PREVALENCE OF VITAMIN D INSUFFICIENCY AND DEFICIENCY AMONG CHILDREN WITH CEREBRAL PASLY AT THE KENTYATTA NATIONAL HOSPITAL.

A Thesis submitted in part fulfilment for the degree of Masters of Medicine (Paediatrics and Child Health), University of Nairobi.

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DECLARATION

I declare that this dissertation is my original work, done under the guidance of my supervisors and has not been published or presented as a dissertation in any other university.

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List of Abbreviations

CI: Confidence Interval

CP: Cerebral Palsy

25(OH) D3: Calcidiol

1, 25(OH) D3: Calcitriol

CA2+: Calcium

PO_4^{3-}: inorganic phosphate

PTH: Parathyroid hormone

VDR: Vitamin D receptor

VDD: Vitamin D Deficiency

ERC: Ethics Review Committee

GMFCS: Gross Motor Function Classification System

HIS: Health Information System

ICC: Intraclass Correlation Coefficient

KNH: Kenyatta National Hospital

OR: Odds Ratio

SPSS: Statistical Package for Social Scientists

TPN: Total Parenteral Nutrition

WHO: World Health Organization

AED: anti-epileptic drug

Operational definition of terms

Prevalence: The commonness of a health phenomenon in a population

Determinants: A factor that can affect the outcome or nature of another factor decisively

Cerebral Palsy: Cerebral Palsy is a heterogeneous group of disorders with motor or postural abnormalities in early development due to non-progressive brain lesions.

The Gross Motor Function Classification System - Expanded & Revised (GMFCS - E&R) is a 5-level classification system that describes the gross motor function of children and youth with cerebral palsy on the basis of their self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility. Distinctions between levels are based on functional abilities, the need for assistive technology, including hand-held mobility devices (walkers, crutches, or canes) or wheeled mobility, and to a much lesser extent, quality of movement.

Vitamin D deficiency: Levels below 20ng/ml

Vitamin D Insufficiency: Levels between 21-30ng/ml

Vitamin D sufficiency: Levels between 30 – 100ng/ml

ABSTRACT

Background: Deficiency of Vitamin D occurs commonly worldwide. Children with cerebral palsy (CP) are at a higher risk of vitamin D deficiency (VDD) due to the comorbidities that occur with CP. These include; feeding difficulties, inadequate language and communication skills, reduced ambulation/sun exposure and associated seizure disorders requiring the use of anti-epileptic drugs (AED). Vitamin D is a key determinant of calcium and phosphate homeostasis.

Objective: This study aimed to determine the prevalence of vitamin D insufficiency and deficiency in children with CP aged 1-18 years undergoing treatment or rehabilitative therapy at the Kenyatta National Hospital (KNH).

Methodology: This was a hospital based cross sectional study. Children with known diagnosis of CP were recruited. The study utilized consecutive sampling until the calculated sample size was achieved. Data on sociodemographic factors, history of use of anticonvulsant, vitamin D supplementation and sun exposure was obtained. Blood sample was taken for analysis of calcium, phosphate and Vitamin D levels.

Data Analysis: Data collected was managed using Microsoft Access data base and data analysis was done using STATA version. Categorical data was summarized as frequencies & their respective percentages while continuous were presented as mean (standard deviation) or median (interquartile range). Vitamin D deficiency, insufficiency & adequate levels were reported as percentages with binomial exact 95%Cis. Univariate and multivariate logistic regression analysis was done for factors associated with Vitamin D insufficiency/deficiency.

Results: The study recruited 80 children with CP with median age (IQR) 42 (21 to 72) months old. Males (50) accounted for 62% and spastic CP was the most frequent type of CP (n= 54, 67%). VDD was seen in 32% of the children, insufficiency in 29% and 32% had normal Vitamin D levels. The predictors of low vitamin D levels were age > 60months with adjusted odds ratio (aOR) increased 4.77-fold ((95%CI 1.11–20.5) (p=0.03)), duration of AED use >1year with aOR increased 4.62-fold (95%CI 1.06–20.2) (p=0.04) and sunlight exposure of duration <1hour with aOR of 0.07 ((95%CI 0.02–0.25) (p=<0.0001)).

Conclusion: The prevalence of Vitamin D insufficiency/deficiency is high at 61%.

INTRODUCTION

1.1 Background

Vitamin D is a fat-soluble vitamin. Only a few foods naturally contain vitamin D with the exception of fatty fish like salmon and herring, so dermal synthesis is the main natural source. Vitamin D exists in two forms, Vitamin D2 (ergocalciferol) and Vitamin D3 (cholecalciferol). Ergocalciferol is produced by plants through photochemical synthesis in yeast while cholecalciferol is from synthesis in the skin. (1). Both forms are prohormones used in vitamin D supplements and in fortification of food.

1.2 Vitamin D synthesis, metabolism, physiology and biological functions

Exposure to ultraviolet (UV) rays in sunlight results in non-enzymatic synthesis of 7-dehydrocholesterol, a cholesterol precursor naturally occurring in the skin to previtamin D3(1). Previtamin D3 undergoes reconfiguration to form cholecalciferol by a temperature dependent mechanism. The dermal synthesis is extremely effective and the short periods of sunlight exposure of the arms and face is estimated to be equal to the consumption of 200 international units per day. The length of sunlight exposure per day needed to receive the equivalent of oral vitamin D supplementation is hard to predict for each person as it is dependent on several factors which include the type of skin, the season and the time of day. Extended periods of exposure to sunlight does not lead to production of harmful levels of vitamin D3 due to conversion of previtamin D3 and vitamin D3 to its inactive metabolites. Commercial preparations of vitamin D3 are produced from synthesis of 7-dehydrocholesterol. Vitamin D obtained from diet is incorporated into micelles which are then absorbed by the enterocytesm and then packaged into chylomicrons.

Vitamin D obtained from both the skin and the diet is inactive and requires activation which occurs in the liver and the kidneys. It undergoes the initial step of hydroxylation through the activity of vitamin D 25 hydroxylase in the liver to form 25(OH) D. The second hydroxylation occurs in the kidneys by the enzyme 25(OH)D 1 α-OHase to form the active form 1,25 (OH)2D. The active form exerts its biological functions through binding to the vitamin D receptor (VDR) which is found in the small intestines, the kidneys, the skeletal muscle and other body tissues.

1, 25 (OH) 2D stimulates absorption of calcium from the gut through epithelial calcium channels (ECaC) and calcium binding proteins (CaBP) in the small intestines. In VDD approximately 10-15% of calcium and 60% of phosphorous is absorbed from the gut. With normal vitamin D levels, the absorption of calcium doubles to approximately 40% and for phosphorous increases to 80%. Through its VDR, 1, 25 (OH) 2D exerts its action in the osteoblasts and stimulates expression of nuclear factor κβ which stimulates maturation of immature monocytes to osteoclasts. Osteoclasts cause dissolution of bone matrix and mobilization of calcium and other skeletal minerals.

1, 25 (OH) 2D stimulates renal calcium reabsorption. It has other biological roles in different tissues in the body, including regulation of immunity, cellular growth , neuromuscular and cardiovascular systems (2). Some of the immune cells like the dendritic cells, the macrophages and the T and B cells express the VDR. These cells can synthesize and/or respond to the bioactive metabolite allowing for paracrine and autocrine functions of Vitamin D(3).

Both calcidiol and calcitriol are enzymatically metabolized into inactive water-soluble forms by the enzyme, 25 hydroxyvitamin D-24- OHase which is upregulated by 1, 25(OH) 2D.

1.3 Clinical effects of vitamin D deficiency

VDD results in disturbances in metabolism of phosphorous, calcium and bone. It leads to decreased absorption of calcium and phosphorous in the diet. Low calcium levels result in increased secretion of parathyroid hormone (PTH). Secondary hyperthyroidism maintains calcium levels by stimulation of release of skeletal calcium and increased renal excretion of phosphorous. The increased activity of the osteoclasts causes foci of weakness in the skeleton and a low bone mineral density. This leads to osteopenia, osteoporosis and an increased likelihood of fractures. Renal excretion of phosphate results in low phosphorus levels. The resulting hypophosphatemia and hypocalcaemia causes a defect in the mineralization of the skeleton. The mineral content in the skeleton of children is low hence deficit in the calcium and phosphorus product results in deformities in the skeleton known as rickets. In older children it results in softening of bones, a condition called osteomalacia.

VDD also causes muscle weakness due to poor neuromuscular function and affected children have difficulty standing and walking. Ensuing hypocalcaemia may also cause tetany or seizures.

VDD increases susceptibility to infectious agents like bacteria and viruses and in some susceptible individuals to autoimmunity(3). It has also been shown to lead to progression of diabetes mellitus and cardiovascular diseases and increased susceptibility to cancer(2)(4).

2 LITERATURE REVIEW

2.1 Vitamin D deficiency

VDD is common worldwide (5). It is estimated that approximately 1 billion children and adults have insufficiency or deficiency of Vitamin D (6) with the prevalence of low vitamin levels ranging from 30 – 80%(7). The prevalence of VDD is highest among children and adolescents worldwide(8). Gordon et al did a study on healthy infants and children and found the prevalence for vitamin D deficiency and insufficiency was 40%(9). In a South African study by White et al, on black preadolescent children, only 34% had sufficient vitamin D levels with mean vitamin D concentration of the total group of 27.3 ± 5.3 ng/mL, categorizing them as Vitamin D insufficient.

In a study by Waris et al, among healthy children attending surgical outpatient clinic at Kenyatta national hospital (KNH), the prevalence of VDD was 12%. Children with CP are at an increased risk for VDD compared to healthy children due to their physical and motor impairments. In a comparative study on VDD among children with CP and healthy children by Toopchidazeh et al , the measured serum levels of vitamin D was statistically lower among children with CP (28.03 ±24.2 ng/ml) than healthy ones (30 ± 1.94 ng/l) with 26.1% more children with CP diagnosed with VDD(10).

To detect and manage VDD efficiently and improve outcomes of children with CP, understanding of the factors that influence its development is crucial. The prevalence of VDD and its determinants in this cohort is lacking in our setup, which is a barrier for proper management.

2.2 Prevalence of vitamin D insufficiency and deficiency among children with cerebral palsy.

The prevalence of VDD in children with CP ranges from 30 - 60 %. In a study by Toopchizadeh et al, that compared the prevalence of VDD among healthy controls and children with CP the prevalence of VDD in children with CP was higher at 44.6 % compared to a prevalence of 18.5 % in healthy controls with severe deficiency seen in 13.8% of CP cases(10). The higher

rates of VDD were associated with inadequate sun exposure, older age and use of anti-epileptic drugs (AED).

In a study by Seth et al, at a tertiary hospital in India, almost two-thirds of the children with CP had low vitamin D levels with 23.3% of those having moderate to severe deficiency while 36.7% of the controls had VDD with 10% of the controls moderately to severely deficient. In these patients, the factors that contributed to VDD was AED use and inadequate exposure to the sun. The effect was more especially with the two factors present together(11).

Pinar et al, in a study at a tertiary hospital in Turkey found that 33.6% of the 235 children with CP in the study had VDD. The results demonstrated that the children who were non-ambulant and had associated comorbidities such as seizure disorders, intellectual and developmental delay, feeding problems, and poor growth were prone to VDD(12).

In the Africa setting, there are no studies on the prevalence of VDD among this cohort. In a study in South Africa that assessed children and young adults with CP who had non-traumatic fractures of the long bones at a care facility, vitamin D deficiency was a contributory factor with noted improvement after three months of vitamin D supplementation.

2.3 Factors associated with low Vitamin D levels in children with CP

2.3.1 Inadequate nutrition

Children with CP have higher rates of poor growth and malnutrition compared to healthy children. They are at risk for both macro and micronutrient deficiency due to the physical and motor impairments associated with CP. In a study by Koriata et al at KNH that assessed 140 children with CP, 70% of the children were malnourished and stunting was more prevalent (13). Moderate to severe wasting was associated with younger age, lack of regular source of income and the severity of disability. In a study by Johnson et al in Botswana among children with CP attending a tertiary hospital, 43% were found to be malnourished with the strongest risk factors being low socioeconomic status and non-ambulatory status(14).

Children with CP have severe motor impairments that affect hand-mouth coordination, chewing, self-feeding, and food ingestion resulting in decreased food intake. Reilly et al, found that 90% of children with CP had oromotor dysfunction. The types of oropharyngeal problems in children with CP include tongue disorders, exaggerated bite reflex, reduced lip closure, delay

in initiation of swallowing, drooling, tactile hypersensitivity and reduced pharyngeal motility. In a study by Parkes et al, chewing and swallowing difficulties and excessive drooling occurred in 20% of children with CP. This results in prolonged feeding times and therefore during family/school meal times they have insufficient intake. It also puts a strain on the caregiver(15,16)(17).

Communication difficulties in children CP have been reported in 38-78% of children with CP. Intellectual disability is the single most important predictor of communication ability. Language and speech problems associated with CP may lead to inability to communicate satiety or hunger leading to inadequate intake.

2.3.2 Inadequate sun exposure and darker skin pigmentation

The bulk of vitamin D stores in the body are from dermal synthesis under ultraviolet (UVB) radiation than from the diet. The measure of UVB radiation reaching the world's surface is influenced by the stratosphere ozone levels, latitude, season of the year, atmospheric pollution and the cloud cover.

An individual's UVB exposure and its biological effects on the skin are influenced by the use of sun protection measures like sunscreens, wearing covering clothing, sun-seeking behavior, low levels of physical activity and skin pigmentation.

Children with CP have physical disabilities that limit their ambulation and sun seeking behavior and thus they require the assistance of a caregiver. Moderately to severely disabled children with CP on gross motor functional classification scale (GMFCS) III – V are non-ambulant and likely to be house bound therefore, they have inadequate exposure to the sun thus resulting in decreased synthesis of vitamin D(10)(12).

Vitamin D levels among blacks are lower due to the darker skin pigmentation. Blacks have increased melanin levels, which protect from UVB radiation thus interfering with the synthesis of Vitamin D(18).

2.3.3 Use of anticonvulsants

Epilepsy frequently occurs in children with CP in 25 -80 % of cases(19–21). Most children require more than one drug for the control of the seizures.

Use of anticonvulsants results in increased inactivation of Vitamin D due to increased induction of cytochrome p450 enzymes in the liver by the anticonvulsant medication. Anti- epileptic medications commonly prescribed in our setup that have been shown to cause induction of microsomal enzymes include carbamazepine, phenobarbital and phenytoin. Resulting biochemical abnormalities include disturbed metabolism of bone, reduced bone density and a two to six fold increase in risk of fractures for those taking AED(22)(23).

In a study by Nettekoven et al, on the effects of anticonvulsants on Vitamin D status, the results showed that 75% of the patients on anticonvulsant medications had VDD while 21% had Vitamin D insufficiency. In these patients, the markers of bone formation and resorption were altered suggesting an accelerated bone turnover(24).

Lee et al reported reductions in serum vitamin D levels in children with CP after initiation of anticonvulsant, with the duration of treatment influencing the prevalence of VDD marginally(25).

In a study by Kija et al, in South Africa on bone abnormalities in children on anticonvulsants, VDD occurred in 16.2% of children on AED compared to 8.8% in the controls while 44.1% of children on anticonvulsant had vitamin D insufficiency in comparison with 39.7% in the control group. The children on anticonvulsants had a lower mean in serum level of vitamin D than the control group (26).

In a meta-analysis by Zejun xu et al, of 11 publications, that compared vitamin D status in children who had been on sodium valproate monotherapy for more than 6 months with healthy children, they found a decrease in vitamin D levels in the children who had been on sodium valproate. A similar decrease was also observed among children on carbamazepine(27).

Those on poly-therapy for control of epilepsy had severe deficiency compared to those on monotherapy(28).

2.4 Measurement of serum levels of vitamin D

The major form of vitamin D in circulation is 25(OH) D and it reflects sources from both cutaneous and dietary intake. It has a half-life of 2-3 weeks and is the standardized measure for vitamin D status compared to 1, 25(OH)D which has a shorter half-life of 4 hours (29).

The concentration of 1, 25(OH) D in circulation is lower than that of 25(OH) D. Its levels are affected by any changes in calcium, phosphate and PTH. It therefore, does not reflect actual body stores of vitamin D. It is thus not used for evaluation of the status of vitamin D levels in patients.

Table 1: Summary of Literature Review

Title, author, year	**Study method/population**	**Study findings**
Prevalence of Vitamin D Deficiency and Associated Risk Factors in Cerebral Palsy, Iran, Vahideh Toopchizadeh et al, 2018	Case control study 65 children with CP and 65 healthy children.	**44.6%** of children with CP had VDD while 18.5**%** of healthy children had VDD.
Vitamin D Status of Children with Cerebral Palsy in Istanbul, Turkey Pinar Akpinar et al 2018	Cross sectional observational study 274 children with CP	**60%** of the children had insufficient/deficient levels. The children with CP classified as GMFCS levels IV-V with other comorbidities were vulnerable to VDD.
Effect of Impaired Ambulation and Anti-Epileptic Drug Intake on Vitamin D Status of Children with Cerebral Palsy Anju Seth et al 2017	Case control 120 children with CP 30 children – healthy controls	VDD was reported in **60% of** children with CP and in **36.7%** of healthy controls. Lack of sunlight exposure and use of AED contributed to suboptimal vitamin D levels.
Vitamin D Status in Tasmanian Children with Cerebral Palsy Tyson Ware et al 2013	Cross sectional 38 children with CP	**34%** had VDD.
Vitamin D status in children with Cerebral Palsy, India, Sowjan Manohar et al 2015	Prospective case control study (100 children with CP and 100 age and sex matched children were taken as controls)	VDD was observed in 32 (**32%)** and insufficiency in 61 **(61%)** of children with CP. Among the healthy children 13% and 38% had deficiency and insufficiency respectively. Feeding impairements, lack of sunlight exposure, poor nutritional status, and the use of AED, type of CP and the GMFCS grade of CP had statistically significant association.

2.5 Conceptual framework

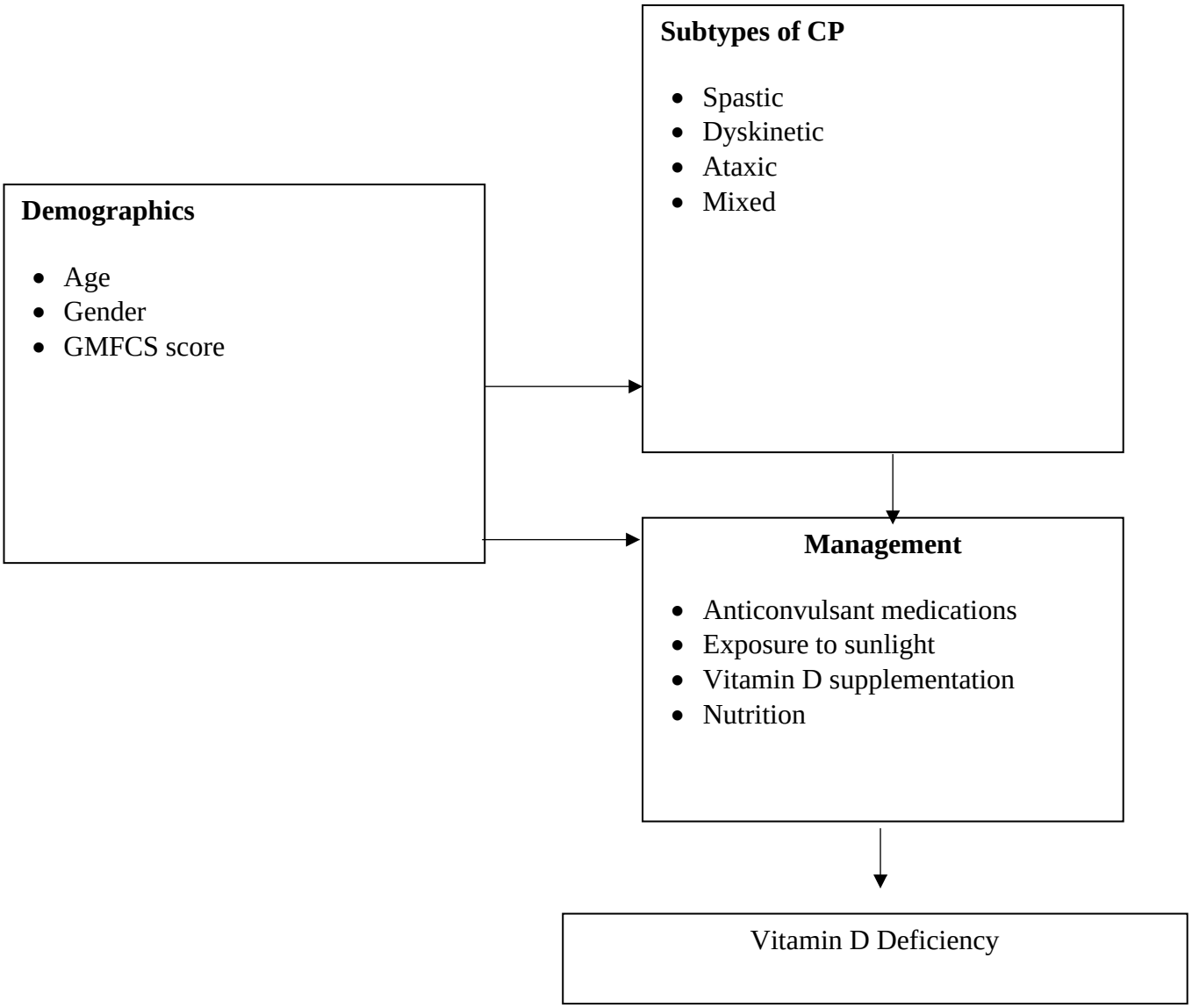

Figure 1. Conceptual framework on the relationship between subtypes of CP, demographic, and management practices in relation to VDD.

3 JUSTIFICATION AND OBJECTIVES

3.1 Justification

High rates of VDD and its associated complications have been reported globally especially among at risk groups. The prevalence of VDD and its determinants has not been described in children with CP in our set up. The paediatric endocrine society recommends screening and supplementation for at risk groups such as those on anticonvulsant therapy, neuromuscular disorders which in our set up has not been routinely implemented. Therefore, the description of vitamin D deficiency epidemiology in children with CP may boost case identification and early initiation of care to prevent adverse outcomes.

3.2 Research question

What is the prevalence of vitamin D deficiency/insufficiency in children with cerebral palsy aged 1-18 years at the Kenyatta National Hospital?

3.3 Primary objective

1. To determine the prevalence of vitamin D insufficiency and deficiency in children with cerebral palsy at the Kenyatta National Hospital.

3.4 Secondary objectives

2. To determine factors associated with Vitamin D insufficiency/deficiency in children with cerebral palsy at Kenyatta National Hospital.

4 METHODOLOGY

4.1 Study design

This was a hospital-based cross-sectional study done between December 2020 and April 2021. The study utilized quantitative data collection and analysis techniques.

4.2 Study site

The study was carried out at the Kenyatta National Hospital (KNH). KNH is the national referral hospital and one of the largest public hospitals in the East African (EA) region. It also serves as a teaching hospital for the University of Nairobi.

The KNH paediatric neurology clinic is a specialized unit, in which children with neurological complications such as developmental delay, seizure, epilepsy and cerebral palsy are managed. The occupational therapy clinic provides health services aimed at rehabilitating and managing existing conditions to improve the well-being of children. Finally, the paediatric general wards handle all paediatric admissions inclusive of children with CP up to the age of 13years. Children between the ages of 13- 18 years are admitted in the adult medical wards.

In the KNH registry records, approximately 200 children with cerebral palsy are attended to in the paediatric and adult neurology clinic, occupational therapy clinic, and paediatric and adult general wards yearly.

Study participants were recruited from the paediatric and adult neurology clinic, the occupational therapy clinic, and the inpatient paediatric and medical general wards of the KNH.

4.3 Study population

The target population for the study were children aged 1-18 years with known diagnosis of cerebral palsy undergoing treatment or rehabilitation at the KNH during the study period until the required sample size was achieved.

4.4 Study period

The study was conducted over a 5-month period between December 2020 and April 2021

4.5 Study outcomes

The study aimed to achieve the following outcomes:

1. To determine the prevalence of vitamin D insufficiency/deficiency in children with cerebral palsy at the Kenyatta National Hospital with Vitamin D levels categorized using the Endocrine society guidelines:

    - ❖ Sufficient serum vitamin D levels = (> 30 ng/ml),
    - ❖ Insufficient serum vitamin D levels = (21-29 ng/ml)
    - ❖ Deficient serum vitamin D levels = (< 20 ng/ml)

2. To determine factors associated with Vitamin D insufficiency/deficiency among children with cerebral palsy at Kenyatta National Hospital.

4.6 Eligibility criteria

4.6.1 Inclusion criteria

- Child aged (1-18 years) with a known diagnosis of cerebral palsy on follow up at the KNH paediatric/adult neurology, occupational therapy clinics and general inpatient wards.
- Children whose parents consented to participation in the study.

4.6.2 Exclusion criteria

- Patient with known renal or liver disease on their medical records.
- Patient known to have malabsorption syndromes.

4.7 Sample size determination

Assuming a precision of 5%, sample size was calculated using a formula by Fisher (1981). The estimated prevalence in our set up was assumed at 50%. The population of qualified patients in our study site was estimated to be 100 in three months as per the KNH inpatient and outpatient registry records for the preceding years.

Formula

$$n = \frac{z^2 \ p\ (1-p)}{d^2}$$

Parameters

n: Estimated sample size

Z: N deviate for 95% CI (1.96)

p: Estimated prevalence of vitamin D in CP (50%)

d: Precision (5%)

N: Estimated target population (100 cases of CP)

Calculation

$n = \frac{z^2 \ 0.336\ (1-0.50)}{(0.05)^2} = 258$

n= 258

Correction factor

$n = \frac{1}{1/n + 1/N}$

$n = \frac{1}{1/258 + 1/100}$

$n = 72$

Allowing for 10% non-response, a sample size of 80 participants was required to get sufficiently powered data at 95% CI.

4.8 Sampling procedure

The convenience sampling procedure as elucidated in-depth by Martinez-Mesa and colleagues (30) was used to recruit study participants. The parents or guardians of children with CP were recruited in the order of attendance at the KNH neurology clinics or wards and objectives of the study were explained to them. The study procedure, risks, and potential benefits to children and medical community were elucidated and written informed consent/assent sought for all children who met our inclusion criteria. Upon receipt of a written consent from a guardian or parent, children were recruited as depicted in Figure 2 and sampling then stopped once the

target sample size was achieved. Consecutive sampling process was preferred due to time restrictions and budgetary limitations.

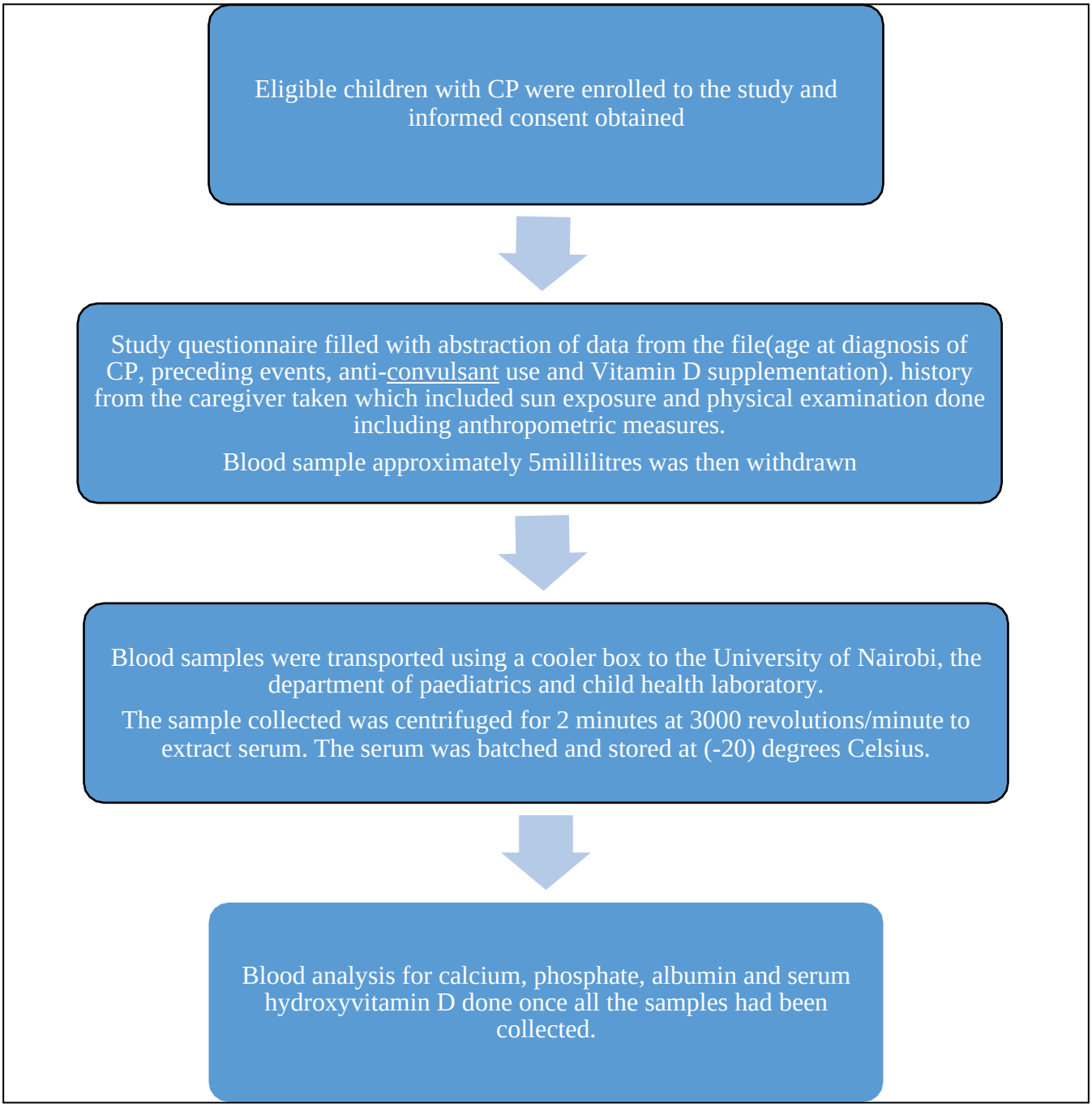

Figure 2 Study recruitment procedure

4.9 Data collection

4.9.1 Study tool

Data collection was conducted using a questionnaire organized in four sections. The first section recorded the demographic characteristics of CP patients, which included the age in years, gender, age at diagnosis of CP and preceding history of cause of CP, the pattern of CP, the type of anticonvulsant drug used and duration of use, the history of vitamin D supplementation and the mode of feeding. The second section was a ten-item sun exposure questionnaire, while the third section had the Gross Motor Function Classification System (GMFCS) used to evaluate the gross motor function of children with CP. The GMFCS evaluates the ability of children diagnosed with CP to be ambulant such as walking, climbing stair, running, or sitting in five grades (I-V), I representing the mildest and V the most severe level(31). The fourth section of the questionnaires had the laboratory results of serum analysis. The concentration of serum calcium, phosphate and 25 hydroxy cholecalciferol levels were recorded as presented in the laboratory reports.

The questionnaire was pre-tested in eligible patients to determine internal reliability. In case of any errors, corrections were made to ensure that reliability was sustained before the actual data collection.

4.9.2 Sample analysis

Calcium and phosphate were measured by standard automated methods (system Reagent for Humastar 600 CPC method. Phosphate reacts with molybdate in a strong acid medium to form a complex. The concentration of serum phosphate is directly proportional to the complex's measured absorbance in the near ultraviolet. Calcium ions react in an alkaloine medium with o-cresolphthalein- complexone to form a purple-colored complex whose absorption is proportional to the sample of calcium concentration.

To obtain the level of ionized calcium, serum albumin levels was obtained and a correction factor used in those participants with low albumin levels. Serum albumin was analyzed and reported in g/l using a calorimetric assay. Albumin is determined in serum using dye-binding methods with green bromocresol or purple bromocresol. Albumin binds to these dyes with high affinity and absorbs light at 628 nanometers (nm) and 600 nm at the respective complexes. The reaction is linear up to a minimum of 60g / L.

The LIASON 25-0H Vitamin D testing technique was used to determine the serum levels of vitamin D. It adopts a “Flash” chemiluminescence technology (CLIA) with a pragmatic micro particle solid phase (MP). This method is rapid, accurate and precise. It is validated according to the National committee for clinical laboratory standards (NCCLS) protocols. Additionally, it is comparable to the gold standard liquid chromatography isotope dilution tandem mass spectrometry (LC-IDM/MS) and well correlated with the radioimmunoassay technique. The measuring range is from 4.0 to 150 ng / ml with the lowest reportable value as 4.0ng / ml, based on an inter-assay accuracy of approximately 20% CV (functional sensitivity).

4.9.3 Data management and analysis

Data handling was done as directed by Borghi and others (32). All filled consent forms and questionnaires were filed and stored in locked cabinets that were only accessible to the principal researcher. Password protected databases were created as backup. While preparing data for analysis, questionnaires were de-identified to respect the privacy of the participants.

The study data were collected using a standard questionnaire and exported to statistical software (STATA) for analysis. Continuous variables were assessed for outliers by plotting visual aids like histogram, scatter plots and qq-plots for assessing normality. Outliers and illogical variables were flagged and corrected by checking correct values in the patient records.

Continuous biochemical and anthropometric variables were presented as means (standard deviation) or medians (Interquartile range) depending on their distribution. Vitamin D deficiency, insufficiency and adequacy were reported as proportions with binomial exact 95% confidence intervals. Medians (IQR) were reported for each category too.

To determine the association of duration of exposure to sunlight per week, anticonvulsant use and other factors associated with vitamin D levels in children with CP at KNH, we used binary logistic regression models and reported both crude and adjusted coefficients transformed to odds ratios and their respective 95% confidence intervals (CI). A binary dependent event was created by collapsing Vitamin D insufficiency and deficiency into one group Vs the group with adequate Vitamin D levels. We calculated total hours of sunlight exposure and classified it into ≤1 hour and >1 hour. Univariate analysis was conducted separately for each of the factors. To perform multivariable analysis, independent variables with P-value <0.05 in the univariate analysis were included together with age and sex as a priori confounders.

4.10 Ethical considerations

1. Approval was sought from the KNH-UON ethics review board before the recruitment of study participants and data collection. The study protocol and research tools such as the consent form and questionnaire were submitted for reviews and used only after approval. Authorisation to conduct the study was also sought from KNH and the department of paediatrics and child health.
2. Consent was administered before recruitment into the study. The parents were approached and the study objectives, procedure, risks, and benefits of the study discussed in English or Kiswahili. Confidentiality and voluntary participation were covered during the discussion and written consent requested before recruitment of the children with CP into the study. The children of parents who declined to offer consent were reassured of continued service delivery.
3. The confidentiality of patients was upheld throughout the study. The interviews and physical evaluations were conducted at the paediatric unit of KNH in a secluded area. During the interviews and examinations, parents were used as chaperones to ease anxiety and to ensure accurate data collection, especially of the demographic characteristics and medical history of children. Each patient was allotted a unique identification number in the order of recruitment, which was not linked to their personal identifiers.
4. Children with CP who were found to have vitamin D deficiency were referred for specialised care. The parents did not incur any cost for the analysis of phosphate, calcium, and Vitamin D levels.

5 FINDINGS AND RESULTS

5.1 Sociodemographic characteristics

The study recruited a total of 80 children with CP with a median age of 42 months (21 to 72). In total 54 (68%) were < 60months and approximately two-third (n=50, 62.5%) were male. Spastic CP was the most frequent type of CP (n=54, 67%). The diagnosis of CP was made early in life, when the children were median (IQR) 11 (5 to 12) months of age. The two most frequent preceding diagnosis/event were perinatal asphyxia (n=44, 55%) and meningitis (n=29, 36%). A total of 22 (28%) were on Vitamin D supplementation with 19/22 (86%) and 3/22 (14%) on intermittent and continuous supplementation respectively. Fifty-eight (72%) of the children were on anticonvulsants, 42 (72%) were on sodium valproate, 40 (69%) on phenobarbitone, 11 (19%) on rivotril/clonazepam, 4 (6.9%) on carbamazepine/Tegretol, 2 (3.5%) on clonazepam and 2 (3.5%) on lamotrigine. Among the 58 children on anticonvulsants, 16 (28%) had been on the drugs for a duration of 0 to 1 year, 28 (48%) had been on anticonvulsants for a period of 1 to 5 years and 14 (24%) had been on anticonvulsants for more than 5 years. The majority of the children with CP were feeding orally (n=67, 84%), 8 (10%) were feeding through tube and 5 (6.3%) had a gastrostomy. The mean (sd) BMI z-score was -1.49 (2.9) with 24(30%) and 10 (13%) severely and moderately wasted respectively. The mean (sd) height-for-age z-score (HAZ) was -2.47 (2.3). Thirty-three (41%) and 14 (18%) were severely and moderately stunted respectively. A total of 20 (25%) had GMFCS grade II and III while 60 (75%) had GMFCS grade IV and V (non-ambulatory).

Table 2. Demographic and health characteristics of children with CP: N=80

Participant characteristics		Frequency (%)
Age in months	<59 months	54 (67.5)
	60+ months	26 (32.5)
	Median (IQR)	42 (21-72)
Gender	Male	50 (62.5)
	Female	30 (37.5)
Type of cerebral palsy	Spastic	54 (67.5)
	Ataxic	6 (7.5)
	Dyskinesia	4 (5.0)
	Mixed	16 (20.0)
Age at diagnosis(months)	Median (IQR)	11(5 - 12)
Preceding events	Birth asphyxia	44 (55.3)
	Meningitis	29 (36.3)
	Kernicterus	5 (6.3)
	Others	4 (5.2)
Antiepileptic drug (AED) use	Yes	58 (72.5)
	No	22 (27.5)
Type of AED (N=58) [$]	Sodium Valproate	42 (72.1)
	Phenobarbitone	40 (69.7)
	Clonazepam	13 (22.4)
	Others	6 (10.3)
Duration of AED use (N=58) [$]	0 – 1 year	16 (27.6)
	1 – 5years	28 (48.4)
	>5years	14 (24)
Vitamin D supplementation	Yes	22 (27.5)
	No	58 (72.5)
Supplementation method (N=22)	Intermittent	19 (86.4)
	Continuous	3 (13.6)
Mode of feeding	Oral	67 (83.8)
	Tube	8 (10.0)
	Gastrostomy	5 (6.3)
Sun exposure time	<1hour	44(55)
	>1hour	36 (45)
Height for age z score:	Mean ±sd	-2.47 ±2.3
	Not stunted (HAZ ≥-2)	33(41.2)
	Moderate stunted (-2 to -3)	14(17.5)
	Severe stunted (HAZ <-3)	33(41.2)
BMI z-score	Mean ±sd	-1.49 ±2.9
	Not wasted (BMIz ≥-2)	46(57.5)
	Moderate wasted (-2 to -3)	10(12.5)
	Severe wasted (BMIz <-3)	24(30.0)

GMFCS E&R score for motor function	II	1(1.2)
	III	19(23.7)
	IV	23(28.7)
	V	37(46.2)

All results are N (%) unless where specified, $CP patient can be on more than one AED.

Socio-demographic characteristics of caregivers

The primary caregiver for majority (n=73, 91%) was their biological mother and majority of the caregivers were in the age group of 30-34 years (31.6%). Approximately two-thirds (n=54, 66%) of the caregivers had a source of income while majority (n=54, 68%) had secondary or higher level of education. Most (n=56, 70%) of the primary caregivers were married (Table 3)

Table 3: Socio-demographic characteristics of caregivers of children with CP.

Caregiver characteristics**(N=79) ***		Frequency (%)
Primary caregiver	Father	1 (1.3)
	Mother	73 (92.4)
	Other	5 (6.3)
Caregiver's age	15-19	1 (1.3)
	20-24	12 (15.2)
	25-29	16 (20.3)
	30-34	25 (31.6)
	35-39	12 (15.2)
	40-44	8 (10.1)
	45+	5 (6.3)
Occupation	No income	26 (32.9)
	Self employed	23 (29.1)
	Professional	10 (12.7)
	Casual worker	20 (25.3)
Education level	Primary	25 (31.6)
	Secondary	31 (39.2)
	Professional	23 (29.1)
Marital status	Single	18 (22.8)
	Married	56 (70.9)
	Divorced/separated	5 (6.3)

*One of the children recruited into the study was from a children's home and was under the care of different caregivers working at the children's home.

5.2 Use of anticonvulsants

Fifty-eight (72%) of the children were on anticonvulsants, 42 (72%) were on sodium valproate, 40 (69%) on phenobarbitone, 11 (19%) on rivotril/clonazepam, 4 (6.9%) on carbamazepine/Tegretol, 2 (3.5%) on clonazepam and 2 (3.5%) on lamotrigine. Among the 58 children on anticonvulsants, 16 (28%) had been on the drugs for a duration of 0 to 1 year, 28 (48%) had been on anticonvulsants for a period of 1 to 5 years and 14 (24%) had been on anticonvulsants for more than 5 years. (**Figure 3**).

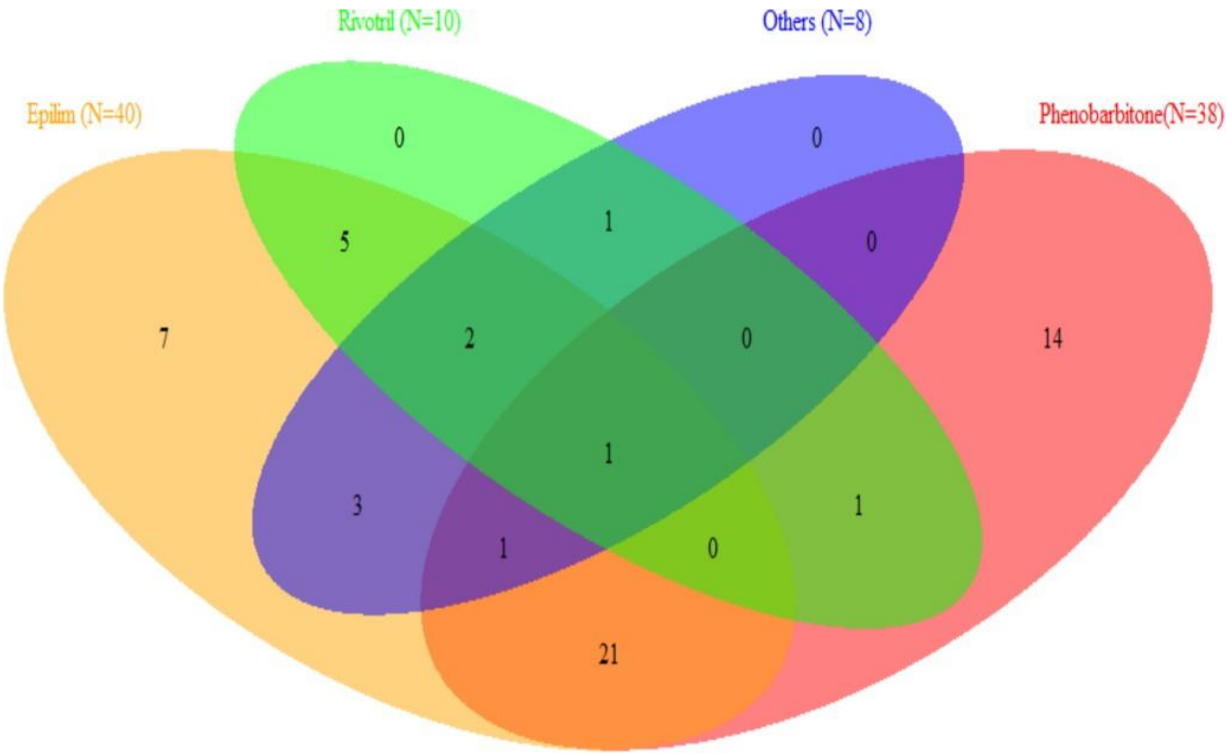

Figure 3: ***Venn diagram showing combinations of anticonvulsants among CP patients.***

Others include 4 children on Carbamazepine 2 on Lamotrigine and 2 on Clonazepam

5.3 Sunlight exposure

None of the 80 children with CP used sunscreen while outdoors. Two-thirds (54, 68%) of the children never wore clothes that protected against sun (long sleeved blouses). Seventy-four (93%) never wore a cap or other headwear. (**Table 4**).

Table 4: Behaviour during sunlight exposure.

	Never	Seldom (1-2 days/week)	Sometimes (2-3 days/week)	Often (3-4 times/week	Always
Used sunscreen with protection-SPT 15/higher	80 (100)	0	0	0	0
Wore clothes that covered the arms (long sleeved blouses or similar)	54 (68)	6 (7.5)	11 (14)	3 (3.8)	6 (7.5)
Wore clothes that covered the legs (long trousers or similar)	50 (63)	7 (8.8)	14 (18)	2 (2.5)	7 (8.8)
Wore a cap or headwear	74 (93)	2 (2.5)	3 (3.8)	0	1 (1.3)
Stayed under a shade while outdoors	73 (91)	2 (2.5)	5 (6.3)	0	0
All results are N (%) unless where specified.					

Duration of exposure to sunlight

Most of the children had exposure to sunlight in the morning from 7 to 11am; 43 (54%) for 0 to 1 hour, 19 (24%) for 1 to 2 hours, 6 (7.5%) for 2 to 3 hours and 1 (1.3%) for 3 to 4 hours. Only 5 (6.3%) and 2 (2.5%) had exposure to sunlight from 11 to 3 pm for 0 to 1 hour and 3 to 4 hours respectively. Between 3 to 7 pm, 6 (7.5%) and 6 (7.5%) children with CP were exposed to sunlight for 0 to 1 hour and 1 to 2 hours respectively (**Table 5**).

Table 5:Duration of exposure to sunlight.

	0–1 hour/day	**1–2 hours/day**	**2–3 hours/day**	**3–4 hours/day**
7 to 11 am	43 (54)	19 (24)	6 (7.5)	1 (1.3)
11 am to 3pm	5 (6.3)	0	0	2 (2.5)
3 pm to 7 pm	6 (7.5)	6 (7.5)	0	0

5.4 Biochemical parameters

Hypocalcaemia was seen in 61% of the children in the study (N =49) and 31 participants had normal calcium levels. Majority of the children had normal phosphate levels (N=45, 56.2%) (Table 6).

Table 6: Biochemical parameters of children with CP

Variable(N=80)	**Frequency**	**Percentage**
Serum Calcium(ionized)		
Normal	31	38.75
Hypocalcaemia	49	61.25
Serum Phosphate levels		
Normal	45	56.2
Hypophosphatemia	28	35.0
Hyperphosphatemia	7	8.75
Biochemical measurements; median (IQR)		
Serum Phosphate	1.61 (1.30–1.86)	
Corrected (ionized) Calcium level	2.18 (2.00–2.38)	
25 Hydroxy cholecalciferol	27.7 (18.3–39)	

5.5 The prevalence of vitamin D insufficiency/deficiency in children with cerebral palsy at the Kenyatta National Hospital.

Among the 80 children with CP, 26 (32%, 95%CI 22 to 44%) had Vitamin D deficiency, with a Vitamin D level median (IQR) of 14.3 (8.52 to 18.2) ng/mI. Twenty-three (29%, 95%CI 19 to 40%) had insufficiency with a Vitamin D level median (IQR) of 26.8 (22.8 to 27.7) ng/mI. A total of 31 (39%, 95%CI 28 to 50%) had adequate levels with a Vitamin D level median (IQR) of 43.1 (34.1 to 67.1) ng/mI (**Table 7** and **Figure 4**). A total of 49 children (61%, 95%CI 50 to 72%) had suboptimal Vitamin D levels with a median (IQR) of 22.0 (13.8 to 27.4) ng/mI.

Table 7:Prevalence of Vitamin D insufficiency/deficiency among children with CP

Vitamin D levels	**N = 80**	**percentage (%)**	**95%CI**	**Vitamin D (calcidiol)ng/ml; median (IQR)**
Adequate	31	39	(28 to 50)	43.1 (34.1–67.1)
Insufficient	**23**	**29**	(19 to 40)	26.8 (22.8–27.7)
Deficiency	**26**	**32**	**(**22 to 44)	14.3 (8.52–18.2)
Insufficiency/ deficiency	**49**	**61**	(50 to 72)	22.0 (13.8–27.4)
Overall	80			27.7 (18.3–39)

The proportions of Vit D deficiency are reported as percentages and their 95% confidence intervals, Vitamin D levels are reported as median (IQR) ng/ml. The suboptimal category includes both insufficient and deficiency Vitamin D levels.

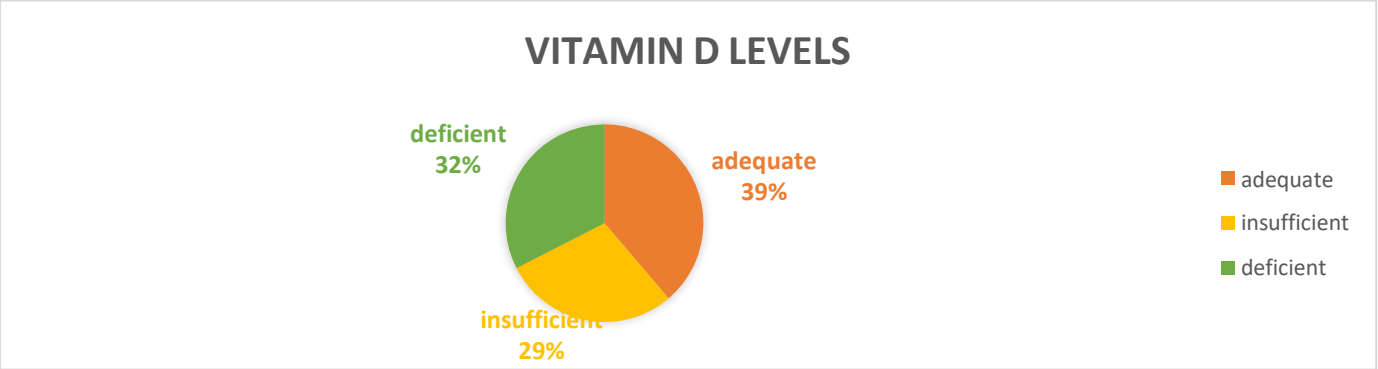

Figure 4: A pie chart showing the proportion of children with CP with suboptimal vitamin D levels.

5.6 Factors associated with Vitamin D insufficiency/deficiency in children with CP at KNH

Demographic characteristics and biochemical parameters of children with CP were analysed for any association with levels of Vitamin D (Table 8). Vitamin D levels differed across the different groups of children. A higher proportion of children aged ≥ 60 months had low vitamin D levels and were at a higher risk of insufficient/deficient Vitamin D levels (COR 5.50 (95%CI 1.67–18.1)) compared to those aged < 60 months, and this was statistically significant (p=0.005).

Among the 58 children on AEDs, 24/31 (77%) and 34/49 (69%) had adequate and suboptimal Vit D levels respectively (P=0.44). The proportion of children with CP on AEDs for ≥ 1 year, was high among those with suboptimal Vit D levels (N=30, 88%) compared to those with adequate levels (N=12, 50%). Use of AED for a duration >1year increases the odds of low vitamin D levels 7.50-fold (95% CI=2.01-27.9), p<0.003, and this was statistically significant.

Among the 31 children with CP with adequate Vit D levels, 13(42%) received Vitamin D supplementation while among the 49 with suboptimal Vit D levels, only 9 (18%) received Vitamin D supplementation. Children who were not on Vitamin D supplementation had significantly higher risk of suboptimal Vitamin D levels with odds increased 3.21-fold (95%CI 1.16–8.86) compared to those on Vitamin D supplementation and this was statistically significant(p=0.02).

Children with CP with moderate to severe stunting had a significantly higher risk of having low vitamin D levels with odds increased 2.50-fold (95%CI 0.99–6.32), p value= 0.05.

A higher proportion of children with CP with sunlight exposure > 1 hour per day had adequate Vitamin D levels (N=24, 77%) compared to those with suboptimal Vitamin D levels (N=12, 24%). children with sunlight exposure >1 hour had lower risk of suboptimal Vitamin D levels (COR 0.09 (95%CI 0.03–0.27)) compared to those with sunlight exposure ≤1 hour and this was statistically significant (p= <0.001).

No other factor was associated with suboptimal Vitamin D levels in the univariate analysis.

Table 8:Factors associated with insufficient/deficient Vitamin D levels among children with CP at KNH.

	Vitamin D level (N (%))		**COR (95% CI)**	**P-value**
	Adequate (N=31)	Suboptimal (N=49)		
Age in months				
< 60	27 (50)	27 (50)	Reference	
≥ 60	4 (15)	22 (85)	5.50 (1.67–18.1)	**0.005**
Sex				
Male	22 (44)	28 (56)	Reference	
Female	9 (30)	21 (70)	1.83 (0.70–4.79)	0.22
Household income				
None	10 (38)	16 (62)	Reference	
Some income	21 (39)	33 (61)	0.98 (0.38–2.57)	0.97
Vitamin D supplementation				
No	18 (31)	40 (69)	3.21 (1.16–8.86)	**0.02**
Yes	13 (59)	9 (41)	Reference	
GMFCS score for motor function				
Ambulatory	9 (45)	11 (55)	Reference	
Non-ambulatory	22 (37)	38 (63)	1.41 (0.51–3.94)	0.50
Use of AED				
No	7 (32)	15 (68)	Reference	
Yes	24 (41)	34 (59)	0.66 (0.23–1.87)	0.44
Duration of AED use				
<1 year	12 (75)	4 (25)	Reference	
≥1 year	19 (30)	45 (70)	7.50 (2.01–27.9)	**0.003**
Sun exposure				
≤ 1 hour	7 (16)	37 (84)	Reference	
>1 hour	24 (67)	12 (33)	0.09 (0.03–0.27)	**<0.001**
BMIz				
Not wasted	18 (39)	28 (61)	Reference	
Wasted	13 (38)	21 (62)	1.04 (0.42–2.58)	0.94
HAZ				
Not stunted	17 (52)	16 (48)	Reference	
Stunted	14 (29)	33 (70)	2.50 (0.99–6.32)	**0.05**
Phosphate serum				
<1.45	10 (36)	18 (64)	1.20 (0.45–3.19)	0.71
Normal	18 (40)	27 (60)	Reference	
>2.1	3 (43)	4 (57)	0.89 (0.18–4.45)	0.89
Corrected Calcium				
<2.25	16 (33)	33 (67)	1.93 (0.77–4.87)	0.16
Normal	15 (48)	16 (52)	Reference	

5.7 Predictors of vitamin D insufficiency and deficiency among children with CP at KNH

In the multivariable model, it was only the participant's age, duration of AED use and duration of sunlight exposure that were associated with suboptimal Vitamin D levels. Children with CP ≥ 60 months old had significantly higher risk of suboptimal Vitamin D levels with adjusted odds ratio(aOR) of 4.77 (95%CI 1.11–20.5) compared to those age < 60 months and this was statistically significant (p=0.03).

Children who had been on AED for ≥ 1 year had significantly higher risk of suboptimal Vitamin D levels (aOR 4.62 (95%CI 1.06–20.2)) compared to those on AED for < 1 year and this was statistically significant (p=0.04).

Children with CP with sunlight exposure >1 hour had a 93% reduction in odds of having suboptimal vitamin D levels (aOR 0.07 (95%CI 0.02–0.25)) compared to those with sunlight exposure ≤1 hour (Table 9).

Table 9: Multivariable analysis of factors associated with low vitamin D levels

	Vitamin D level (N (%))		**Adjusted regression aOR (95% CI) ***	**P-value***
	Adequate (N=31)	Suboptimal (N=49)		
Age in months				
< 60	27 (50)	27 (50)	Reference	
≥ 60	4 (15)	22 (85)	4.77 (1.11–20.5)	**0.03**
Sex				
Male	22 (44)	28 (56)	Reference	
Female	9 (30)	21 (70)	2.23 (0.63–7.92)	0.22
Vitamin D supplementation				
No	18 (31)	40 (69)	Reference	
Yes	13 (59)	9 (41)	3.21 (0.86–11.9)	0.08
Duration of AED use				
<1 year	12 (75)	4 (25)	Reference	
≥1 year	19 (30)	45 (70)	4.62 (1.06–20.2)	**0.04**
Sun exposure				
≤ 1 hour	7 (16)	37 (84)	Reference	
>1 hour	24 (67)	12 (33)	0.07 (0.02–0.25)	**<0.001**
HAZ			¶	
Not stunted	17 (52)	16 (48)	Reference	
Stunted	14 (29)	33 (70)	2.95 (0.85–10.2)	0.09

6 DISCUSSION, CONCLUSION AND RECOMMENDATION

6.1 Discussion

In this study we sought to determine the prevalence of Vitamin D deficiency in children with CP. Vitamin D deficiency occurs commonly in children with CP and this has been attributed to inadequate sun exposure due to their reduced ambulation, use of anticonvulsants and poor nutrition. In this study, we tried to correlate the vitamin D status in children with CP to duration of sunlight exposure, vitamin D supplementation, use of anticonvulsants, age and nutritional status which have been associated with vitamin D deficiency in these children.

The prevalence of Vitamin D deficiency in children with CP in our study was 32.5% while 28.7% had insufficiency and the total alteration in Vitamin D levels was 61% with median calcidiol levels 22.0ng/ml (13.8–27.4). This is similar to other reported prevalence of 25-hydroxyvitamin D deficiency in children with CP around the world varying from 20% to 60%. The previous study done in our set up by Waris et al was among healthy children and the prevalence of vitamin D deficiency was 12%. The prevalence of Vitamin D deficiency among children with CP in Africa has not been characterised. In a cross-sectional study by Akpinar et al in Turkey, among children with CP they found a prevalence of vitamin D deficiency of 28.8% and insufficiency of 22.6%(33) while in another study by Hendersonn et al they found a prevalence of 19%. Sowjan et al found a prevalence of vitamin D deficiency at 32% and insufficiency at 61% among children with CP in India(34). Le Roy et al, in a study in Spain, among children with CP found that 47.8% had insufficiency and 30.4% had deficiency(35). The high prevalence rate found in our study is expected due to the severe physical and motor impairments in these children limiting their ability to walk and thus heavy reliance on the caregiver for daily living activities.

Cutaneous synthesis of vitamin D through UV light accounts for 90% of Vitamin D stores in the body(36). In our study, there was a statistically significant association between duration of sunlight exposure of >1hour with Vitamin D levels both in the univariate and multivariable logistic regression with those exposed to sunlight for >1 hour having a lower risk of low vitamin D levels with adjusted odds ratio of 0.07 (95%CI 0.02–0.25) as compared to those with sunlight exposure ≤1 hour ($p<0.02$). Seth et al found that UV score was an independent predictor of Vitamin D deficiency in the univariable analysis and was the only variable that was statistically significant in multivariable logistic regression ($p< 0.0001$)(11). There is no

scientifically approved safe threshold for duration of exposure to sunlight that allows for sufficient vitamin D synthesis without increasing the risk of harmful effects of UV radiation like skin inflammation, skin cancers and degenerative aging. Personal UV dosing also depends on several factors that include the strength of solar radiation, use of protective clothing, shade and sun blocks. Ambient UV exposure varies in different geographical regions according to the intensity of sunlight and the atmosphere it must pass through and it is thought to be highest near the equator. Kenya is centred at the equator and thus receives adequate UV exposure throughout all the seasons of the year. For sufficient Vitamin D levels, it is estimated that 30 minutes of midday (12.00) sunlight several times a week is required but it is thought that people with darker pigmentation require a longer duration for synthesis of Vitamin D levels. Most of the children in our study (86%) were exposed to the sun early in the morning between the hours of 7.00am to 11.00am. Other factors that play a role in sufficient synthesis of vitamin D from the skin include the amount of surface area exposed to sunlight. In our study, 63% and 68% of the participants reported they had their arms and legs exposed respectively while outdoors. Skin complexion which is determined by the type and amount of epidermal melanin is an important determinant of UV sensitivity. Eumelanin which is expressed more in people with dark pigmentation blocks UV photons thus the less UV permeable to the epidermis for synthesis of Vitamin D. All the children in our study were of darker pigmentation and had skin complexion of Fitzpatrick scale VI.

Reduced time spent outdoors by the children in our study could also be due to socio-cultural factors and stigma associated with having a child with disability and so parents could tend to shy away from bringing the child outdoors especially in crowded areas. The study recruited children mostly from urban and peri-urban setting and this could also influence the amount of sun exposure due to high rise buildings and limited outdoor spaces.

In our study, children with CP aged >60 months had a significantly increased risk of having suboptimal vitamin D levels with aOR of 4.77 ((95%CI 1.11–20.5) (p value=0.03)). Other studies have found that with increase in age, the levels of 25-hydroxyvitamin D levels are reduced in children with CP. Reduced outdoor activity and consequently reduced sun exposure is regarded as one of the causes for higher rates of 25-hydroxyvitamin D deficiency in older age. In the aforementioned study by Toopchizedeh et al, there was a significant negative correlation between age and 25-hydroxyvitamin D levels (P=0.007) (39).

The use of anticonvulsants has been shown to affect vitamin D levels and bone health. In our study children who had been on anticonvulsants for a duration of > 1year had a higher likelihood of low vitamin D levels with odds increased 4.62fold (95% CI 1.06–20.2) compared to those who had been on anticonvulsants for a duration <1 year and this was statistically significant($p=0.04$). Most of the children in the study were on combination of different anticonvulsants with only 36% being on a single drug. In a study by Nettekoven et al, they demonstrated vitamin D deficiency in 75% of children taking anticonvulsants and insufficient levels in 21% of the children and this deficiency was mostly seen in children taking combinations of different anticonvulsants(24). In a study by Polyxeni et al, which aimed to assess the effects of anticonvulsant use over a period of 3 years they found a decreasing trend in serum Vitamin D levels ($p<0.03$) with 49% of the study participants acquiring vitamin D deficiency over that study period(37).

The paediatric endocrine society recommends screening and supplementation of vitamin D in children with neuromuscular disorders like CP. In our study, 27.5% had received Vitamin D supplements with only 3.75% receiving regular vitamin D supplements. In the univariable analysis Vitamin D supplementation had a significant association with Vitamin D levels with a crude odds ratio of 1.69 (0.99–2.87) and p value of < 0.05 but was not statistically significant in the multivariable analysis. This could be due to the fact that the sample size was small and majority of the children received intermittent supplementation for short durations. In a study by Kilpinen-Loisa et al that evaluated effect of high dose vitamin D3 supplementation on serum vitamin D levels among disabled children, they found a significant increase from baseline in serum levels of Vitamin D after supplementation as compared to those who did not receive vitamin D supplements in that study(38).

Poor nutrition due to feeding difficulties in children with CP predisposes them to both macronutrient and micronutrient deficiencies. Poor nutritional status was found to be significant key predictor of low vitamin D levels in a study by sowjan et al in children with CP. There was no significant association between vitamin D levels and nutritional status in children with CP in our study and this could be due to the fact that the majority (58%) of the children in the study were not wasted and had BMI z score $\geq$-2.

There was no statistically significant association between gender, nutritional status, biochemical parameters, household income and vitamin D supplementation with levels of

Vitamin D. Our study was powered to evaluate only prevalence and thus we were unable to establish causal associations.

6.2 Study strengths and limitations

- **Strengths:** The results of the study represent a true cross-section of patients cared for in a tertiary referral hospital. The evaluation of vitamin D levels was done during the same season for all patients to avoid seasonal variability.
- **Limitations:** The study was cross sectional and we were unable to compare with other groups of children due to limited budget. The sample size was powered to establish the prevalence of Vitamin D deficiency and not the causal associations. Also, we did not assess adherence to anticonvulsant medication and Vitamin D supplementation. The study is prone to recall bias from caregiver's history on vitamin D supplementation and we could not verify information from the caregiver on sun exposure as the duration given was an approximation.

6.3 Conclusion

- The prevalence of Vitamin D insufficiency and deficiency in children with CP is high at 61%.
- In this study, sunlight exposure of duration of >1 hour was associated with adequate vitamin D levels and this was statistically significant.
- Children older than 60 months are at higher risk of developing vitamin D deficiency.
- The use of anticonvulsants for a duration of >1year was associated with suboptimal vitamin D levels and this was statistically significant.

6.4 Recommendation

- We recommend that children with CP be exposed to the sunlight frequently for a duration of >1 hour per day and especially in older children aged > 60 months. This can be achieved by educating the caregivers on importance of sun exposure as it is the main source of Vitamin D.
- We recommend Vitamin D supplementation be instituted regularly in children with CP especially those on long term use of anticonvulsants.
- Further research is needed to determine the appropriate timing and dosing of vitamin D supplementation in children with CP. Also, a larger study powered to assess for factors associated with low Vitamin D levels is necessary.

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APPENDIX

Appendix 1: Questionnaire

☒0 – 1 years

☐1– 5 years

☐>5 years

6. Vitamin D Supplementation

☐Yes ☐No

If yes, duration and consistency

☐Intermittent supplementation

☐Continuous supplementation

7. Mode of feeding

Oral ☐Yes ☐No

Tube feeding ☐Yes ☐No

Gastrostomy ☐Yes ☐No

8. Anthropometric measurements

Anthropometric measurement

Height (cm) /Estimated using tibia length…...

Weight (kg)…….

Mid upper arm circumference ……

Body mass index (BMI)……

9. Primary caregiver

☐Father ☐mother ☐ other

Caregiver details

Age (years)

Occupation /source of income

☐No income ☐self-employed ☐casual labourer ☐professional

Education level ☐Primary

☐Secondary

☐Tertiary

☐None

Marital status ☐Single ☐married ☐divorced/separated

Section two: Exposure to sunlight

10. Behaviour during sunlight exposure

(check appropriate box)

	Never	Seldom (1-2 days/week)	Sometimes (2-3 days/week)	Often (3-4 times/week	Always
Used sunscreen with protection-SPT 15/higher					
Wore clothes that covered the arms (long sleeved blouses or similar)					
Wore clothes that covered the legs (long trousers or similar)					
Wore a cap or headwear					
Stayed in the shades while outdoors					

11. Sunlight exposure – how many hours on average were you outside per day during the measure week?

	I was not outside during this period	0-1hour	1-2 hours	2-3 hours	3-4 hours
7.00 - 11.00 AM					
11.00 – 3.00PM					
3.00PM - 7.00PM					

Section 3. Gross motor function

(As determined using the Gross Motor Function Classification System – Expanded and Revised in Appendix 2)

12. GMFCS score for motor function

☐I

☐II

☐III

☐IV

☐V

Section 4. Labs

13. Serum Phosphate level……
14. Serum calcium (uncorrected) ……
15. Serum Albumin level……..
16. Corrected (ionized) Calcium level……..
17. 25 Hydroxy cholecalciferol…….

Any other relevant information

……
……
……
……
……
……

END

Appendix 2 : Gross Motor Function Classification System – Expanded and Revised

Before 2nd birthday

LEVEL I: Infants move in and out of sitting and floor sit with both hands free to manipulate objects. Infants crawl on hands and knees, pull to stand and take steps holding on to furniture. Infants walk between 18 months and 2 years of age without the need for any assistive mobility device.

LEVEL II: Infants maintain floor sitting but may need to use their hands for support to maintain balance. Infants creep on their stomach or crawl on hands and knees. Infants may pull to stand and take steps holding on to furniture.

LEVEL III: Infants maintain floor sitting when the low back is supported. Infants roll and creep forward on their stomachs.

LEVEL IV: Infants have head control but trunk support is required for floor sitting. Infants can roll to supine and may roll to prone.

LEVEL V: Physical impairments limit voluntary control of movement. Infants are unable to maintain antigravity head and trunk postures in prone and sitting. Infants require adult assistance to roll.

Between 2nd and 4th birthday

LEVEL I: Children floor sit with both hands free to manipulate objects. Movements and out of floor sitting and standing are performed without adult assistance. Children walk as the preferred method of mobility without the need for any assistive mobility device.

LEVEL II: Children floor sit but may have difficulty with balance when both hands are free to manipulate objects. Movements in and out of sitting are performed without adult assistance. Children pull to stand on a stable surface. Children crawl on hands and knees with a reciprocal pattern, cruise holding onto furniture and walk using an assistive mobility device as preferred methods of mobility.

LEVEL III: Children maintain floor sitting often by "W-sitting" (sitting between flexed and internally rotated hips and knees) and may require adult assistance to assume sitting. Children creep on their stomach or crawl on hands and knees (often without reciprocal leg movements) as their primary methods of self-mobility.

Children may pull to stand on a stable surface and cruise short distance. Children may walk short distances indoors using a hand-held mobility device (walker) and adult assistance for steering and turning.

LEVEL IV: Children floor sit when placed, but are unable to maintain alignment and balance without use of their hands for support. Children frequently require adaptive equipment for sitting and standing. Self-mobility for short distances (within a room) is achieved through rolling, creeping on stomach, or crawling on hands and knees without reciprocal leg movement.

LEVEL V: Physical impairments restrict voluntary control of movement and the ability to maintain antigravity head and trunk postures. All areas of motor function are limited. Functional limitations in sitting and standing are not fully compensated for with adaptive equipment and assistive technology. At Level V, children have no means of independent movement and are transported. Some children achieve self-mobility using a powered wheelchair with extensive adaptations.

Between 4th and 6th birthday

LEVEL I: Children get into and out of, and sit in, a chair without the need for hand support. Children move from the floor and from chair sitting to standing without the need for objects for support. Children walk indoors and outdoors, and climb stairs. Emerging ability to run and jump. LEVEL II: Children sit in a chair with both hands free to manipulate objects. Children move from the floor to standing and from chair sitting to standing but often require a stable surface to push or pull up on with their arms. Children walk without the need for a handheld mobility device indoors and for short distances on level surfaces outdoors. Children climb stairs holding onto a railing but are unable to run or jump.

LEVEL III: Children sit on a regular chair but may require pelvic or trunk support to maximize hand function. Children move in and out of chair sitting using a stable surface to push on or pull up with their arms. Children walk with a hand-held mobility device on level surfaces and climb stairs with assistance from an adult. Children frequently are transported when traveling for long distances or outdoors on uneven terrain.

LEVEL IV: Children sit on a chair but need adaptive seating for trunk control and to maximize hand function. Children move in and out of chair sitting with

assistance from an adult or a stable surface to push or pull up on with their arms. Children may at best walk short distances with a walker and adult supervision but have difficulty turning and maintaining balance on uneven surfaces. Children are transported in the community. Children may achieve self-mobility using a powered wheelchair.

LEVEL V: Physical impairments restrict voluntary control of movement and the ability to maintain antigravity head and trunk postures. All areas of motor function are limited. Functional limitations in sitting and standing are not fully compensated for with adaptive equipment and assistive technology. At Level V, children have no means of independent movement and are transported.

Between 6th and 12th birthday

Level I: Children walk at home, school, outdoors, and in the community. Children are able to walk up and down curbs without physical assistance and stairs without the use of a railing. Children perform gross motor skills such as running and jumping but speed, balance, and coordination are limited. Children may participate in physical activities and sports depending on personal choices and environmental factors.

Level II: Children walk in most settings. Children may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas, confined spaces or when carrying objects. Children walk up and down stairs holding onto a railing or with physical assistance if there is no railing. Outdoors and in the community, children may walk with physical assistance, a hand-held mobility device, or use wheeled mobility when traveling long distances. Children have at best only minimal ability to perform gross motor skills such as running and jumping. Limitations in performance of gross motor skills may necessitate adaptations to enable participation in physical activities and sports.

Level III: Children walk using a hand-held mobility device in most indoor settings. When seated, children may require a seat belt for pelvic alignment and balance. Sit-to-stand and floor-to-stand transfers require physical assistance of a person or support surface. When traveling long distances, children use some form of wheeled mobility. Children may walk up and down stairs holding onto a railing with supervision or physical assistance. Limitations in walking may necessitate

adaptations to enable participation in physical activities and sports including self-propelling a manual wheelchair or powered mobility.

Level IV: Children use methods of mobility that require physical assistance or powered mobility in most settings. Children require adaptive seating for trunk and pelvic control and physical assistance for most transfers. At home, children use floor mobility (roll, creep, or crawl), walk short distances with physical assistance, or use powered mobility. When positioned, children may use a body support walker at home or school. At school, outdoors, and in the community, children are transported in a manual wheelchair or use powered mobility. Limitations in mobility necessitate adaptations to enable participation in physical activities and sports, including physical assistance and/or powered mobility.

Level V: Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control arm and leg movements. Assistive technology is used to improve head alignment, seating, standing, and and/or mobility but limitations are not fully compensated by equipment. Transfers require complete physical assistance of an adult. At home, children may move short distances on the floor or may be carried by an adult. Children may achieve self-mobility using powered mobility with extensive adaptations for seating and control access. Limitations in mobility necessitate adaptations to enable participation in physical activities and sports including physical assistance and using powered mobility.

Between 12th and 18th birthday

Level I: Youth walk at home, school, outdoors, and in the community. Youth are able to walk up and down curbs without physical assistance and stairs without the use of a railing. Youth perform gross motor skills such as running and jumping but speed, balance, and coordination are limited. Youth may participate in physical activities and sports depending on personal choices and environmental factors.

Level II: Youth walk in most settings. Environmental factors (such as uneven terrain, inclines, long distances, time demands, weather, and peer acceptability) and personal preference influence mobility choices. At school or work, youth may walk using a handheld mobility device for safety. Outdoors and in the community, youth may use wheeled mobility when traveling long distances.

Youth walk up and down stairs holding a railing or with physical assistance if there is no railing. Limitations in performance of gross motor skills may necessitate adaptations to enable participation in physical activities and sports.

Level III: Youth are capable of walking using a hand-held mobility device. Compared to individuals in other levels, youth in Level III demonstrate more variability in methods of mobility depending on physical ability and environmental and personal factors. When seated, youth may require a seat belt for pelvic alignment and balance. Sit-to-stand and floor-to-stand transfers require physical assistance from a person or support surface. At school, youth may self-propel a manual wheelchair or use powered mobility. Outdoors and in the community, youth are transported in a wheelchair or use powered mobility. Youth may walk up and down stairs holding onto a railing with supervision or physical assistance. Limitations in walking may necessitate adaptations to enable participation in physical activities and sports including self-propelling a manual wheelchair or powered mobility.

Level IV: Youth use wheeled mobility in most settings. Youth require adaptive seating for pelvic and trunk control. Physical assistance from 1 or 2 persons is required for transfers. Youth may support weight with their legs to assist with standing transfers. Indoors, youth may walk short distances with physical assistance, use wheeled mobility, or, when positioned, use a body support walker. Youth are physically capable of operating a powered wheelchair. When a powered wheelchair is not feasible or available, youth are transported in a manual wheelchair. Limitations in mobility necessitate adaptations to enable participation in physical activities and sports, including physical assistance and/or powered mobility.

Level V: Youth are transported in a manual wheelchair in all settings. Youth are limited in their ability to maintain antigravity head and trunk postures and control arm and leg movements. Assistive technology is used to improve head alignment, seating, standing, and mobility but limitations are not fully compensated by equipment. Physical assistance from 1 or 2 persons or a mechanical lift is required for transfers. Youth may achieve self-mobility using powered mobility with extensive adaptations for seating and control access. Limitations in mobility necessitate adaptations to enable participation in physical activities and sports including physical assistance and using powered mobility.

Appendix 3. Study timelines

	2020 - 2021								
	Feb-	April	May	July-	Sept	NOV 2020-	MARCH 2021	APRIL	MAY
Proposal development									
Presentation of proposal									
Ethical approval									
Data collection									
Data analysis									
Presentation									

Appendix 4. Budget

Activity	**Item**	**Kshs**
Proposal Development	Printing costs	5,000
Data Collection	Questionnaires	10,000
	One research assistants @1000/day for 30 days	30,000
	Laboratory costs	150,000
Data Analysis	Statistician	40,000
Thesis Development	Printing costs	5,000
	Contingency fund (10% of total budget)	20,000
	TOTAL	**260,000**

Appendix 5: Consent Form

A) Children below the age of 6 years the following consent forms will be issued to the guardian/parent(S)

B) This form shall also be issued to parent(s)/guardians of children above the age of 6 years and below 18 years; in addition to the assent form to be filled by the child himself/herself

C) English and Swahili versions of both the consent and assent forms shall be issued

CONSENT INFORMATION FORM (ENGLISH VERSION)

- ✓ My name is Dr. Cecilia Cherobon Kiriongi, a paediatric resident at Kenyatta National Hospital undertaking a Master degree in paediatrics and child health at the University of Nairobi.

- ✓ This study is being conducted with the permission of Kenyatta National Hospital-University of Nairobi and Ethics and research committee (KNH-UON ERC Protocol No P276/05/2020

- ✓ I am conducting a study on vitamin D levels, calcium and phosphate in children with Cerebral Palsy aged 18 years and below, seen at Kenyatta National Hospital. Your son's/daughter's is being requested to participate in the study because he/she meets the conditions required to be included in the study (inclusion criteria).

Purpose

- ✓ The results of the study will help us get important information that will help in the care of children with Cerebral Palsy seen at Kenyatta National Hospital.

Procedure

- ✓ This interview will take 30-45 minutes, I will not write down his/her name, and all the information he/she provides will be kept SAFE and will not be shared with anyone else. His/ Her participation in this survey totally depends on you and him/her.

- ✓ If you consent to participate in this study, I will proceed to ask a series of questions and will subsequently note your responses in writing.

- ✓ I will conduct a physical examination of him/her.

- ✓ 5mls of blood will then be withdrawn for tests. The blood sample will be used to carry out the following tests; Vitamin D, Calcium and Phosphate.

- ✓ I will inform you of the tests results and the test results shall remain confidential. The results will be availed to the primary physician within 72hours to improve the care of your child.

- ✓ The purpose of this consent is to ask you to permit me to do so. If you decline, it will not affect the quality of care that will be provided to him/her.

- ✓ If you agree to participate, I shall ask you to sign the consent form. However, this form will not be linked to your answer. Your individual answers will only be seen by the researcher and will be stored safely, only accessible to the researcher.

The risks to you as a participant in the study

- ✓ Pain at the puncture site following specimen collection.
- ✓ Swelling may appear at the site of the venipuncture.
- ✓ Note: should any of the above occur, the principal investigator/assistant clinician will be available to assist.

The benefits to you as a participant in the study.

- ✓ Free evaluation of vitamin D, calcium and phosphate.

- ✓ A copy of the results will be provided to the primary physician and yourself.

- ✓ The results will assist in improving management and follow up of him/her.

Right to Withdraw/participate.

- ✓ Your son's/ daughter's participation in this research is voluntary and your choice to participate or not will not affect the quality of care given to your child at any point.

- ✓ You have the right to refuse to participate or withdraw at any point.

- ✓ Do you have any questions?

The parent/ guardian has given consent

- ✓ **Yes 1**
  No…..... 2

CONSENT FORM (STATEMENT OF CONSENT)

Participant's statement

- ✓ I have read this consent or had the information read me. I have the chance to discuss the research with the researcher/ researcher assistant. The risks and benefits have been explained to me. I understand that my participation in this study is voluntary and that I may choose to withdraw at any time. I understand that all efforts will be made to keep information regarding my personal identity confidential.

- ✓ I agree to participate in the study on Vitamin D levels, Calcium and Phosphate in children with CP at KNH.
- ✓ I do this with the full understanding for the purpose of the study and procedures involved. These procedures include filling in the study questionnaire and having 5 millilitres of blood withdrawn for laboratory tests, namely: serum vitamin D, ionized calcium and phosphate. These tests will enable know their levels in the body.

- ✓ Signature of the parent/guardian…….

- ✓ Signature of the witness ……..... Date ……..

Researcher's statement

- ✓ I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has willingly and freely given his/her consent.

- ✓ Researcher's name ……

- ✓ Signature…… Date…….

What if you have questions/ concerns in future?

- ✓ If you have further questions or require further information or clarification about participation in this study, you may contact the following:

  Name: Dr Cecilia Cherobon kiriongi (Primary Researcher)
  Mobile Number: 0724577217
  Email: cchero61@gmail.com

  Name: Dr Bashir Admani
  Mobile Number: 0721967818
  Email: pedbashir@yahoo.com

  Name : Dr Florence Murila
  Mobile Number : 0729430022
  Email : fmurila@gmail.com

  Name: Dr Paul Laigong
  Mobile Number : 0720 386861
  Email : drlaigongp@gmail.com

Kenyatta National Hospital/University of Nairobi Ethics and Research Committee
College of Health Sciences
P.O BOX 19676 00202 Nairobi
Telephone: (254-020) 2726300-9 Ext 44355
Email: uonknh-erc@uonbi.ac.ke

What are your other choices?

- ✓ Your decision to participate in research is voluntary.
- ✓ You are free to decline participation in the study and you can withdraw from the study at any time without injustice and loss of any benefit.

ASSENT FORM (ENGLISH VERSION)-for children above 6 years and below 18 years

- ✓ My name is Dr Cecilia Cherobon kiriongi, a paediatric resident at Kenyatta National Hospital undertaking a Masters degree in paediatrics and child health, in the school of Medicine, Department of Paediatrics and Child health, University of Nairobi.

- ✓ This study is being conducted with the permission of Kenyatta National Hospital – University of Nairobi and Ethics and research committee (KNH-UON ERC Protocol no…….

- ✓ Am conducting a study on vitamin D levels, parathyroid, calcium and phosphate in children with chronic kidney disease aged 18 years and below, seen at Kenyatta National Hospital. You are being requested to kindly participate in the study because you the meet the conditions to be included in the study.

BENEFITS

- ✓ You have a chronic kidney disease. You also came to hospital regularly for the doctor to check if you are doing well. To enable the doctor, know how well you are doing, its important to know the levels of above-mentioned tests.

PURPOSE

- ✓ We want to find out if the levels of vitamin D, calcium and phosphate is good to allow your body to function well. Sometimes due to your chronic illness, the levels may be reduced.

PROCEDURES

- ✓ If you accept, I will ask you some questions to enable me know more about you and your illness.
- ✓ I will then examine you before taking some blood from your arm.
- ✓ We will take about three tablespoons of blood.
- ✓ We will send the blood to a lab for tests.

- ✓ These tests will help us know the levels of vitamin D, calcium and phosphate in your body.
- ✓ We will provide these results to your doctor each time and then he will be able to take care of you in a better way

RISKS, STRESS AND DISCOMFORT

- ✓ The needle we use to take the blood may hurt. You might get a bruise on your arm. Sometimes you may develop a swelling at this site.
- ✓ In case this happens, please call us so that we may assist you.

WHO CAN YOU CALL IF YOU NEED HELP OR HAVE ANY QUESTIONS?

- ✓ If you have further questions or require further information or clarification about participation in this study, you might conduct the following:

Name: Dr Cecilia Cherobon kiriongi (primary researcher)
Mobile Number: 0724577217
Email: cchero61@gmail.com

Name: Dr Bashir Admani
Mobile Number: 0721967818
Email: pedbashir@yahoo.com

Name : Dr Florence Murila
Mobile Number : 0729430022
Email : fmurila@gmail.com

Name: Dr Paul Laigong
Mobile Number : 0720 386861
Email : drlaigongp@gmail.com

Kenyatta National Hospital/University of Nairobi Ethics and Research Committee
College of health sciences
P.O BOX 19676 00202

Telephone: (254-020) 2726300-9 Ext 44355

Email: uonknh-erc@uonbi.ac.ke

OTHER INFORMATION

- ✓ All the information provided and the results of the study are confidential .
- ✓ Your name will not be on the sample of blood we take

  .
- ✓ You do not have to take part in this study if you don't want to.
- ✓ We will give you a copy of this paper to keep.

…….. ……

Signature and Name of the investigator Date

Subject's statement:

- ✓ This research study has been explained to me. I agree to take part in this study. I have had a chance to ask questions. If I have more questions, I can ask the doctor.

…… …….

Signature and Name of subject Date

…… ……..

Signature and Name of parent /legal guardian Date

KISWAHILI CONSENT FORMS.

FOMU YA MAELEZO YA KISWAHILI.

- ✓ Jina langu ni Dr,Cecilia Cherobon Kiriongi, mtaalamu wa Watoto katika hospitali kuu la taifa la Kenyatta ,nafanya shahada la utaalamu katika afya ya Watoto, katika Idara ya Maabara ya Afya na Afya ya Watoto, chuo kikuu cha Nairobi.

- ✓ Utafiti huu unafanyika kwa idhini ya hospitali ya Taifa la Kenyatta- Chuo Kikuu cha Nairobi na Kamati ya maadili na utafiti (Protocol ya KNH-UON ERC.....)

- ✓ Ninafanya utafiti juu ya upungufu wa vitamini D, kalsiamu, fosfati kwa Watoto wenye ugonjwa wa cerebral palsy wenye umri wa miaka 18 na chini, ambao wameonekana katika hospitali ya Taifa la Kenyattta. Mwana/ binti wako wanaombwa kushiriki katika utafiti kwa sababu yeye hukutana na masharti yanayotakiwa kuingizwa katika utafiti (vigezo vya kuingizwa)

KUSUDI

- ✓ Matokeo ya utafiti itatusaidia kupata maelezo muhimu ambayo itasaidia katika Huduma ya Watoto wenye ugonjwa wa cerebral palsy katika hospitali ya Taifa ya Kenyatta.

UTARATIBU

- ✓ Mahojiano haya yatachukua dakika 30-45, sitaandika jina lake, na maelezo yote atakayotoa itahifadhiwa SALAMA na haitashirikiwa na mtu mwingine yeyote. Ushiriki wake katika utafiti huu kabisa unategemea wewe na yeye.

- ✓ Ikiwa unakubali kushiriki katika somo/utafiti hili, nitaendelea kuuliza maswahili mfufulizo na hatimaye kuandika majibu yako kwa maandishi.

- ✓ Nitafuatilia kufanya uchunguzi wa kimwili.

- ✓ Milimita tano ya damu yatatolewa kwa ajili ya vipimo. Sampuli ya damu itatumika kutekeleza vipimo vifuatavyo; kiwango cha vitamini D, madini ya kalsiamu na ya fosfati. Uchunguzi huu unatusaidia kujua viwango hivi katika mwili wa mtoto wako.

- ✓ Nitawajulisha matokeo ya vipimo na haya matokeo yanabaki Siri. Matokeo pia yatatolewa kwa daktari ili kuboresha utunzanji wa mtoto wako.

- ✓ Kusudi la idhini hii ni kukuuliza uniruhusu nifanye hivyo.

- ✓ Ikiwa hautakubali kusajiliwa ,hauathiri ubora wa utunzaji ambao atapewa.

- ✓ Ikiwa unakubaliana kushiriki,nitawaomba kusaini fomu ya kibali. Hata hivyo fomu hii haiwezi kuunganishwa na jibu lako. Majibu yako binafsi yataonekana tu na mtafiti na itahifadhiwa kwa usalama.

HATARI KWAKO KAMA MSHIRIKI KATIKA UTAFITI

- ✓ Maumivu kwenye tovuti ya kufuatia mkusanyiko wa vipimo.
- ✓ Kuvimba huweza kuonekana kwenye tovuti ya kutengana (hematoma).

Note: Lolote likitokea , wasiliana na mtafiti – Dr Cecilia cherobon kiriongi.

FAIDA KWAKO KAMA MSHIRIKI KATIKA UTAFITI

- ✓ Tathmini ya bure ya viwango vyo vitamini D, madini ya kalsiamu, fosfati.

- ✓ Nakala ya matokeo yatatolewa kwa daktari na wewe.

- ✓ Matokeo yatasaidia kuboresha afya yake.

HAKI YA KUJIONDOA/ KUSHIRIKI

- ✓ Ushiriki wa mwana wako/ binti katika utafiti huu ni hiari na uchanguzi wako wa kushiriki au la hautaathiri ubora wa huduma aliyopewa mtoto wako wakati wowote.

- ✓ Una haki ya kukataa kushiriki au kujiondoa wakati wowote.

- ✓ Una maswali yoyote?

Mzazi / mlezi ametoa kibali

Ndiyo… 1

Hapana…..... 2

FOMU YA SAHA(TAARIFA YA KUSHA).

Taarifa ya Mshiriki.

- ✓ Nimeisoma kibali hiki . Nimekuwa na fursa ya kujadili utafiti na mtafiti/ msaidizi wa utafiti. Hatari na faida zimeelezwa kwangu. Ninaelewa kwamba ushiriki wangu katika utafiti huu ni hiari yangu. Ninaelewa kwamba jitihada zote zitafanywa kweka taarifa kuhusu utambulisho wangu binafsi.

- ✓ Mimi,…… ninakubali kushiriki katika utafiti juu ya upungufu wa vitamin D, madini ya kalsiamu, na fosfati kwa Watoto wenye ugonjwa wa cerebral palsy wenye umri wa miaka kumi na nane na chini.

- ✓ Ninafanya hivi kwa ufahamu kamili kwa madhumuni ya utafiti na taratibu zilizohusika. Taratibu hizi ni pamoja na kujaza dodoso la utafiti na kutolewa mililita tano ya damu kwa ajili ya vipimo vya vitamini D, madini ya kalsiamu, na fosfati. Vipimo hivi vitatusaidia kujua kiwango zao katika mwili.

  Saini ya mzazi/ mlezi……

  Saini ya shahidi…….

  Tarehe……

Taarifa ya Mtafiti.

- ✓ Mimi, mtafiti, nimeeleza kikamilifu maelezo muhimu ya utafiti huu kwa mshiriki aliyechaguliwa hapo juu na kuamini kuwa mshiriki ameelewa na ametoa idhini yake kwa hiari yake.

- ✓ Jina la Mtafiti……Saini…….Date…….

Nini ikiwa una maswali / wasiwasi baadaye?

- ✓ Ikiwa una maswali Zaidi au unahitaji maelezo Zaidi au ufafanuzi kuhusu ushiriki katika utafiti, tafadhali piga simu au tuma ujumbe wa maandishi kwa:

  Jina: Dr. Cecilia Cherobon Kiriongi
  Nambari ya simu: 0724577217
  Barua pepe: cchero61@gmail.com

  Jina: Dr Bashir Admani
  Nambari ya simu: 0721967818
  Barua pepe: pedbashir@yahoo.com

  Name : Dr Florence Murila
  Mobile Number : 0729430022
  Email : fmurila@gmail.com

  Jina: Dr Paul Laigong
  Nambari ya simu: 0720 386861
  Barua pepe: drlaigongp@gmail.com

  Kenyatta National Hospital/ University of Nairobi Ethics and Research Committee
  College of health sciences
  P.O BOX 19676 00202
  Nambari ya simu: (254-020) 2726300-9 Ext 44355
  Barua pepe: uonknh-erc@uonbi.ac.ke

Je ,ni uchaguzi gani mwingine?

- ✓ Uamuzi wako wa kushiriki katika utafiti ni wa hiari. Wewe ni huru kupungua kushirika katika utafiti na unaweza kujiondoa kwenye utafiti wakati wowote bila udhalimu na kupoteza faida yoyote

FUNA YA KUFUNA (kwa Watoto Zaidi ya miaka 6 na chini ya miaka 18)

- ✓ Jina langu ni DK. Cecilia Cherobon Kiriongi, mwenyeji wa Watoto katika hospitali ya Taifa ya Kenyatta anafanya shahada ya Masters katika Watoto wa afya na afya ya Watoto, katika shule ya Dawa, Idara ya Maabara ya Afya na Afya ya Watoto, Chuo Kikuu cha Nairobi.

- ✓ Utafiti huu unafanyika kwa idhini ya hospitali ya Taifa ya Kenyatta- Chuo Kikuu cha Nairobi na Kamati ya Ma'adili na Utafiti (Protocol ya KNH-UON ERC hakuna.....)

- ✓ Ninafanya utafiti juu ya upungufu wa vitamini d, madini ya kalisiamu, fosfati na homoni ya paradundumio kwa Watoto wenye ugonjwa wa figo wa muda mrefu wenye umri wa miaka 18 na chini, waliona hospitali ya kitaifa ya Kenyatta. Unatakiwa kushiriki kikamilifu katika utafiti kwa sababu unakabiliana na masharti ya kuingizwa katika utafiti.

MAFANZO

- ✓ Una ugonjwa sugu. Pia unakuja hospitali mara kwa mara kwa daktarin ili uone kama unafanya vizuri. Ili kuwawezesha daktarin kujua jinsi unavyofanya vizuri ni muhimu kujua vipimo vya vitamini d, madini ya kalisiamu na fosfati katika mwili wako.

KUSUDI

- ✓ Tunataka kujua kama ngazi vya vipimo hivyo katika mwili wako ni nzuri ya kuruhusu mwili wako kufanya kazi vizuri. Wakati mwingine kutokana na ugonjwa wako sugu viwango hivyo vinaweza kupunguka.

TARATIBU

- ✓ Ikiwa unakubali, nitakuuliza baadhi ya maswali ili nisaidie kujua Zaidi kuhusu wewe na ugonjwa wako.
- ✓ Nitawachunguza kabla ya kuchukua damu kutoka mkono wako.
- ✓ Tutachukua kuhusu vijiko vitatu vya damu.

- ✓ Tutatuma damu kwenye maabara kwa ajili ya vipimo.
- ✓ Tutatoa matokeo haya kwa daktari wako kila wakati na kisha atakuwezesha kwqa njia bora Zaidi.

HATARI AU WASIWASI WOWOTE

- ✓ Siri tunayotumia kuchukua damu inaweza kuumiza.
- ✓ Unaweza kupata maradhi juu ya mkono wako.
- ✓ Wakati mwingine, unaweza keundeleza uvimbe kwenye tovuti pia.
- ✓ Ikiwa hii itatokea, tafadhali piga simu ili tupate kukusaidia.

UNAWAFUNA NINI UNAFUNA KUSAFU AU UWE NA MASWALI YOYOTE?

- ✓ Ikiwa una maswali Zaidi au unahitaji maelezo Zaidi au ufafanuzi kuhusu ushiriki katika utafiti, tafadhali piga simu au tuma ujumbe wa maandishi kwa:

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  Jina: Dr Paul Laigong

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TAARIFA NYINGINE

- ✓ Hatuwezi kumwambia yeyote aliyeshiriki katika utafiti huu. Jina lako halitakuwa kwenye sampuli ya damu tunayochukua. Huna budi kushiriki katika utafiti huu ikiwa hutaki. Hakuna mtu atakayekuwa na furaha na wewe. Tutakupa nakala ya karatasi hii kuweka

…… …….. …….

Saini Jina Tarehe ya uchunguzi

TAARIFA YA SOMO

- ✓ Utafiti huu wa utafiti umeelezewa kwangu. Nakubali kushiriki katika utafiti huu. Nimekuwa na nafasi ya kuuliza maswali. Ikiwa nina maswali Zaidi, ninaweza kumuliza dakatri.

…..... …… ……...

Saini Jina Tarehe ya somo

…..... …… ……...

Saini Jina Tarehe