

## Bone Densitometry in Children with Idiopathic Nephrotic Syndrome

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### Abstract

Childhood nephrotic syndrome (NS) is defined by nephrotic-range proteinuria, generalized edema, hypoalbuminemia, and hyperlipidemia with normal renal function. Dual-energy X-ray absorptiometry (DXA) is a two-dimensional imaging technology developed to assess bone mineral density (BMD) of the entire human skeleton. The aim of our study to assess bone mineral density among pediatrics with idiopathic nephrotic syndrome undergoing corticosteroids treatment. This study was a cross sectional study, which was done on 30 cases with idiopathic nephrotic syndrome undergoing corticosteroids treatment (at Nephrology clinic pediatric department Benha University Hospital) in the period from January 2019 till June 2019, the other group formed of 25 children with age and sex matched to the first group and apparently healthy, considered as a control group. The following investigations were done (serum creatinine, blood urea nitrogen (BUN), phosphorous (P), calcium (total and ionized; Ca), alkaline phosphatase (ALP), parathyroid hormone (PTH). BMD was measured. There was highly statistically significant increase in PTH, Ph, and ALP among Cases than Controls. There was statistically significant decrease in Ca among Cases than Controls. There was highly statistically significant decrease in z score, BMD and BMC among Cases than Controls. Patients with INS would have BMD deficits when compared to their peers. Osteopenia and osteoporosis assessed by DXA was frequent in children with INS. Bone mineralization was negatively affected by steroid treatment in children with INS.

**Keywords:** Bone mineral density, Idiopathic nephrotic syndrome, Children.

### 1. Introduction

Youth nephrotic syndrome (NS) will be characterized Eventually Tom's perusing nephrotic-range proteinuria, summed up edema, hypoalbuminemia, What's more hyperlipidemia for ordinary renal capacity [1].

NS for the most part could make partitioned under essential What's more optional etiologies. Elementary nephrotic syndrome (PNS), otherwise called idiopathic infection nephrotic syndrome (INS), which connected with glomerular maladies inalienable of the kidney Furthermore not identified with systemic reasons. Nephrotic syndrome for Youngsters is Typically An repetitive state requiring master management, which conveyed crazy Toward the pediatric nephrologist. Constantly on Youngsters introducing with their initial scene from claiming NS ought further bolstering be admitted should clinic to symptomatic assessment, nursing Also medicinal oversaw economy What's more parental training [2].

Osteoporosis might have been characterized as "a systemic skeletal issue portrayed Toward a low bone impostor and Toward micro-architectural crumbling for bone tissue, for a resulting build done bone delicacy and powerlessness to fracture" [3].

Throughout adolescence Also adolescence, skeletal demonstrating brings about sex- and maturation-specific expands done bone thickness. Metabolic bone malady (MBD) may be described Eventually Tom's perusing transforms clinched alongside skeletal mineralization because of poor bone mineral content (BMC). Kids might make particularly powerless of the impacts about gc once

bone shaping What's more crest bone impostor [4].

Dual-energy X-beam absorptiometry (DXA) is a two-dimensional imaging engineering organization formed should evaluate bone mineral thickness (BMD) of the whole mankind's skeleton What's more likewise particularly for skeletal locales known to a chance to be the vast majority defenseless should crack [5].

Those grade objectives of administration about osteoporosis need aid avoidance of fractures including vertebra fractures Furthermore scoliosis What's more change Previously, function, versatility Furthermore ache. Another time from claiming OI What's more osteoporosis oversaw economy need landed over which change over function; versatility Also expedient restoration need aid vital conclusions [6]. The point from claiming our examine to assess bone mineral thickness "around pediatrics for idiopathic infection nephrotic syndrome undergoing corticosteroids medication.

### 2. Patients and Methods

#### 2.1 Patients

This study was a cross sectional study, which was done on 30 cases with idiopathic nephrotic syndrome undergoing corticosteroids treatment (at Nephrology clinic pediatric department Benha University Hospital) in the period from January 2019 till June 2019, the other group formed of 25 children with age and sex matched to the first group and apparently healthy, considered as a control group.

## 2.2. Ethical considerations

Informed consents were obtained from all cases and controls guardians included in this study which was approved by the local ethical committee of Benha University.

## 2.3 Inclusion criteria

- Idiopathic nephrotic syndrome children treated by corticosteroids for more than 6 months.
  - **Steroid dependent nephrotic syndrome (SDNS)**, defined as nephrotic syndrome with 2 consecutive relapses during alternate day prednisolone therapy or within 2 weeks of its discontinuation.
  - **Steroid resistant nephrotic syndrome (SRNS)**, defined as persistence of edema and proteinuria after 4 weeks of initial standard prednisolone therapy or to 4 weeks of daily prednisolone for relapse.
  - **Frequently-relapsing nephrotic syndrome (FRNS)**: defined as two or more relapses within 6 months of the initial response, or with four or more relapses during any 12-month period after initial steroid responsive episode.[7] .
- Both sexes were included.
- Laboratory criteria for Idiopathic nephrotic syndrome (heavy proteinuria > 40 mg/m<sup>2</sup>/h, hypoalbuminemia < 2.5 g/L, hypercholesterolemia > 250 mg/dL, and edema) with normal renal function (normal glomerular filtration by Schwartz formula) [7] .

## 2.4. Exclusion criteria

- Children suffering from any bone disease before being nephrotic child.
- Children with secondary NS.

## 2.5 Methods

**History:** Sex, age, age of onset, duration, residence, Family history of NS, type of treatment, its duration, and dates and number of relapses. Steroid-dependent NS or steroid-resistant NS.

**Clinical examination:** Anthropometric measurements, vital signs, odema, ascities and bone pain

## Laboratory investigations

### Dexa Scan

DEXA scan is a special type of X-ray that measures bone mineral density (BMD) ,DEXA stands for "dual energy X-ray absorptiometry", This type of scan may also be called (DXA scan, bone density scan, bone densitometry scan)

DEXA scans are often used to diagnose or assess someone's risk of osteoporosis, a condition that weakens bones and makes them more likely to break.

### Details of the test

The scan generally takes 10 to 20 minutes. It's painless, and the amount of radiation get from the X-rays the scan uses is low. Instead, Patient lies on an open X-ray table and try to stay still as the scanner passes over his body.

A DXA scanner is a machine that produces two X-ray beams. One is high energy and the other is low energy, the machine measures the amount of X-rays that pass through the bone from each beam, this will vary depending on how thick the bone is based on the difference between the two beams.

BMD was measured at the lumbar spinal region (L2-L4) using dual-energy X-ray absorptiometry (DXA) (Challenger Envision osteodensitometer, DMS, England). BMD was classified according to [8], on the basis of BMD Z-score. Scores was calculated from the following equation: Z-score = (BMD [g/cm<sup>3</sup>] of the patient — BMD predicted for age and sex/SD for BMD [age, sex, and height matched]). A patient will be considered osteopenic if the Z-score was <-1.0. If the Z-score was ≤-2.5, the patient was classified as having severe osteopenia (osteoporosis). [6] Serum creatinine,

- blood urea nitrogen (BUN),
- phosphorous (P),
- calcium (total and ionized; Ca),
- alkaline phosphatase (ALP).

All serum calcium, serum phosphorus and alkaline phosphatase are done by Biochemistry analyzer (Biosystem) A15 autoanalyzer. lot no of (calcium, phosphorus and alkaline phosphatase) is (16005,15007 and15-0841).

- parathyroid hormone (PTH), Serum intact parathyroid hormone using a direct label, two-site ELISA assay intended for the quantitative determination of PTH in serum ( Biomerica, USA; normal range: 10-65 pg/ml) lot no (2329), company name (Diasorin) and instrument name (Diasorin Liaison) PTH 4-2016 / W0886200.

## 2.6 Statistical analysis

Patients were divided into two groups: Group 1 (Cases group) and Group 2 (Controls group).

Group 1 (Cases group) were subdivided into two groups, Group 1A (taken steroid) and Group 1B (taken steroid and immunosuppression drugs).

The collected data were tabulated and analyzed using SPSS version 22 software (Spss Inc, Chicago, ILL Company). Categorical data were presented as number and percentages. Chi square test (  $\chi^2$  ), or Fisher's exact test (FET) were used to analyze categorical variables. Quantitative data were tested for normality using Kolomogrov Smirnov test assuming normality at  $P > 0.05$ . Quantitative data were expressed as mean  $\pm$  standard deviation, median and range. Student "t" test was used to analyze normally distributed variables among 2 independent groups, or Man Whitney U test for nonparametric ones. Spearman's correlation

coefficient ( rho ) was used to assess correlation between non parametric variables. The accepted level of significance in this work was stated at 0.05 (P <0.05 was considered significant).

### 3.Results

This study was conducted on 30 cases with idiopathic nephrotic syndrome on corticosteroids treatment (at Nephrology clinic pediatric department Benha University Hospital) and 20 healthy child age and sex matched to cases served as control group. In current study the age of studied

children of NS were ranged from 3.5-16 years, Mean  $\pm$  SD was  $9.06 \pm 3.9$  years. During study sex distribution in our cases we found the male predominance (60%). regarding drugs, steroid was (83.3%), steroid and immunosuppressive was (16.7%). regarding response to steroids, frequent relapse was (46.6%), steroid dependent (36.6%) and steroid resistant (16.7%). Regarding to presenting symptoms and signs among the studied cases, the most common presenting symptom was puffiness of eye lid (93.3%) while the most common sign was edema of lower limb (66.6%).

**Table (1)** Comparison between Cases and Controls regarding anthropometric measurements.

		Cases (No.= 30)	Controls (No.= 20)	t.test	P. value
<b>Height(cm.)</b>	Rang	50 - 165	80 - 156	-2.951-	0.005
	Mean $\pm$ SD	98.77 $\pm$ 42.314	130.20 $\pm$ 26.58		
<b>Weight(kg)</b>	Rang	12 - 105	22 - 105	-1.398-	0.016
	Mean $\pm$ SD	55.17 $\pm$ 24.05	43.60 $\pm$ 22.29		
<b>BMI(kg/m<sup>2</sup>)</b>	Rang	16 - 38.39	17.71 - 31.19	2.427	0.019
	Mean $\pm$ SD	30.25 $\pm$ 2.95	25.039 $\pm$ 1.51		

This table shows that, There was statistically significant decrease in height among Cases than Controls. There was statistically significant

increase in weight and BMI among Cases than Controls.

**Table (2)** Comparison between Cases and Controls regarding Ph, Ca, PTH and ALP.

		Cases (No.= 30)	Controls (No.= 20)	t.test	P. value
<b>Ph</b> <b>(mg/dl)</b>	Rang	3 - 6	2.5 - 3.5	.847	0.000*
	Mean $\pm$ SD	4.77 $\pm$ .8764	2.905 $\pm$ .27		
<b>Ca</b> <b>(mg/dl)</b>	Rang	6 - 11	9 - 11	-	0.006
	Mean $\pm$ SD	9.017 $\pm$ 1.50	10.03 $\pm$ .55	2.879-	
<b>PTH</b> <b>(pg/ml)</b>	Rang	12 - 96	5 - 51	1.439	0.015
	Mean $\pm$ SD	47.71 $\pm$ 27.64	38.25 $\pm$ 11.809		
<b>ALP</b> <b>(U/L)</b>	Rang	55 - 152	42 - 110	4.611	0.000*
	Mean $\pm$ SD	109.20 $\pm$ 26.74	76.80 $\pm$ 20.133		

\*Highly statistically significant

This table shows that, there was statistically significant increase in PTH among Cases than Controls. There was highly statistically significant

increase in Ph, and ALP among Cases than Controls. There was statistically significant decrease in Ca among Cases than Controls.

**Table (3)** Comparison between Cases and Controls regarding z score, Bone mineral density (BMD) and Bone mineral content (BMC).

		Cases (No.= 30)	Controls (No.= 20)	t.test	P. value
<b>z score</b>	Rang	-3.3- - 4	-0.9- - 3.1	-3.015-	0.004
	Mean $\pm$ SD	-0.577- $\pm$ 1.77	0.785 $\pm$ 1.17		
<b>BMD(g/cm<sup>2</sup>)</b>	Rang	0.32 - 0.869	0.58 - 1.29	-5.718-	0.000*
	Mean $\pm$ SD	0.56 $\pm$ 0.165	0.87 $\pm$ 0.218		
<b>BMC(g)</b>	Rang	7.36 - 80.61	23.34 - 80.61	-4.392-	0.000*
	Mean $\pm$ SD	25.07 $\pm$ 18.178	48.52 $\pm$ 18.97		

\*Highly statistically significant

This table shows that, There was statistically significant decrease in z score among Cases than Controls. There was highly statistically significant

decrease in z score, BMD and BMC among Cases than Controls.

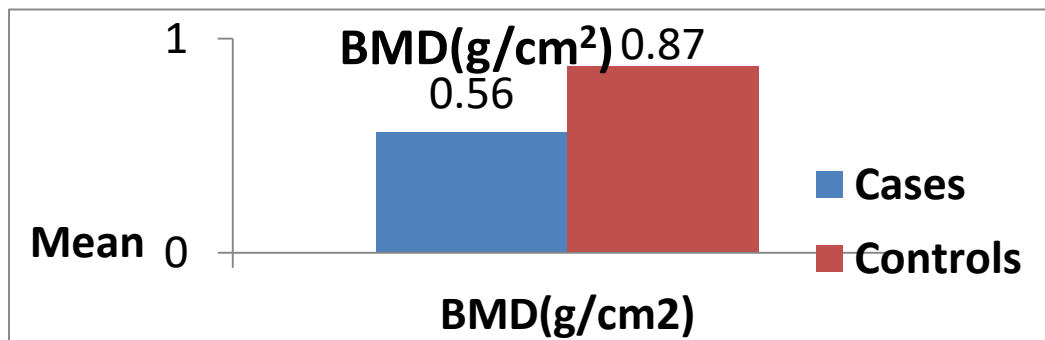


Fig (1) Comparison between Cases and Controls regarding BMD(g/cm2).

Table (4) Comparison between Cases and Controls regarding Bone mineral density categories.

			Cases (No.= 30)	Controls (No.= 20)	X <sup>2</sup>	P. value
Bone mineral density categories	average	No.	18	20	10.526	.005
		%	60.0%	100.0%		
	osteopenia	No.	8	0		
		%	26.7%	.0%		
	osteoporosis	No.	4	0		
		%	13.3%	.0%		

This table shows that, There was statistically significant difference between Cases and Controls regarding Bone mineral density categories.

Table (5) Correlation between BMD and other numerical data.

BMD	Pearson's correlation	
	r	p
Age (years)	0.799	0.000*
Age of onset of disease	0.760	0.000*
Durations of drugs	-0.054-	0.046
Height(cm)	0.834	0.000*
Weight(kg)	.8160	0.000*
SBP	-0.708-	0.000*
DBP	-0.745-	0.000*
creatinine	-0.163-	0.039
urea	-0.198-	0.041
Ph (mg/dl)	0.022	0.03
(Ca (mg/dl)	0.112	0.04
PTH (pg/dl)	-0.244-	0.02
ALP (U/L)	-0.137-	0.047
z score	0.424	0.019
BMD(g/cm2)	0.547	0.002
BMC(g)	0.873	0.000*

\*Highly statistically significant

This table shows that, There were statistically significant positive correlations between BMD and (age, age of onset of disease, HEIGHT, WEIGHT,BMI).There were highly statistically

significant positive correlations between BMD and (z score and BMC). There were statistically significant negative correlations between BMD

and (Durations of drug, SBP ,DBP, creatinine, urea, PTH and ALP).

#### 4.Discussion

On present study the agdistis from claiming mulled over know youngsters from claiming NS were went starting with 3. 5-16 years, intend  $\pm$  sd might have been  $9.06 \pm 3.9$  A long time.

This is in understanding with moon et al. , [9] who investigated the impacts about glucocorticoids on BMD Furthermore bone geometry Previously, kids for NS Furthermore they found those intend of age might have been  $10.7 \pm 3.1$  A long time.

This is in contradiction for Rhuma et al. , [10] who accounted that ins is An malady about pre-school age-old kids for crest agdistis occurrence about 2-3 a considerable length of time.

Throughout examine sex distribution in our cases we discovered the male predominance (60%).

Our effects were underpinned via Rhuma et al. , [10] and Ephraim et al. , [11] Concerning illustration they accounted that ins were influenced guys more than females.

Viewing with introducing manifestations Also indications "around the concentrated on cases, the The greater part as a relatable point showing side effect might have been puffiness for eye cover (93. 3%) same time the mossycup oak regular sign might have been edema about bring down appendage (66. 6%).

This will be in understanding for beam et al., [12] who news person that edema is a standout amongst the clinical signs about nephrotic syndrome.

Also, Sahana, [13] found that know patients exhibited for puffiness about face and swelling about limbs same time Sahana , [13] news person ascites might have been available Previously, 63% Furthermore genital edema clinched alongside 31%, pleural radiation clinched alongside 15% for situations Furthermore HTN in 12% about situations. Those illustration from claiming this difference for frequencies were those The greater part NS cases clinched alongside our study were relapsed instances (46. 6%) that reflect catch up on standard time as stated by protocol Furthermore familiarity with guardian Eventually Tom's perusing right on time show fate from claiming backslide alternately indications of contamination Toward wellbeing education, In this way they were looked punctual for medicinal exhortation What's more administration in the recent past presence for stamped ascitis or genital edema showed up.

Done our investigation accordind should corticosteriod treatment for NS patients, The greater part of our patients were around steroid help (83. 3%) same time (16. 7%) steroid Also immunosuppressive.

Done our contemplate we arranged the patients accordind of the react of the corticosteriod therapy, we watched those The majority about our patients

(46. 6%) complained starting with relapsed incessant backslide trailed by (36. 6%) steroid indigent and (16. 7%) steroid safe.

Our outcomes were underpinned via Sahana, [13] who discovered 63% from claiming situations were around backslide.

Alfakeekh. , [14] demonstrated that patients with grade youth nephrotic syndrome create alterations for their cell division and humoral insusceptibility that predisposes them of the advancement from claiming infection, and lead them should have incessant relapses. Also, contamination Might a chance to be fundamentally improved Toward immunosuppressive operators.

Also, these finding were clarified Toward Alwadhhi Also as much partners [15], they accounted that scenes from claiming nephrotic syndrome are frequently all the temporally connected with event from claiming contamination. Concerning illustration glucocorticoids What's more other immuno-suppressive pills may be the backbone from claiming therapy, contamination happening Throughout treatment will be well-known and is incompletely logical by those relative immunocompromised state.

Those present consider demonstrated that, there might have been statistically noteworthy expand for weight Also BMI Around situations over Controls.

Weight Also BMI for our patients were statistically noteworthy expand Similarly as contrasted with control aggregation.

Comparable effects were accounted for by (Lestari et al. , [16] Also Ribeiro et al. , [17].

This camwood be clarified Eventually Tom's perusing productive about corticosteroid Similarly as the greater part our patients on corticosteroid to long time.

Weight Furthermore bone mineralization side impacts ought be acknowledged starting with corticosteroids medication [17]. The utilization about high-dose and long haul steroids prompts expanded sustenance admission complex What's more repressed vitality consumption through incitement about neuropeptide-Y Furthermore repressed arrival of corticotrophin hormone. Those procedure triggers a anabolic methodology Also prompts Weight. [7] Be that as this may be in contradiction with moon. , [9] who discovered weight Furthermore BMI were comparable the middle of the tolerant and control aggregations ( $P > 0.05$ ).

This consider demonstrated that, there might have been statistically huge decline for ca "around instances contrasted with control assembly.

In understanding for our outcomes Koşan. , [18] discovered that, hypocalcemia is accounted done clinched alongside A large portion about patients with nephrotic syndrome looking into corticosteroids treatment.

Also, this is in understanding Additionally with El-Mashad. , [19] who meant will survey bone

mineral thickness (BMD) On know youngsters with idiopathic infection nephrotic syndrome (NS) for typical glomerular filtration rate (GFR). They found ionized ca were essentially bring down done instances over those controls.

This might be clarified Toward corticosteroids foundation hypocalcemia Eventually Tom's perusing diminished ca adsorption starting with gut and kidneys. [17]. Our effects were in contradiction with Sinha. , [20] who watched that no statistically huge distinction Previously, calcium "around situations over controls.

Furthermore Pańczyk-Tomaszewska. , [21] who accounted for typical serum calcium levels to kids with NS Furthermore explaine as much outcomes that might be expected should expanded PTH.

In this study, there were critical raised levels of serum P, ALP, Furthermore PTH over patients vs. Controls.

These outcomes are for understanding with Pańczyk-Tomaszewska. , [21] Also Esmaceili. [22]. Koşan. [18] suggerer that corticosteroids in a roundabout way influence bone by lessened intestinal calcium absorption Also expanded urinary calcium misfortunes.

Hyperparathyroidism accounted for in this consider might have been prone because of hypocalcemia prompted Eventually Tom's perusing corticosteroids; large amounts of PTH need aid referred to should actuate reabsorption about ca from bone, as specified Toward Aceto. , [23]. Bone-specific ALP, which is a standout amongst the isoenzymes, may be processed Eventually Tom's perusing osteoblasts Also will be a great marker from claiming bone formation; it might have been higher in the patients over clinched alongside solid kids. Its increment Throughout corticosteroids treatment On know youngsters for NS might have been Additionally found Toward Koşan. [18] this rise might a chance to be identified with expanded bone turnover What's more change about huge proteinuria.

This may be in understanding Additionally for El-Mashad. [19] who found that, serum P, ALP, Furthermore PTH were higher clinched alongside instances over the controls. Osteopenia might have been recorded Eventually Tom's perusing DXA examine for 11 patients (44%) and osteoporosis done two patients (8%). Crack hazard might have been gentle done six (24%), direct On two (8%), What's more stamped Previously, three (12%) of patients. Bone mineralization might have been negatively influenced Toward steroid medication Previously, kids with NS.

Bone mineral thickness On our patients Toward DXA examine we found, Osteopenia might have been recorded by DXA examine in 8 patients (26. 7%), Also osteoporosis On 4 patients (13. 3%) Also this might have been Exceptionally statistically noteworthy diminishing in z score, BMD Furthermore BMC Around situations over controls.

This is in understanding with El-Mashad. , [19] who discovered that, Osteopenia might have been recorded Eventually Tom's perusing DXA examine clinched alongside 11 patients (44%) Also osteoporosis over two patients (8%). Bone mineralization might have been negatively influenced by steroid medication clinched alongside Youngsters for NS.

This may be in understanding Additionally with Basiratnia. [24] who inferred that bone misfortune might happen clinched alongside a few steroid-dependent nephrotic patients, particularly the individuals for a higher combined measurement about steroid; higher combined doses were connected with additional steroid utilization Furthermore Subsequently that's only the tip of the iceberg bone reduction.

Indeed, straight correspondence the middle of those combined measurements for GCs Furthermore BMD might have been recorded. These outcomes were in understanding for the individuals news person Toward Pańczyk-Tomaszewska. [21] who closed that Youngsters with NS dealt with with corticosteroids would during danger from claiming bone impostor misfortune. Also, Aceto. [23] indicated that GCs decreased BMD Z-score to SSNS, Furthermore that BMD Z-score altogether correlates for the aggregate measurement of prednisone.

Kids requiring repeater courses from claiming corticosteroids need a expanded danger from claiming bone fractures. The estimation of the bone mineral thickness (BMD) by double X-beam absorptiometry (DXA) will be presently those A large portion utilized system with recognize bone misfortune [25]. An opposite association the middle of steroid dosage Furthermore BMD measured Toward DXA need been found On kids for nephrotic syndrome (NS) who as of late began for steroids [26]. There will be a Acquaintanceship between diminished BMD and fractures Previously, know youngsters [27]. Therefore, BMD measured Eventually Tom's perusing DXA appears on be an sufficient technobabble on assess the danger from claiming bone reduction Previously, kids with steroid medication for renal infection. [28].

## 5. Conclusion

Patients with INS would have BMD deficits when compared to their peers. Osteopenia and osteoporosis assessed by DXA was frequent in children with INS. Bone mineralization was negatively affected by steroid treatment in children with INS.

## References

- [1] V. Phan, Skeletal findings in the first 12 months following initiation of glucocorticoid therapy for pediatric nephrotic syndrome, Osteoporos, Int., Vol. 25(2), PP. 627–637, 2014.

- [2] S. J. Park and J. Il Shin, Complications of nephrotic syndrome, *Korean J. Pediatr.*, Vol. 54 (8), p. 322, 2011.
- [3] R. Bartl and C. Bartl, Definition of Osteoporosis, in *Bone Disorders*, Springer, PP. 109–110, 2017.
- [4] V. S. Quintal, E. Diniz, V. de F. Caparbo, and R. M. R. Pereira, Bone densitometry by dual-energy X-ray absorptiometry (DXA) in preterm newborns compared with full-term peers in the first six months of life, *J. Pediatr.*, (Rio. J.), Vol. 90 (6), PP. 556–562, 2014.
- [5] H. P. Dimai, Use of dual-energy X-ray absorptiometry (DXA) for diagnosis and fracture risk assessment; WHO-criteria, T-and Z-score, and reference databases, *Bone*, Vol. 104, PP. 39–43, 2017.
- [6] N. Bishop, Fracture prediction and the definition of osteoporosis in children and adolescents: the ISCD 2013 Pediatric Official Positions, *J. Clin. Densitom.*, Vol. 17(2), PP. 275–280, 2014.
- [7] P. Niaudet and O. Boyer, Idiopathic nephrotic syndrome in children: clinical aspects, *Pediatr. Nephrol.*, PP. 839–882, 2016.
- [8] A. M. Bakr, Bone mineral density and bone turnover markers in children with chronic renal failure, *Pediatr. Nephrol.*, Vol. 19 (12), PP. 1390–1393, 2004.
- [9] R. J. Moon, Children with nephrotic syndrome have greater bone area but similar volumetric bone mineral density to healthy controls, *Bone*, Vol. 58, PP. 108–113, 2014.
- [10] N. R. Rhuma, A. S. El Boeshi, L. T. Sabei, and A. M. Kara, A descriptive retrospective study on children with newly diagnosed nephrotic syndrome presented to Tripoli Children Hospital during the period between Jan. to Dec. 2014, *Libyan Int. Med. Univ. J.*, Vol. 1(1), PP. 45–57, 2016.
- [11] R. K. D. Ephraim, R. C. Brenyah, F. B. Osei, E. O. Anto, A. L. Basing, and K. O. Darkwah, Demographic, Clinical and Therapeutic Characteristics of Children Aged 0-15 years with Nephrotic Syndrome: A Retrospective Study of the Komfo Anokye Teaching Hospital, Kumasi, Ghana, *Asian J. Med. Heal.*, PP. 1–9, 2017.
- [12] E. C. Ray, H. Rondon-Berrios, C. R. Boyd, and T. R. Kleyman, Sodium retention and volume expansion in nephrotic syndrome: implications for hypertension, *Adv. Chronic Kidney Dis.*, Vol. 22(3), PP. 179–184, 2015.
- [13] K. S. Sahana, Clinical Profile of Nephrotic Syndrome in Children, *J. EVol. Med. Dent. Sci.*, Vol. 3 (04), PP. 863–870, 2014.
- [14] K. Alfakeekh, Immunosuppressive burden and risk factors of infection in primary childhood nephrotic syndrome, *J. Infect. Public Health*, Vol.12 (1), PP. 90–94, 2019.
- [15] R. K. Alwadhhi, J. L. Mathew, and B. Rath, Clinical profile of children with nephrotic syndrome not on glucocorticoid therapy, but presenting with infection, *J. Paediatr. Child Health*, Vol. 40 (1-2), PP. 28–32, 2004.
- [16] N. Lestari, N. Nurani, and M. Julia, Corticosteroids and obesity in steroid-sensitive and steroid-resistant nephrotic syndrome, *Paediatr. Indones*, Vol. 55(4), PP. 194–198, 2015.
- [17] D. Ribeiro, S. Zawadzynski, L. F. Pittet, T. Chevalley, E. Girardin, and P. Parvex, Effect of glucocorticoids on growth and bone mineral density in children with nephrotic syndrome, *Eur. J. Pediatr.*, Vol. 174(7), PP. 911–917, 2015.
- [18] C. Koşan, G. Ayar, and Z. Orbak, Effects of steroid treatment on bone mineral metabolism in children with glucocorticoid-sensitive nephrotic syndrome, *West Indian Med. J.*, Vol. 61(6), PP. 627–630, 2012.
- [19] G. M. El-Mashad, M. A. El-Hawy, S. M. El-Hefnawy, and S. M. Mohamed, Bone mineral density in children with idiopathic nephrotic syndrome, *J. Pediatr.* (Versão em Port.), Vol. 93 (2), PP. 142–147, 2017.
- [20] N. Sinha, P. Wade, R. G. Ghildiyal, and H. Maniar, Biochemical bone markers in children with steroid sensitive nephrotic syndrome in remission, *Int. J. Contemp. Pediatr.*, Vol. 5(4), p. 1588, 2018.
- [21] M. Pańczyk-Tomaszewska, Markers of bone metabolism in children with nephrotic syndrome treated with corticosteroids, in *Body Metabolism and Exercise*, Springer, 2014, PP. 21–28.
- [22] M. Esmaeili, A. Azarfar, and S. Hoseinalizadeh, Calcium and vitamin D metabolism in pediatric nephrotic syndrome; an update on the existing literature, *Int. J. Pediatr.*, Vol. 3(2),1, PP. 103–109, 2015.
- [23] G. Aceto, Bone health in children and adolescents with steroid-sensitive nephrotic syndrome assessed by DXA and QUS, *Pediatr. Nephrol.*, Vol. 29(11), PP. 2147–2155, 2014.
- [24] M. Basiratnia, M. H. Fallahzadeh, A. Derakhshan, and G. Hosseini-Al-Hashemi, Bone mineral density in children with relapsing nephrotic syndrome, *Iran. J. Med. Sci.*, Vol. 31(2), 2006.
- [25] C. van Kuijk, Pediatric bone densitometry, *Radiol. Clin.*, Vol. 48(3), PP. 623–627, 2010.
- [26] J. Feber, Skeletal findings in children recently initiating glucocorticoids for the treatment of nephrotic syndrome, *Osteoporos. Int.*, Vol. 23(2), PP. 751–760, 2012.
- [27] B. S. Zemel, Revised reference curves for bone mineral content and areal bone mineral density according to age and sex for black and non-black children: results of the bone mineral density in childhood study, *J. Clin. Endocrinol. Metab.*, Vol. 96 (10), PP. 3160–3169, 2011.
- [28] M. P. Gruppen, Prevention of steroid-induced low bone mineral density in children with renal

diseases: a systematic review, *Nephrol. Dial. Transplant.*, Vol. 28 (8), PP. 2099–2106, 2013.