephrotic syndrome, growth

hormone levels are below normal and cumulative doses of corticosteroids have a negative impact on linear growth. [16]

In order to determine the prevalence and type of dental anomalies in children with idiopathic nephrotic syndrome and how they relate to glucocorticoid dosage and treatment duration, a study was carried out among children with this diagnosis. The findings of the study demonstrated that long-term glucocorticoid usage in children with nephrotic syndrome increases the risk of tooth development anomalies, pulp calcification, and abnormalities in the metabolism of bone tissue. Additionally, they recommend that patients with steroid-sensitive nephrotic syndrome receive ongoing dental care.[17]

Another study which was conducted among children with Primary Nephrotic Syndrome with the aim to investigate the percentage of dental caries, gingivitis, hypertrophic gingivitis, and developmental defects of enamel (DDE) in children with Primary nephrotic syndrome was confirmed and proved that The Primary nephrotic syndrome patients showed significantly higher scores of Simplified Oral Hygiene Index (OHI-S), Gingival Index(GI)and Filled Teeth Index (dmf)t, and higher proportions of dental caries and DDE than other groups suggesting that it is necessary to establish a periodic dental protocol for PNS patients to improve their oral health status.[18]

A case-control study performed on idiopathic nephrotic syndrome and healthy children to determine the dental caries, developmental defects of the enamel oral hygiene and gingival condition along Streptococcus mutans (SM) and Lactobacillus species. (LB) bacteria in saliva which have provided evidence that the idiopathic nephrotic syndrome patients more severe gingivitis and more frequently teeth affected by enamel hypoplasia.[19]

3. BEHAVIORAL CHANGES

In the paediatric population, corticosteroids are frequently used to treat conditions such as asthma, malignancy, inflammatory bowel disease and rheumatoid arthritis, etc Steroid-induced toxicities such as stunted growth, hypertension, obesity and cataracts have been described by many studies worldwide. The effects of steroid therapy on emotional disturbances such as anxiety have also been well acknowledged. Corticosteroids affect behaviour via indirect mechanisms. They have been shown to induce chemical changes in specific sets of neurons responsible for influencing behavioural outcomes by either strengthening or weakening particular neural pathways. At low circulating levels, corticosteroids exert permissive action on the mediation of acute freezing behaviour and acute fear-related plus maze behaviour via the brain mineralocorticoid receptor mechanism. In contrast, at high levels, corticosteroids enhance the acquisition, conditioning and consolidation of an inescapable stressful experience via their glucocorticoid receptor mechanism.[20]

A prospective research was carried out in order to gauge the frequency and intensity of the behavioral side effects of high-dose oral steroid therapy in children with nephrotic syndrome. A standardized psychological questionnaire was used to assess the behavior of twelve children both throughout the diagnosis process and again following four weeks of steroid medication. Additionally, a group of control children were evaluated. When compared to the control group, the group of children with nephrotic behavior showed a statistically significant rise in the total behavior score (P=0.03), particularly in the aggressive and poor attention behavior categories.

Four of the children with nephrotic syndrome developed abnormal behavior in the clinical range compared with none of the controls. In conclusion, children with nephrotic syndrome treated with high-dose oral steroids are at risk of developing clinically relevant behavioral changes.[21]

A prospective study was carried out to define the frequency and severity of steroid-related behavioral side effects in children with steroid-sensitive idiopathic nephrotic

syndrome (SSNS) during treatment for relapse in which 10 children with SSNS underwent behavioral assessment using the Child Behavior Checklist at baseline and during high dose prednisone therapy for relapse. The result showed that out of the 10 children, 8 had normal behavior at baseline. Of these 8 children, 5 had Child Behavior Checklist scores above the 95th percentile for anxious/depressive behavior and/or aggressive behavior during relapse. Such scores are in the range normally considered appropriate for referral to a mental health provider. The 2 children who had abnormal behavior at baseline also experienced a worsening of their behavior during relapse. Regression analysis showed that prednisone dose was a strong predictor of abnormal behavior, especially increased aggression. The study found that when receiving high-dose prednisone therapy for relapse, children with steroid sensitive nephrotic syndrome frequently face significant issues with anxiety, despair, and increased aggression. [22]

Other studies on the behavioral effect of corticosteroids on children with idiopathic nephrotic syndrome was undertaken. The investigators reported that children with idiopathic nephrotic syndrome presented with internalizing problems, including withdrawal and somatic complaints, but not anxiety, depression or externalizing problems. However, when the children were on high-dose steroid therapy, their anxiety, depression and aggressiveness scores increased significantly. It is apparent that children with idiopathic nephrotic syndrome who are on steroid therapy are at high risk of developing psychological problems. Studies looking into psychological problems among children with INS who are on steroid therapy are limited in Southeast Asian countries.[23]

A cross sectional study was undertaken for the purpose of assessing the emotional and behavioral problems, temperament, family environment, and evaluate the health-related quality of life in children with Nephrotic syndrome A purposive sampling technique was used. A sample of 32 children between ages 6 and 12 years with nephrotic syndrome -steroid-sensitive (infrequent relapsers, frequent relapsers, or those with steroid-dependent) and steroid-resistant-for more than 6 months duration and managed by the Pediatric Nephrology department were recruited. The control group of 30 healthy children was matched for age and gender. The assessment was conducted using the Strengths and Difficulties Questionnaire (SDQ), Pediatric Quality of Life Inventory™ (PedsQL 4.0), Malhotra Temperament Schedule, and Family Environment Scale. It was found that children with Nephrotic Syndrome had an overall lower score on the Quality of life scale ($P < .003$) and the Steroid resistant nephrotic syndrome subtype had poor scores on Strengths and Difficulties Questionnaire (SDQ ($P < .023$) and QOL ($P < .017$. The findings of the study concluded that children with Nephrotic Syndrome have a risk of emotional and behavioural problems as well as poor quality of life.[24]

4. OBESITY

Children with nephrotic syndrome need high-dose corticosteroids to achieve remission. Studies have estimated a 35-43% risk of obesity in these patients after corticosteroid treatment.

A retrospective cohort research was conducted to investigate the incidence of obesity in children who had received corticosteroids for nephrotic syndrome, as well as to compare the risk of obesity in children with steroid-sensitive nephrotic syndrome (SSNS) and steroid-resistant nephrotic syndrome. The study found that among children with nephrotic syndrome who received corticosteroids, the frequency of obesity is 22% and central obesity is 50%. In a comparison of Steroid sensitive nephrotic syndrome and steroid resistant nephrotic syndrome groups, cumulative steroid dose, as well as the risks of obesity and central obesity, do not differ significantly between groups. [25]

The long-term Glucocorticosteroids therapy in children with nephrotic syndrome caused

the excess body weight or obesity and gastro-intestinal disorders. A retrospective study conducted among children with nephrotic syndrome receiving steroid therapy. The researcher calculated the Body Mass Index of each child. The study provides results stating that children who had received Glucocorticosteroids for six months were overweight, had reactive pancreatitis, leukemoid reaction, liver damage. The long-term use of glucocorticoid in children with nephrotic syndrome caused excess body weight and gastrointestinal problems.[26]

A study conducted on the long-term (five years) effects of prednisone therapy in children with frequently relapsing nephrotic syndrome has showed that long-term steroid therapy was associated with a higher rate of obesity, short stature as well as the occurrence of different metabolic syndrome (MetS) abnormalities.[27]

CONCLUSION

Nephrotic syndrome (NS) is a rare, serious and debilitating kidney condition, caused by a range of different diseases that damage the glomeruli. Treatment of the disease includes blood pressure medications, Water pills (diuretics), cholesterol-reducing medications, blood thinners (anti-coagulants), immune system-suppressing medications, where corticosteroids are currently used as first-line treatment. The side effects being corticosteroids associated with ocular complications like Posterior Subcapsular Cataract (PSC), glaucoma, increased intra-ocular pressure, ptosis, mydriasis, eyelid skin atrophy, keratitis, thinning of cornea and sclera, repeated hordeolum exacerbations, dental complications, obesity, etc. These findings indicate the need for proper regular assessment and those children should be under the constant care of Dentist, ophthalmologist, child psychiatrist, et.

Children on continuous or regular steroid therapy must be periodically evaluated regarding their dental, eyes and mental health.

Declaration by Authors

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REFERENCES

1. Piekoszewska-Ziętek, P., Olczak-Kowalczyk, D., Pańczyk-Tomaszewska, M., & Gozdowski, D. (2022). Developmental abnormalities of teeth in children with nephrotic syndrome. international dental journal, 72(4), 572-577.
2. Pediatric Nephrotic Syndrome: Practice Essentials, Background, Pathophysiology. (n.d.). Retrieved June 27, 2024, from https://emedicine.medscape.com/article/982920-overview
3. Nephrotic Syndrome-StatPearls-NCBI Bookshelf. (n.d.). Retrieved June 27, 2024, from https://www.ncbi.nlm.nih.gov/books/NBK470444/
4. Kidney Disease in Children-NIDDK. (n.d.). Retrieved June 27, 2024, from https://www.niddk.nih.gov/health-information/kidney-disease/children
5. Agrawal, V., Devpura, K., Mishra, L., & Agarwal, S. (2017). Study on steroid induced ocular findings in children with nephrotic syndrome. Journal of Clinical and Diagnostic Research: JCDR, 11(3), SC05.
6. Yan, H., Tan, X., Yu, J., Liang, T., Shi, W., Li, L., & Peng, C. (2022). The occurrence timeline of steroid-induced ocular hypertension and cataract in children with systemic autoimmune diseases. International Ophthalmology, 42(7), 2175-2184.
7. Balıkçı AT, Ulutaş HG, Akacı O. Evaluation of corneal and lens densitometry with Pentacam HR in children with Nephrotic Syndrome: A controlled, prospective study. Photodiagnosis and Photodynamic Therapy. 2022 Dec 1;40:103184.
8. Hariharan, R., Krishnamurthy, S., Kaliaperumal, S., Karunakar, P., & Deepthi, B. (2021). Incidence and predictive risk factors for ophthalmological complications in children with nephrotic syndrome receiving long-term oral corticosteroids: a

cohort study. Paediatrics and International Child Health, 41(3), 199-205
9. Gaur, S., Joseph, M., Nityanandam, S., Subramanian, S., Koshy, A. S., Vasudevan, A., ... & Iyengar, A. (2014). Ocular complications in children with nephrotic syndrome on long term oral steroids. The Indian Journal of Pediatrics, 81, 680-683.
10. Ng, J. S., Wong, W., Law, R. W., Hui, J., Wong, E. N., & Lam, D. S. (2001). Ocular complications of paediatric patients with nephrotic syndrome. Clinical & experimental ophthalmology, 29(4), 239-243.
11. Hegarty, J., Mughal, M. Z., Adams, J., & Webb, N. J. (2005). Reduced bone mineral density in adults treated with high-dose corticosteroids for childhood nephrotic syndrome. Kidney international, 68(5), 2304-2309.
12. Ribeiro, D., Zawadynski, S., Pittet, L. F., Chevalley, T., Girardin, E., & Parvex, P. (2015). Effect of glucocorticoids on growth and bone mineral density in children with nephrotic syndrome. European journal of pediatrics, 174, 911-917.
13. Soliman, A. S., Abukhatwah, M. W., Kamal, N. M., Sweed, E. M., Alelyani, A. M., Althobaiti, S. D & Afifi, W. E. (2022). Bone densitometry in children with idiopathic nephrotic syndrome on prolonged steroid therapy: A tertiary multicenter study. Medicine, 101(33), e29860.
14. Lettgen, B., Jeken, C., & Reiners, C. (1994). Influence of steroid medication on bone mineral density in children with nephrotic syndrome. Pediatric Nephrology, 8, 667-670.
15. Cetin, N., Gencler, A., & Sivrikoz, I. A. (2019). Bone mineral density and vitamin D status in children with remission phase of steroid-sensitive nephrotic syndrome. Saudi Journal of Kidney Diseases and Transplantation, 30(4), 853-862.
16. El-hameed, A., El-Gendy, S. A., El-gawaad, A., Elsayed, R. A., & Mahmoud, H. H. (2021). Effect of Steroid Therapy on Growth hormone in Children with Nephrotic Syndrome. Benha Journal of Applied Sciences, 6(4), 79-87.
17. Piekoszewska-Ziętek, P., Olczak-Kowalczyk, D., Pańczyk-Tomaszewska, M., & Gozdowski, D. (2022). Developmental abnormalities of teeth in children with nephrotic syndrome. international dental journal, 72(4), 572-577.
18. Luong, H. M., Nguyen, T. T., Tran, H. T., Tran, P. T., Nguyen, P. N., Nguyen, H. T., ... & Tong, S. M. (2021). Oro-dental health and primary nephrotic syndrome among Vietnamese children. Children, 8(6), 494.
19. Kaczmarek, U., Wrzyszcz-Kowalczyk, A., Jankowska, K., Prościak, K., Mysiak-Dębska, M., Przywitowska, I., & Makulska, I. (2020). Oral health conditions in children with idiopathic nephrotic syndrome: a cross-sectional study. BMC Oral Health, 20(1), 213.
20. Mahmud, M. N., Othman, A., & Ilias, M. I. (2023). Increased behavioural problems associated with corticosteroid use in children with nephrotic syndrome: a Southeast Asian perspective. Singapore medical journal, 64(9), 557-562.
21. Hall, A. S., Thorley, G., & Houtman, P. N. (2003). The effects of corticosteroids on behavior in children with nephrotic syndrome. Pediatric Nephrology, 18, 1220-1223.
22. Soliday, E., Grey, S., & Lande, M. B. (1999). Behavioral effects of corticosteroids in steroid-sensitive nephrotic syndrome. Pediatrics, 104(4), e51-e51.
23. Manti, P., Giannakopoulos, G., Giouroukou, E., Georgaki-Angelaki, H., Stefanidis, C. J., Mitsioni, A., ... & Kolaitis, G. (2013). Psychosocial and cognitive function in children with nephrotic syndrome: association with disease and treatment variables. BioPsychoSocial medicine, 7, 1-7.
24. Aier, A., Pais, P., & Raman, V. (2022). Psychosocial Functioning and Health-Related Quality of Life in Children with Nephrotic Syndrome: Preliminary Findings. Journal of Indian Association for Child and Adolescent Mental Health, 18(4), 306-314.
25. Lestari, N., Nurani, N., & Julia, M. (2015). Corticosteroids and obesity in steroid-sensitive and steroid-resistant nephrotic syndrome. Paediatrica Indonesiana, 55(4), 194-8.
26. Batishcheva, G. A., Zhdanova, O. A., Nastausheva, T. L., & Chernov, Y. N. (2019). Characteristics of adverse side effects of corticosteroid therapy in children with nephrotic syndrome and methods of

pharmacological correction. Research Results in Pharmacology, 5(1), 37-43.
27. Soliman, A., Hamed, N., De Sanctis, V., Elbaba, M., Alyafei, F., Alaaraj, N & Khater, D. (2022). The long-term (five years) effects of prednisone therapy in children with frequently relapsing nephrotic syndrome: A controlled study of anthropometric parameters and metabolic abnormalities. Acta Bio Medica: Atenei Parmensis, 93(5).

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