**PEDIATRIC ENDOCRINOLOGY- A TROPICAL PERSPECTIVE**

**Nishant Raizada, MD, DM Endocrinology, Associate Professor and Head,** Department of Endocrinology, Center for Diabetes, Endocrinology and Metabolism, University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India. [drnishantraizada@gmail.com](mailto:drnishantraizada@gmail.com)

**Phibakordor L. Nonglait, MD, Senior Resident ,** Department of Endocrinology, Center for Diabetes, Endocrinology and Metabolism, University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India. [phiba27@gmail.com](mailto:phiba27@gmail.com)

**Updated May 8, 2023**

**ABSTRACT**

Pediatric endocrine disorders are frequently seen in tropical countries. While broadly the spectrum of pediatric endocrine disorders in the tropics is not entirely different from that seen in other parts of the world, some aspects of these disorders are unique to the tropics. Many pediatric endocrine disorders are underreported from the tropics, presumably because of limited access to medical care in terms of both diagnostic and therapeutic facilities. Lack of formal training of pediatricians and physicians in pediatric endocrinology may be a contributor. Some conditions such as exogenous Cushing syndrome are seen very frequently in tropics because of easy access and unrestrained use of glucocorticoids by quacks/ faith healers. Malnutrition is an important contributor to short stature in many tropical countries where a large section of the population is living in abject poverty. Iodine deficiency disorders are seen in many countries despite iodine fortification of salt or other edible items. Lack of universal screening for congenital hypothyroidism often leads to late detection of this disorders contributing to significant morbidity and mortality. Vitamin D deficiency and nutritional rickets is rampant even in areas where sunlight is abundant year around. Since most of the pediatric endocrine disorders are easily treatable and can have severe consequences when diagnosis or treatment is delayed, increasing the awareness of these disorders in the healthcare workers in the tropics is necessary.

**PITUITARY DISEASE**

The common pituitary disorders reported from the tropics include craniopharyngiomas, growth hormone deficiency, pituitary adenomas (including prolactinomas), and Cushing’s disease.

**Craniopharyngiomas**

Craniopharyngiomas are common suprasellar tumors in childhood. A retrospective analysis of 62 pediatric (onset <18 years) craniopharyngiomas was reported from a tertiary care hospital from India. The presenting features included central diabetes insipidus (6.5%), central hypothyroidism (43.5%), secondary adrenal insufficiency (32%), and delayed puberty (24%). On follow up 90% had some form of anterior pituitary deficiency and 22.6% developed obesity. GH therapy was given to 14% of cases. Incomplete surgical removal was frequent and radiotherapy was used in many cases (1). Another study from Egypt reported 137 patients with pediatric craniopharyngiomas. They were treated with surgery alone (65), radiotherapy after surgery (71), or surgery for Ommaya insertion with intracystic interferon injection (1). Subtotal resection was seen in 58 patients (42.33%) while 48 cases (35.04%) had gross total resection/near total resection. The 5-year progression-free survival (PFS) was 52.3%, ( surgery alone 34.49% and radiotherapy after surgery 72.25% ) (2). Both craniopharyngiomas and gliomas were most common supratentorial pediatric brain tumors in Nigeria (3). In a study of 37 pediatric craniopharyngiomas who underwent surgery, gross total resection was possible in 43.2%, near total resection in six patients 16.2%. and subtotal resection (STR) in 40.5%. The recurrence-free survival rate was 81.1% and 70.3% at 5- and 10-year follow-up, respectively. Diabetes insipidus, anterior pituitary hormone deficits, and obesity were common in follow up (4). In a study from Pakistan, craniopharyngiomas were 14.3% of the reported pediatric intracranial tumors (5). Another study from Pakistan has reported the use of gamma knife radiosurgery in craniopharyngiomas. The patients included 17 children. Nearly 80% of the patients achieved tumor control with gamma knife (6). An uncommon variant called papillary craniopharyngiomas has been reported in 13 cases from Pakistan (7).

**Growth Hormone Deficiency And Related Disorders**

Isolated growth hormone deficiency (IGHD) and combined pituitary hormone deficiency (CPHD) are the two presentations of growth hormone (GH) deficiency. The mutations involved in IGHD are GH*1* and *GHRHR* while CPHD is associated with mutations in transcription factor genes *PROP1*, *POU1F1*, and *HESX1.* Genetic analysis performed in 51 patients with CPHD at a tertiary care center in India reported that 10 (20%) patients had POU*1F1* and *PROP1* mutations and of these 5 were novel and 2 previously reported. No mutations were identified in *HESX1* (8).

A study of growth hormone deficient patients from South India reported that smaller pituitary size was associated with worse height deficits and bone age delays. However, they had a better response to GH therapy (9).

Children with IGHD had several biochemical and cardiac parameters that may be associated with an increased CVD risk in later life. This included higher waist-hip-ratio, total cholesterol, non-high-density lipoprotein-cholesterol, serum homocysteine, C-reactive protein (CRP), and pro-brain natriuretic peptide (pro-BNP). Left ventricular mass (LVM) and interventricular septal thickness were significantly lower (10).

A novel POU*1F1* c.605delC mutation in combined pituitary hormone deficiency (CPHD) was identified by Sanger sequencing carried out in 160 trios and 100 controls. In vitro studies showed that the this mutation codes for a truncated protein with reduced transactivation capacity on downstream targets like growth hormone (*GH*) and prolactin (*PRL*) (11).

Laron dwarfism first reported among Israeli Jewish children is a rare disorder characterized by low IGF-1 and high GH levels. A case series of nine such cases (6 male, 3 female) was reported from South India. The short stature was extreme with a mean height Z score of 7.7 (SD 0.8). Clinical features included characteristic facial features, microcephaly, micropenis and developmental delay. All children had typical hormonal profile of low IGF-1 and elevated GH (12). Laron syndrome has been reported from Africa and South America (13)(14)(15).

**Pituitary Adenomas**

While adult pituitary tumors are relatively common, pediatric pituitary adenomas (PPA) are less common. A retrospective study of 74 cases of PPA was published from a center in North India. The median age was 15 years and 42 % were females. Headache and menstrual abnormalities were common presentations. Corticotroph adenomas (32.4%) and somatotropinomas (25.7%) were among the common types. TSHoma and pituitary blastomas were very few. In 81% cases, transsphenoidal surgery was performed while adjuvant medical management and radiotherapy was required in 25% and 18% respectively. Remission rates in Cushing's and acromegaly were 62.5% and 57.8%, respectively, and post operative hormone deficits were seen in 33% (16).

Giant prolactinoma (GP) are rare pituitary tumors in childhood and adolescence. A series of 18 cases of GP has been reported from India. GP constituted 20% of pediatric prolactinomas at this center. The authors conducted a systematic review including these 18 and 77 other cases from the literature. They found a male predominance with pubertal arrest/delay. Dopamine agonist (DA) monotherapy showed good results as monotherapy (17).

**Cushing’s Disease**

Cushing’s disease is an important cause of hypercortisolism in children. It is caused by an ACTH secreting pituitary adenoma. A retrospective study of 48 pediatric cases of Cushing’s disease who underwent transsphenoidal adenectomy between 1998 and 2008 was published from India. Weight gain, round facies, and short stature were the most common clinical manifestations. Low dose dexamethasone suppression test and midnight cortisol showed 100% sensitivity for establishing hypercortisolism, while midnight ACTH had 100% sensitivity for confirming ACTH dependence. Magnetic resonance imaging and unstimulated BIPSS were used to confirm Cushing’s disease. Post surgical remission was 56% after first transsphenoidal adenectomy with higher remission rate of 75% in those with microadenoma. Eight patients were given radiotherapy and four of these achieved remission (18).

**GROWTH AND PUBERTAL DISORDERS**

Short stature and delayed puberty are commonly seen in children visiting pediatric endocrine clinics in the tropics.

**Short Stature**

Malnutrition, systemic illnesses, endocrine disorders, and syndromic disorders are among the major causes of short stature in the tropics.

MALNUTRITION

Malnutrition in early childhood is an important cause of short stature in tropical counties. The role of early childhood undernutrition on physical growth and cognitive achievement was assessed in a nationwide population-based cohort study in India. Data on undernutrition was taken from Human Development Survey (IHDS) in 2004 to 2005 while the outcomes on physical and cognitive outcomes during preadolescent (8 to 11 years) years was assessed in 2011 to 2012. The study assessed 7868 children and 4334 were undernourished. Undernourished children had 1.73 times increased odds of short stature. It was associated with decreased odds of achieving a higher reading and arithmetic outcomes. The findings were worse in female children.(19)

SYNDROMIC SHORT STATURE AND OTHER CAUSES

Noonan syndrome (NS), an autosomal dominant disorder, is caused by mutations in genes associated with the RAS / mitogen-activated protein kinase (MAPK) pathway. A large series of 363 patients with Noonan’ syndrome was published from India. The exons of PTPN11 gene were sequenced in all patients. Congenital cardiac anomalies (mostly right sided defects) were present in 84% of patients. The downward-slanting palpebral fissures, hypertelorism, low-set posteriorly rotated ears, short stature, pectus excavatum, and unilateral or bilateral cryptorchidism were common clinical findings. The most common variants in this series were in exon 8 (c.922A > G, c.923A > G), observed in 22 of the affected. Thirty-two previously described pathogenic variants in eight different exons in PTPN11 gene were detected in 107 patients (20). Similar findings were reported from a study in Morocco (21). Noonan syndrome has been described in Latin America, Africa and other countries in Asia. The facial characteristics of Noonan syndrome cases worldwide were similar to those of European descent (22).

Achondroplasia is a skeletal dysplasia that is a common cause of disproportionate short stature. In a study of forty cases with disproportionate short stature from India , achondroplasia was the most common skeletal dysplasia with c. 1138 G>A, p. Gly380Arg mutation seen in all cases (23). Achondroplasia has been reported from Pakistan and Africa also (24,25).

Idiopathic short stature (ISS)refers to the short stature where all the conventional clinical and biochemical work up is normal. Genetic studies in 61 patients with ISS in India showed that four patients had a heterozygous variant in SHOX gene while two had novel, likely pathogenic variants, in the IGFALS gene (26).

Thalassemia is a frequent cause of short stature and pubertal delay. Inadequate chelation therapy and lack of awareness among treating physicians on endocrine complications lead to higher prevalence of undiagnosed endocrine issues in these children. In a study from central India, short stature (88%), delayed puberty (71.7%), hypothyroidism (16%), and diabetes mellitus (10%), were reported in children with thalassemia (88).

**Puberty**

Pubertal disorders can be broadly classified as delayed puberty and early (precocious puberty). Secular trends of gradual reduction in the age of puberty have started becoming apparent in tropics.

SECULAR TRENDS IN PUBERTY

The age of normal puberty has shown a decline in many tropical countries- a trend which mimics that witnessed in the developed world decades earlier. Data regarding normal puberty from Egypt suggests that in girls with BMI ≥85th percentile all pubertal stages started earlier as compare to girls with BMI less than 85th centile. No such association between BMI and pubertal stage was noticed in males (27). A decline in the age of pubertal maturation of girls in Nigeria was also reported. The median age at beginning of breast maturation (B2) and menarche were 9 and 12 years respectively. The age at menarche was significantly associated with overweight/obesity and high social class (28). Similar findings have been reported from India where a study of 2010 school girls reported that median age of thelarche and menarche was 10.8 and 12.4 years with obese girls showing a six month earlier onset of thelarche and menarche when compared to those with normal BMI (29). Similar findings were reported from Western India (30). School girls in Riyadh, Saudi Arabia also had earlier onset of puberty similar to that seen developed countries (31).

DELAYED PUBERTY

Delayed puberty is a common pubertal disorder. It may be a normal variant such as constitutional delay in growth and puberty or represent a pathology. Pathological causes are classified as hypogonadotropic or hypergonadotropic hypogonadism. In a retrospective study of 136 patients with delayed puberty from Sudan, permanent or functional hypogonadotropic hypogonadism was seen in 37.5 and 36% while hypergonadotropic hypogonadism was seen in 11.7%. Constitutional delay in growth and puberty was present in 14.7%. Type 1 diabetes and celiac disease were common systemic illnesses (32). A study of 42 cases of delayed puberty from India (19 boys, 23 girls) underlying systemic illnesses were the dominant cause of pubertal delay in girls (11/23) while the major cause in boys were endocrinopathies (6/19). Malnutrition, chronic infections, and anemia were common systemic illnesses (33).

An unusual association of hypopituitarism along with Turner syndrome was reported in six Tunisian patients (34). A study of 11 Turner syndrome patients was reported from Cameroon, seven had monosomy while four had mosaic Turner syndrome. Most of these had presented with delayed puberty or short stature. Other clinical features were short neck, forearm carrying-angle deformity, a low hairline, and a webbed neck. Horse shoe kidney was found in two cases but none had cardiac abnormalities. The average age at diagnosis was 18.4 years indicating a delay in the diagnosis (35).

Differentiation between CDGP and hypogonadotropic hypogonadism is challenging in tropical countries. Most patients do not have regular height measurements and estimation of growth velocity in the years preceding to the presentation is often not possible. GnRH stimulation test has been employed but has limited utility because of significant overlap in the hormonal levels between the two groups. GnRHa-stimulated inhibin B (GnRH-iB) has been developed as a convenient test to differentiate between CDGP and hypogonadotropic hypogonadism. A cut-off value of 113.5 pg/ml in boys and 72.6 pg/ml in girls could predict spontaneous pubertal onset with 100% sensitivity and specificity (36).

PRECOCIOUS PUBERTY

Precocious puberty is a common pubertal disorder. It is classified as central precocious puberty (caused by premature activation of the hypothalamic-pituitary-gonadal axis) or peripheral precocious puberty (due to secretion of gonadal steroids from other causes without activation of the hypothalamic-pituitary-gonadal axis).

A retrospective analysis of 55 children (36 girls) with precocious puberty was reported from India. Central precocious puberty occurred in 62% (34 cases, out of which 19 were idiopathic) while peripheral precocious puberty was found in 14 children. The commonest cause of peripheral precocious puberty was congenital adrenal hyperplasia (46%) (37). A rare case of precocious pseudopuberty due to a virilizing adrenocortical carcinoma progressing to central precocious puberty after surgery has also been reported (38). Idiopathic precocious puberty responds well to GnRH analogue therapy as reported from a series for India (39).

There appears to be an increase in the incidence of central precocious puberty especially in girls in the COVID-19 lockdown in India as compared to the pre-lockdown period (40).

**DISORDERS OF BONE AND MINERAL METABOLISM**

Vitamin D deficiency and nutritional rickets are very common in tropics. Primary hyperparathyroidism and less common forms of rickets like vitamin D resistant and hypophosphatemic rickets also occur.

**Vitamin D Deficiency And Nutritional Rickets**

Tropical countries have high prevalence of nutritional rickets. The human body can generate vitamin D in the skin from sunlight. Although tropical countries get abundant sunlight, vitamin D deficiency (VDD) is common. Harsh summers limit sunlight exposure in many tropical countries. Adequate sunlight exposure was found in only 27 % neonates in Ethiopia (41). In some countries, atmospheric pollutions limits sunlight penetration in winters (42). Darker skin color with high melanin content, different socio-cultural factors, and genetic variation also contribute to vitamin D deficiency. Infants are at a high risk of vitamin D deficiency which could be due to low vitamin D content in breastmilk, and inadequate vitamin D content of complementary foods and maternal vitamin D deficiency. Routine vitamin D supplementation at a dose of 400 IU per day till 12 months of age in breastfed infants has been recommended in India (43). Oral vitamin D supplementation of mothers during lactation has been shown to reduce risk of vitamin D deficiency in infants at 6 months of age by almost 95% (44). Nationwide data from India suggests that prevalence of vitamin D deficiency defined as serum 25OHD <12 ng/ml was 14% (1-4 years), 18% (5- 9 years), and 24% (10-19 years) (43). However, VDD prevalence ranging from 60-87 % has been reported in low birth weight infants and 71-88% in normal birth weight infants in Delhi, India (45) (46). In Uganda, a study found that prevalence of VDD in LBW infants was 12.1 % but most of these had received supplemental vitamin D (47). A larger study including five countries from sub-Saharan Africa, showed that prevalence of vitamin D deficiency in children aged 0-8 years was 7.8% (48). Countries closed to the Equator had less VDD. In India, a study from the state of Kerala reported a VDD prevalence of 11.1%. The reasons implicated for this relatively lower prevalence were latitude and fish intake in the diet (49). Data suggests that in several African countries nutritional rickets is common although VDD prevalence is not high. Children requiring surgical correction of deformities resulting from rickets in Malawi, Africa had lower dietary calcium intake but VDD was uncommon (50). Low dietary calcium intake has been implicated as a causative factor for rickets in Studies from Nigeria and Bangladesh (51,52). Serum alkaline phosphatase has been explored as a low-cost biochemical test to screen for nutritional rickets in children in Nigeria. A cut off of ALP > 350 U/L has been proposed in one study (53). Severe vitamin D deficiency can present as osteomalacic myopathy in children and adolescents (54).

For the treatment of rickets and vitamin D deficiency, oral cholecalciferol in a daily dosing schedule (2000 IU below 1 year of age and 3000 IU in older children) for 12 weeks has been recommended by some Indian guidelines (43). However, compliance issues are common in underprivileged populations. When compliance to daily dosing cannot be ensured, this guideline has suggested intermittent regimen provided the child is above 6 months of age. Sunlight exposure was shown to be inferior to oral vitamin supplementation (400IU/day) in preventing rickets or vitamin D deficiency in infants in India (55). A single intramuscular dose of 600,000 IU of vitamin D has shown to be safe and effective for treatment of nutritional rickets in India (56).

**Primary Hyperparathyroidism**

Pediatric primary hyperparathyroidism (PHPT)has been reported in two studies from India. George et al performeda retrospective analysis of 15 children and adolescents with PHPT (age <20 yr.) between 1993 and 2006. The mean age was 17.7 (range 13-20 years) with 80% of patients being female. Clinical features included bone pain, proximal myopathy, bony deformities, fractures, palpable osteitis fibrosa cystica, nephrolithiasis, and acute pancreatitis. No cases had evidence of multiple endocrine neoplasia. Nearly a third of the cases developed post-operative hungry bone syndrome occurred in 33.3%. Histology was suggestive of parathyroid adenoma in all cases (57). Sharanappa et al reported retrospective data (September 1989-August 2019) of 35 pediatric PHPT patients (< 18 years) who underwent parathyroidectomy. The mean age was 15.2±2.9 years and with male to female ratio of 1:1.9. Skeletal manifestations were seen in 83% while renal manifestations occurred in 29%. Parathyroid adenoma was present in 91.4% patients, whereas the remaining had hyperplasia. Except one patients all others had hungry bone syndrome in postoperative period (58). Adolescent PHPT can present as posterior reversible encephalopathy syndrome (59). Neonatal severe hyperparathyroidism is a rare disorder. One such case has been reported from India (60).

**Other Forms Of Rickets**

A case series of 36 patients with refractory rickets published from India reports that renal tubular acidosis (63%), vitamin D dependent rickets (14 %) (VDDR I in 2 and VDDR II in 3 patients), chronic renal failure (11%), hypophosphatemic rickets (6 %), and chronic liver disease (6%) were common causes (61). Pseudohypoparathyroidism may also present with bony deformities resembling rickets (62). Hereditary vitamin-D resistant rickets was reported in eight patients in Tunisia. Two mutations in vitamin D receptor gene were found: p.K45E (5 patients with alopecia) and a novel p.T415R mutation located in the ligand-binding domain.

X linked hypophosphatemic rickets is the most common cause of phosphopenic rickets. It can be caused by loss of function mutations in the PHEX gene which leads to an increase in the phosphaturic hormone fibroblast growth factor-23 (FGF-23). Two novel mutations in the PHEX gene has been reported from two families from India (63). A family suffering from XLH has been reported from Pakistan (64). Idiopathic tumoral calcinosis (ITC) refers to the deposition of calcium hydroxyapatite crystals or amorphous calcium usually in juxta-articular tissue in a tumor-like fashion. ITC has been reported in an 8-year-old child who had the symptoms at 4 years of age (65).

**THYROID**

Common thyroid disorders in pediatric age group include hypothyroidism, iodine deficiency disorders, thyroiditis, and thyroid cancer

**Congenital Hypothyroidism**

Congenital hypothyroidism can be a devastating disease if not diagnosed and treated on time. Congenital hypothyroidism is much more common in tropical countries as compared to developed world. The prevalence in India is estimated to be one in 1000-1500 births (66). The Indian Society for Pediatric and Adolescent Endocrinology (ISPAE) has published guidelines on screening, diagnosis, and management of congenital hypothyroidism (66,67). High prevalence of CH has been reported from Sri Lanka as well as Iran (68,69). A cut off of ≥20 mIU/L for capillary TSH screening for CH beyond 24 hours of life has been proposed in the India for deciding on recalling the patient for further workup while a repeat capillary sample was advised for TSH values between 10 and 20 mIU/L (70).

Despite the above research, most tropical countries do not have universal screening for CH. This contributes to significant morbidity due to this potentially treatable condition.

**Iodine Deficiency Disorder**

Iodine deficiency disorders are among the top causes of thyroid disease worldwide. Several tropical countries are affected by IDD. India and Pakistan have both initiated fortification of common salt with iodine. This measure has been successful in reducing total goiter rate in children, indicating an improvement in iodine status. However, several underprivileged populations in both countries have evidence of iodine deficiency (71,72). Africa also had a high prevalence of mild to moderate iodine deficiency but several iodine fortification programs have been started which resulted in improvement in the overall iodine status. Some high risk populations such as pregnant females may still face iodine deficiency (73).

**Thyroiditis**

A case series of 97 children with Hashimoto’s thyroiditis aged 5-12 years has been reported from India. The children were followed up for a six-month period. Goiter was seen in 89 while eight had an atrophic form. The mean age was 9.9 years and the male to female ratio was 1:5.4. Overt hypothyroidism was present in 73.4% while hyperthyroidism was seen in 3.1%. 13.2 % were subclinical hypothyroidism and 10.3% were euthyroid. A large percentage of subclinical hypothyroid and euthyroid children developed overt hypothyroidism in the 6 month follow up. (79)

It is possible that the prevalence of autoimmune thyroiditis has increased after iodine fortification of the diet. In a case control study, 43 children with goiter and autoimmune thyroiditis were compared with 43 children with euthyroid goiter without autoimmune thyroiditis. Urinary iodine concentration (UIC) was significantly higher in children with autoimmune thyroiditis. A positive correlation between UIC and antimicrosomal antibody titers was found. A UIC ≥300 μg/L was strongly associated with autoimmune thyroiditis (80).

**Hypothyroidism**

Acquired hypothyroidism in most tropical countries is now predominantly autoimmune, barring those where severe iodine deficiency is still prevalent.

The control of hypothyroidism with levothyroxine therapy in children in tropical countries is often poor because of poverty, lack of proper advice, and reduced access to laboratory testing. Research work on treatment of hypothyroidism is being done. Both bedtime and early morning intake of thyroxine had equal efficacy in maintaining a normal TSH in children with hypothyroidism in a randomized controlled trial from North India (78).

Van Wyk Grumbach syndrome is a syndrome characterized by prolonged untreated hypothyroidism, short stature, and isosexual precocious puberty. This syndrome is considered to be rare with very few cases reported so far in recent times. However, many cases of Van Wyk Grumbach have been reported from tropical countries like India and Sri Lanka (74,75,76). A case series of this rare syndrome has been reported from Pakistan (77). This illustrates that availability of trained physicians as well as laboratory facilities is still a challenge in tropical countries.

**Hyperthyroidism**

Pediatric hyperthyroidism has been reported in the tropics. Graves’ disease is the most common cause of pediatric hyperthyroidism. The factors differentiating pediatric Graves from adult disease are predominance of neuropsychiatric symptoms, gradual and often insidious onset, and absence of infiltrative ophthalmopathy.

In a seven-year period, 24 children with hyperthyroidism were reported in a study from India. Twenty of these had Graves’ disease while one had toxic nodular goiter and one had neonatal Graves’ disease while the remaining two were factitious. Behavioral problems, excitability, hyperkinesis, and irritability were most common symptoms. Ocular involvement was present in 85% while 30 % had cardiac involvement. Goiter was noted in 18 out of 24 cases. Carbimazole was used for treatment and remission occurred in seventeen cases (81). Neonatal thyrotoxicosis has been reported from India (82).

A case of a three and a half-year-old boy who had an autonomous functioning thyroid nodule which was cured by radioiodine ablation has been reported from India (83). Radioiodine therapy has been used for pediatric and adolescent Graves’ disease. Carbimazole therapy does not appear to influence the outcome of radioiodine therapy (84). Thyroid storm precipitated by empyema thoracis has been reported in a 16 year old girl (85).

**Thyroid Cancer**

Thyroid cancer is not common in pediatric populations and usually occurs as papillary carcinoma (PTC). A publication from a oncology center in India reports that pediatric differentiated thyroid cancer has high rates of extrathyroidal involvement as well as lymph node and distant metastasis (86). These findings however are not unique to tropical countries as similar profile has been reported from other parts of the world. Pediatric PTC often do not have TERT promoter mutations and have a lower prevalence of BRAFV600E mutation as reported in a study from India (87). Globally, the mortality rates of pediatric PTC are similar to that of adult PTC. The data on survival in pediatric PTC from tropical countries is limited.

**REFERENCES**

1. Harsha GS, Dabadghao P, Sudhanshu S. Long-Term Outcomes of Paediatric-Onset Craniopharyngioma: A Retrospective Analysis from a Tertiary Care Centre in North India. Neurol India. 2022;70:600–605.

2. Enayet AER, Atteya MME, Taha H, Zaghloul MS, Refaat A, Maher E, Abdelaziz A, El Beltagy MA. Management of pediatric craniopharyngioma: 10-year experience from high-flow center. Childs Nerv Syst ChNS Off J Int Soc Pediatr Neurosurg. 2021;37:391–401.

3. Ca N, Sc O, Go E. Paediatric brain tumours managed in Enugu, Southeast Nigeria: Review of one centre experience. Niger Postgrad Med J. 2018;25. doi:10.4103/npmj.npmj\_132\_18.

4. Sarkar S, Chacko SR, Korula S, Simon A, Mathai S, Chacko G, Chacko AG. Long-term outcomes following maximal safe resection in a contemporary series of childhood craniopharyngiomas. Acta Neurochir (Wien). 2021;163:499–509.

5. Riaz Q, Naeem E, Fadoo Z, Lohano M, Mushtaq N. Intracranial tumors in children: a 10-year review from a single tertiary health-care center. Childs Nerv Syst ChNS Off J Int Soc Pediatr Neurosurg. 2019;35:2347–53.

6. Saleem MA, Hashim ASM, Rashid A, Ali M. Role of gamma knife radiosurgery in multimodality management of craniopharyngioma. Acta Neurochir Suppl. 2013;116:55–60.

7. Tariq MU, Din NU, Ahmad Z, Memon W. Papillary craniopharyngioma: A clinicopathologic study of a rare entity from a major tertiary care center in Pakistan. Neurol India. 2017;65:570–76.

8. Birla S, Khadgawat R, Jyotsna VP, Jain V, Garg MK, Bhalla AS, Sharma A. Identification of Novel PROP1 and POU1F1 Mutations in Patients with Combined Pituitary Hormone Deficiency. Horm Metab Res Horm Stoffwechselforschung Horm Metab. 2016;48:822–27.

9. Khadilkar VV, Prasad HK, Ekbote VH, Rustagi VT, Singh J, Chiplonkar SA, Khadilkar AV. Response of Indian growth hormone deficient children to growth hormone therapy: association with pituitary size. Indian J Pediatr. 2015;82:404–9.

10. Gupta S, Dayal D, Rohit MK, Gawalkar AA, Raj KM, Attri SV, Sachdeva N, Kaur H. Comprehensive assessment of cardiovascular disease risk in children with short stature due to isolated growth hormone deficiency: a case-control study. J Pediatr Endocrinol Metab JPEM. 2022;35:1059–68.

11. Birla S, Vijayakumar P, Sehgal S, Bhatnagar S, Pallavi K, Sharma A. Characterization of a Novel POU1F1 Mutation Identified on Screening 160 Growth Hormone Deficiency Patients. Horm Metab Res Horm Stoffwechselforschung Horm Metab. 2019;51:248–55.

12. Sethuraman C, Venkatasamy S. Clinical profile of Laron dwarfism - experience from a tertiary care institute in Chennai. J Pediatr Endocrinol Metab JPEM. 2023;36:466–69.

13. Berg MA, Argente J, Chernausek S, Gracia R, Guevara-Aguirre J, Hopp M, Pérez-Jurado L, Rosenbloom A, Toledo SP, Francke U. Diverse growth hormone receptor gene mutations in Laron syndrome. Am J Hum Genet. 1993;52:998–1005.

14. Hopp M, Rosenbloom AL, Griffiths J, Kgwete S, Vaccarello MA. Growth hormone receptor deficiency (Laron syndrome) in black African siblings. South Afr Med J Suid-Afr Tydskr Vir Geneeskd. 1996;86:268–70.

15. Besson A, Salemi S, Eblé A, Joncourt F, Gallati S, Jorge AAL, Mullis PE. Primary GH insensitivity ’(Laron syndrome) caused by a novel 4 kb deletion encompassing exon 5 of the GH receptor gene: effect of intermittent long-term treatment with recombinant human IGF-I. Eur J Endocrinol. 2004;150:635–42.

16. Jayant SS, Pal R, Rai A, Gupta K, Radotra BD, Walia R, Dhandapani S, Tripathi M, Ahuja CK, Gupta P, Bhansali A, Das L, Dutta P. Paediatric Pituitary Adenomas: Clinical Presentation, Biochemical Profile and Long-Term Prognosis. Neurol India. 2022;70:304–11.

17. Kumar S, Sarathi V, Lila AR, Sehemby M, Memon SS, Karlekar M, Sankhe S, Patil VA, Shah N, Bandgar T. Giant prolactinoma in children and adolescents: a single-center experience and systematic review. Pituitary. 2022;25:819–30.

18. Shah NS, George J, Acharya SV, Lila AR, Sarathi V, Bandgar TR, Jalali R, Goel AH, Menon P. Cushing disease in children and adolescents: twenty years’ experience in a tertiary care center in India. Endocr Pract Off J Am Coll Endocrinol Am Assoc Clin Endocrinol. 2011;17:369–76.

19. Soni A, Fahey N, Bhutta ZA, Li W, Frazier JA, Moore Simas T, Nimbalkar SM, Allison JJ. Early childhood undernutrition, preadolescent physical growth, and cognitive achievement in India: A population-based cohort study. PLoS Med. 2021;18:e1003838.

20. Athota JP, Bhat M, Nampoothiri S, Gowrishankar K, Narayanachar SG, Puttamallesh V, Farooque MO, Shetty S. Molecular and clinical studies in 107 Noonan syndrome affected individuals with PTPN11 mutations. BMC Med Genet. 2020;21:50.

21. El Bouchikhi I, Samri I, Iraqui Houssaini M, Trhanint S, Bouguenouch L, Sayel H, Hida M, Atmani S, Ouldim K. The first PTPN1 1 mutations in hotspot exons reported in Moroccan children with Noonan syndrome and comparison of mutation rate to previous studies. Turk J Med Sci. 2015;45:306–12.

22. Kruszka P, Porras AR, Addissie YA, Moresco A, Medrano S, Mok GTK, Leung GKC, Tekendo-Ngongang C, Uwineza A, Thong M-K, Muthukumarasamy P, Honey E, Ekure EN, Sokunbi OJ, Kalu N, Jones KL, Kaplan JD, Abdul-Rahman OA, Vincent LM, Love A, Belhassan K, Ouldim K, El Bouchikhi I, Shukla A, Girisha KM, Patil SJ, Sirisena ND, Dissanayake VHW, Paththinige CS, Mishra R, Klein-Zighelboim E, Gallardo Jugo BE, Chávez Pastor M, Abarca-Barriga HH, Skinner SA, Prijoles EJ, Badoe E, Gill AD, Shotelersuk V, Smpokou P, Kisling MS, Ferreira CR, Mutesa L, Megarbane A, Kline AD, Kimball A, Okello E, Lwabi P, Aliku T, Tenywa E, Boonchooduang N, Tanpaiboon P, Richieri-Costa A, Wonkam A, Chung BHY, Stevenson RE, Summar M, Mandal K, Phadke SR, Obregon MG, Linguraru MG, Muenke M. Noonan syndrome in diverse populations. Am J Med Genet A. 2017;173:2323–34.

23. Singh A, Pradhan G, Prasad R, Mishra OP, Kapoor S. Spectrum of Disproportionate Short Stature at a Tertiary-care Center in Northern India. Indian Pediatr. 2017;54:971–72.

24. Stephen L, Holmes H, Roberts T, Fieggen K, Beighton P. Orthodontic management of achondroplasia in South Africa. South Afr Med J Suid-Afr Tydskr Vir Geneeskd. 2005;95:588–89.

25. Ullah F, Ghaffar T, Afridi AK, Ali A, Aamir A ul hasan. SHORT STATURE: WHA T IS THE CAUSE IN OUR POPULATION. J Ayub Med Coll Abbottabad JAMC. 2016;28:135–40.

26. Kumar A, Jain V, Chowdhury MR, Kumar M, Kaur P, Kabra M. Pathogenic/likely pathogenic variants in the SHOX, GHR and IGFALS genes among Indian children with idiopathic short stature. J Pediatr Endocrinol Metab JPEM. 2020;33:79–88.

27. Abou El Ella SS, Barseem NF, Tawfik MA, Ahmed AF. BMI relationship to the onset of puberty: assessment of growth parameters and sexual maturity changes in Egyptian children and adolescents of both sexes. J Pediatr Endocrinol Metab JPEM. 2020;33:121–28.

28. Irewole-Ojo FO, Senbanjo IO, Oduwole AO, Njokanma OF. Age of pubertal events among school girls in Lagos, Nigeria. J Pediatr Endocrinol Metab JPEM. 2018;31:313–21.

29. Khadgawat R, Marwaha RK, Mehan N, Surana V, Dabas A, Sreenivas V, Gaine MA, Gupta N. Age of Onset of Puberty in Apparently Healthy School Girls from Northern India. Indian Pediatr. 2016;53:383–87.

30. Lohiya N, Jahagirdar R, Deshpande R, Goyal A. Sexual maturity assessment in Indian children-a study from western India. J Pediatr Endocrinol Metab JPEM. 2021;34:567–72.

31. Felimban N, Jawdat D, Al-Twaijri Y, Al-Mutair A, Tamimi W, Shoukri M, Tamim H, Al-Alwan I. Pubertal characteristics among schoolgirls in Riyadh, Saudi Arabia. Eur J Pediatr. 2013;172:971–75.

32. Galal MS, Musa SA, Babiker OO, Hamdan HZ, Abdullah MA. Clinical profile and aetiologies of delayed puberty: a 15 years’ experience from a tertiary centre in Sudan. J Pediatr Endocrinol Metab JPEM. 2022;35:938–45.

33. Bhakhri BK, Prasad MS, Choudhary IP, Biswas K. Delayed puberty: experience of a tertiary care centre in India. Ann Trop Paediatr. 2010;30:205–12.

34. Mnif-Feki M, Safi W, Bougacha-Elleuch N, Abid G, Moalla M, Elleuch M, Ben Salah DH, Rekik N, Belguith N, Abdelhedi F, Kammoun T, Hachicha M, Charfi N, Mnif F, Kammoun H, Hadj Kacem H, Hadj-Kacem F, Abid M. Occurrence of Hypopituitarism in Tunisian Turner Syndrome patients: familial versus sporadic cases. Gynecol Endocrinol Off J Int Soc Gynecol Endocrinol. 2021;37:848–52.

35. Wonkam A, Veigne SW, Abass A, Ngo Um S, Noubiap JJN, Mbanya J-C, Sobngwi E. Features of Turner syndrome among a group of Cameroonian patients. Int J Gynaecol Obstet Off Organ Int Fed Gynaecol Obstet. 2015;129:264–66.

36. Chaudhary S, Walia R, Bhansali A, Dayal D, Sachdeva N, Singh T, Bhadada SK. Unravelling a novel, promising and convenient tool for differential diagnosis of delayed puberty: GnRHa-stimulated inhibin B (GnRH-iB). J Endocrinol Invest. 2022;45:2265–73.

37. Dayal D, Yadav J, Seetharaman K, Aggarwal A, Kumar R. Etiological Spectrum of Precocious Puberty: Data from Northwest India. Indian Pediatr. 2020;57:63–64.

38. Goyal A, Malhotra R, Khadgawat R. Precocious pseudopuberty due to virilising adrenocortical carcinoma progressing to central precocious puberty after surgery. BMJ Case Rep. 2019;12:e229476.

39. Selvaraj A, Prasad HK, Narayanasamy K, Thiagarajan A, Nedunchelian K. Clinical Profile of Adolescents With Delayed Puberty. Indian Pediatr. 2021;58:684–85.

40. Mondkar SA, Oza C, Khadilkar V, Shah N, Gondhalekar K, Kajale N, Khadilkar A. Impact of COVID-19 lockdown on idiopathic central precocious puberty - experience from an Indian centre. J Pediatr Endocrinol Metab JPEM. 2022;35:895–900.

41. Ashebir YG, Sebsibe GT, Gela D, Kebede MA. Attitudes of mothers attending public hospitals in Addis Ababa, Ethiopia, to neonatal sunlight exposure: a cross-sectional study. BMJ Paediatr Open. 2022;6:e001554.

42. Ray R, Dabas A, Shah D, Malhotra RK, Madhu SV, Gupta P. Seasonal Variation in Serum 25-hydroxy Vitamin D and its Association with Clinical Morbidity in Healthy Infants from Northern India. Indian Pediatr. 2019;56:1020–24.

43. Gupta P, Dabas A, Seth A, Bhatia VL, Khadgawat R, Kumar P, Balasubramanian S, Khadilkar V, Mallikarjuna HB, Godbole T, Krishnamurthy S, Goyal JP, Bhakhri BK, Ahmad A, Angadi K, Basavaraj GV, Parekh BJ, Kurpad A, Marwaha RK, Shah D, Munns C, Sachdev HPS. Indian Academy of Pediatrics Revised (2021) Guidelines on Prevention and Treatment of Vitamin D Deficiency and Rickets. Indian Pediatr. 2022;59:142–58.

44. Trivedi M, Faridi MMA, Aggarwal A, Madhu SV, Malhotra RK. Oral Vitamin D Supplementation to Mothers During Lactation-Effect of 25(OH)D Concentration on Exclusively Breastfed Infants at 6 Months of Age: A Randomized Double-Blind Placebo-Controlled Trial. Breastfeed Med Off J Acad Breastfeed Med. 2020;15:237–45.

45. Agarwal R, Virmani D, Jaipal ML, Gupta S, Gupta N, Sankar MJ, Bhatia S, Agarwal A, Devgan V, Deorari A, Paul VK, Investigators of LBW Micronutrient Study Group, Departments of Pediatrics and Endocrinology. Vitamin D status of low birth weight infants in Delhi: a comparative study. J Trop Pediatr. 2012;58:446–50.

46. Jain V, Gupta N, Kalaivani M, Jain A, Sinha A, Agarwal R. Vitamin D deficiency in healthy breastfed term infants at 3 months & their mothers in India: seasonal variation & determinants. Indian J Med Res. 2011;133:267–73.

47. Chebet M, Piloya T, Ameda F, Mukunya D, Kiguli S. Vitamin D deficiency in low-birth-weight infants in Uganda; a cross sectional study. PloS One. 2022;17:e0276182.

48. Mogire RM, Morovat A, Muriuki JM, Mentzer AJ, Webb EL, Kimita W, Ndungu FM, Macharia AW, Cutland CL, Sirima SB, Diarra A, Tiono AB, Lule SA, Madhi SA, Sandhu MS, Prentice AM, Bejon P, Pettifor JM, Elliott AM, Adeyemo A, Williams TN, Atkinson SH. Prevalence and predictors of vitamin D deficiency in young African children. BMC Med. 2021;19:115.

49. Vijayakumar M, Bhatia V, George B. Vitamin D status of children in Kerala, southern India. Public Health Nutr. 2020;23:1179–83.

50. Braithwaite VS, Freeman R, Greenwood CL, Summers DM, Nigdikar S, Lavy CBD, Offiah AC, Bishop NJ, Cashman J, Prentice A. The aetiology of rickets-like lower limb deformities in Malawian children. Osteoporos Int J Establ Result Coop Eur Found Osteoporos Natl Osteoporos Found USA. 2016;27:2367–72.

51. Ahmed S, Goldberg GR, Raqib R, Roy SK, Haque S, Braithwaite VS, Pettifor JM, Prentice A. Aetiology of nutritional rickets in rural Bangladeshi children. Bone. 2020;136:115357.

52. Sempos CT, Durazo-Arvizu RA, Fischer PR, Munns CF, Pettifor JM, Thacher TD. Serum 25-hydroxyvitamin D requirements to prevent nutritional rickets in Nigerian children on a low-calcium diet-a multivariable reanalysis. Am J Clin Nutr. 2021;114:231–37.

53. Thacher TD, Sempos CT, Durazo-Arvizu RA, Fischer PR, Munns CF, Pettifor JM. The Validity of Serum Alkaline Phosphatase to Identify Nutritional Rickets in Nigerian Children on a Calcium-Deprived Diet. J Clin Endocrinol Metab. 2021;106:e3559–64.

54. Sahni SS, Kakkar S, Kumar R, Goraya JS. Osteomalacic Myopathy in Children and Adolescents with Vitamin-D Deficiency. Neurol India. 2021;69:1650–54.

55. Goyal A, Dabas A, Shah D, Malhotra RK, Dewan P, Madhu SV, Gupta P. Sunlight Exposure vs Oral Vitamin D Supplementation for Prevention of Vitamin D Deficiency in Infancy: A Randomized Controlled Trial. Indian Pediatr. 2022;59:852–58.

56. Mondal K, Seth A, Marwaha RK, Dhanwal D, Aneja S, Singh R, Sonkar P. A Randomized controlled trial on safety and efficacy of single intramuscular versus staggered oral dose of 600 000IU Vitamin D in treatment of nutritional rickets. J Trop Pediatr. 2014;60:203–10.

57. George J, Acharya SV, Bandgar TR, Menon PS, Shah NS. Primary hyperparathyroidism in children and adolescents. Indian J Pediatr. 2010;77:175–78.

58. Sharanappa V, Mishra A, Bhatia V, Mayilvagnan S, Chand G, Agarwal G, Agarwal A, Mishra SK. Pediatric Primary Hyperparathyroidism: Experience in a Tertiary Care Referral Center in a Developing Country Over Three Decades. World J Surg. 2021;45:488–95.

59. Pal R, Dutta A, Agrawal K, Jain N, Dutta P, Bhansali A, Behera A, Bhadada SK. Primary Hyperparathyroidism Presenting as Posterior Reversible Encephalopathy Syndrome: A Report of Two Cases. J Clin Res Pediatr Endocrinol. 2020;12:432–38.

60. Gupta P, Tak SA, S AV, Misgar RA, Agarwala S, Jain V, Sharma R. A Case of Neonatal Severe Hyperparathyroidism: Challenges in Management. Indian J Pediatr. 2022;89:1025–27.

61. Joshi RR, Patil S, Rao S. Clinical and etiological profile of refractory rickets from western India. Indian J Pediatr. 2013;80:565–69.

62. Bajpai A, Sharma J, Hari P, Bagga A. Pseudohypoparathyroidism presenting with bony deformities resembling rickets. Indian J Pediatr. 2004;71:345–48.

63. Ma SL, Vega-Warner V, Gillies C, Sampson MG, Kher V, Sethi SK, Otto EA. Whole Exome Sequencing Reveals Novel PHEX Splice Site Mutations in Patients with Hypophosphatemic Rickets. PloS One. 2015;10:e0130729.

64. Khan PA, Mustafa G, Shabbir G, Azam M, Athar M, Zulqarnain A. X-linked hypophosphatemic rickets: report of a family from southern Punjab, Pakistan. JPMA J Pak Med Assoc. 2004;54:335–38.

65. Gupta M, Thakur S, Sharma R, Gupta A. Idiopathic tumoral calcinosis presenting in early childhood. BMJ Case Rep. 2019;12:e227083.

66. Desai MP, Sharma R, Riaz I, Sudhanshu S, Parikh R, Bhatia V. Newborn Screening Guidelines for Congenital Hypothyroidism in India: Recommendations of the Indian Society for Pediatric and Adolescent Endocrinology (ISPAE) - Part I: Screening and Confirmation of Diagnosis. Indian J Pediatr. 2018;85:440–47.

67. Sudhanshu S, Riaz I, Sharma R, Desai MP, Parikh R, Bhatia V. Newborn Screening Guidelines for Congenital Hypothyroidism in India: Recommendations of the Indian Society for Pediatric and Adolescent Endocrinology (ISPAE) - Part II: Imaging, Treatment and Follow-up. Indian J Pediatr. 2018;85:448–53.

68. Lucas G. Guidelines on management of congenital hypothyroidism in Sri Lanka. Sri Lanka J Child Health. 2015;44:75–76.

69. Dorreh F, Chaijan PY, Javaheri J, Zeinalzadeh AH. Epidemiology of congenital hypothyroidism in Markazi Province, Iran. J Clin Res Pediatr Endocrinol. 2014;6:105–10.

70. Verma P, Kapoor S, Kalaivani M, Vats P, Yadav S, Jain V, Thelma BK, Science and Engineering Research Board – Newborn Screening Initiative Group (SERB-NBS) members. An Optimal Capillary Screen Cut-off of Thyroid Stimulating Hormone for Diagnosing Congenital Hypothyroidism: Data from a Pilot Newborn Screening Program in Delhi. Indian Pediatr. 2019;56:281–86.

71. Lowe N, Westaway E, Munir A, Tahir S, Dykes F, Lhussier M, McKeown M, Zimmerman M, Andersson M, Stinca S, Zaman M. Increasing Awareness and Use of Iodised Salt in a Marginalised Community Setting in North-West Pakistan. Nutrients. 2015;7:9672–82.

72. Menon PSN. Prevention of Iodine Deficiency Disorders in Children in India - the Way Forward. Indian J Pediatr. 2019;86:113–15.

73. Businge CB, Longo-Mbenza B, Kengne AP. Iodine deficiency in pregnancy along a concentration gradient is associated with increased severity of preeclampsia in rural Eastern Cape, South Africa. BMC Pregnancy Childbirth. 2022;22:98.

74. Kandasamy D, Malik R, Sharma R, Jana M. Case 308: Van Wyk-Grumbach Syndrome. Radiology. 2022;305:746–50.

75. Reddy P, Tiwari K, Kulkarni A, Parikh K, Khubchandani R. Van Wyk Grumbach Syndrome: A Rare Consequence of Hypothyroidism. Indian J Pediatr. 2018;85:1028–30.

76. Egodawaththe NS, Seneviratne SN, Gunasekara S, Amarasekara SM, Weerasekara K. Van Wyk-Grumbach syndrome and oligosyndactyly in a 6-year-old girl: a case report. J Med Case Reports. 2020;14:166.

77. Riaz M, Ibrahim MN, Laghari TM, Hanif MI, Raza J. Van Wyk Grumbach Syndrome. J Coll Physicians Surg--Pak JCPSP. 2020;30:1332–34.

78. Navid A, Dayal D, Kaur H, Gupta A, Attri S. Comparative efficacy of early morning versus bedtime administration of levothyroxine in children with hypothyroidism: a prospective, open label, randomized, case-control study. Pediatr Endocrinol Diabetes Metab. 2021;27:178–82.

79. Rajamanickam R, Shanmugavelu L, Subramanian S, Prasad HK, Krishnamoorthy N. Hashimoto’s Thyroiditis in South Indian Centre. Indian J Pediatr. 2016;83:1227–31.

80. Palaniappan S, Shanmughavelu L, Prasad HK, Subramaniam S, Krishnamoorthy N, Lakkappa L. Improving iodine nutritional status and increasing prevalence of autoimmune thyroiditis in children. Indian J Endocrinol Metab. 2017;21:85–89.

81. Menon PS, Singh GR. Hyperthyroidism in children: an Indian experience. J Pediatr Endocrinol Metab JPEM. 1996;9:441–46.

82. Sonowal R, Anjali A, Kumar A. Neonatal Thyrotoxicosis Co-existing With Early Onset Sepsis. Indian Pediatr. 2021;58:86.

83. Gundgurthi A, Dutta MK, Garg MK, Pandit AG. Autonomous functioning thyroid nodule successfully treated with radioiodine in a 3 and a half-year-old boy. J Pediatr Endocrinol Metab JPEM. 2012;25:345–47.

84. Ballal S, Soundararajan R, Singh H, Garg A, Chopra S, Bal C. Influence of prior carbimazole on the outcome of radioiodine therapy in pediatric and adolescent Graves’ disease. Nucl Med Commun. 2015;36:566–72.

85. Thakur C, Kumar P, Goyal JP, Vyas V. Thyroid Storm in an Adolescent Girl Precipitated by Empyema Thoracis. Oman Med J. 2022;37:e371.

86. Thankamony P, Nirmal G, Chandar R, Nair AKR, Veeramoni Iyer Mriduladevi P. Differentiated thyroid carcinoma in children: A retrospective analysis of 125 pediatric cases from a single institution in India. Pediatr Blood Cancer. 2021;68:e29076.

87. Chakraborty D, Shakya S, Ballal S, Agarwal S, Bal C. BRAF V600E and TERT promoter mutations in paediatric and young adult papillary thyroid cancer and clinicopathological correlation. J Pediatr Endocrinol Metab JPEM. 2020;33:1465–74.

88. Dixit N, Shaw CK, Varshney GA, Kumar R, Saini PA, Verma P. Endocrinal Complications in Children and Adolescents with Thalassemia Major in Central India: An Observational Study. Indian J Pediatr. 2022;89:983–88.