Studies of the Nutritional Problem of Puerto Rico

II. Appraisal of Vitamin Deficiency Based on Physcial and Biomicroscopic Examinations and X-Ray Studies of the Long Bones of a Hospital Population of 310 Infants and Children[1]

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THE CONFERENCE on Methods and Procedures for Nutritional Survey,[2] held at Atlantic City on October 18, 1941, stated that "an assessment on the nutritional status of a population can be done at present by conducting, on a suitable sample, a properly planned dietary and food intake survey, together with an adequate physical and medical examination, the latter to include a slit-lamp examination of the eyes and the securing of blood samples for the determination of hemoglobin, plasma ascorbic acid concentration, and the concentration of blood serum or plasma albumin." The present study has been limited to physical and medical examinations, the latter consisting of slit-lamp examinations of the conjunctiva and cornea and roentgenographic investigation of the long bones. An appraisal on this basis will, therefore, give only partial information that may very well be either substantiated or denied in the future by the chemist or by the nutritionist.

A hospital population of 310 infants and children were studied; 175 were males and 135 females; 248 were white and 62 were either Negroes or mulattoes. Their ages varied between one month and 16 years, with an average of 5.3 years. Fifty-eight infants fluctuated between 3 and 18 months, with an average of 11 months. All the children were ward cases at one or the other of five insular institutions: 49 at the Municipal Hospital of San Juan, 44 at the Bayamón District Hospital, 47 at the Fajardo District Hospital, 60 at the Arecibo District Hospital, and 87 at the University Hospital, therefore this series of 310 children represented a hospital population of the low-income group. Medical, surgical, and orthopedic cases were included. In the medical cases diagnoses such as malnutrition, nutritional edema, nutritional diarrhea, and gastroenteritis predominated.

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2. Report of a conference on methods and procedures. Nutrition survey of population groups. Pub.Health Rep., 57:189, 1942.

Two hundred of them underwent physical and slit-lamp examinations. X-rays of the long bones were made of 263. Dr. A. Díaz Atiles and Dr. R. Fernández Marchante, pediatricians of the University Hospital, kindly permitted us to study the X-rays of the long bones in 87 children in their service.

Physical Examination. There were 22 cases (11 percent) of the so-called nutritional edema with about half of this number exhibiting signs of dehydration. The skin in 7 cases showed bilateral pellagrous dermatitis—3 of them active and extensive and 4 in the process of recovery. Follicular hyperkeratosis was found at the knee joints and elbows in 6 cases; all but one were mild. There were very few sebaceous plugs at the nasolabial folds of 2 cases; purpura and petechiae were observed in 2 more. The following additional skin lesions also appeared at examination: impetigo contagiosum in 5, measles in 2, congenital lues in 2, tinea alba in one, and mosquito bites in 3 cases.

It has been stated that disability from vitamins A, D, and C arises mainly in the period of growth of the child; as regards thiamin, nicotinic acid, and riboflavin, the deficiency is essentially one in adults. Our study of the skin of 200 infants and children showed the contrary—nicotinic acid deficiency seemed to predominate. The two cases showing purpura and petechiae, respectively, were not scurvy, and follicular hyperkeratosis sufficiently pronounced to be attributed to vitamin A deficiency was observed in only one child.

The lips were red, shiny, and inflamed in 8 cases. Infectious diseases such as tuberculosis, lues, bronchitis, and gastroenteritis could be accounted for in 6 of them. Herpes labialis was seen in 2 instances; one was a case of a large abscess and the other a case of nephrosis. Fissuring and masseration at the angles of the mouth, the so-called angular cheilitis that is presumably due to riboflavin deficiency, was observed in 14 cases (7 percent). In 6 it was active; in 5 it was in the process of healing. It was unilateral in one case and accompanied by herpes labialis in another. The 14 cases of angular cheilitis could be subdivided thus: 4 were cases of malnutrition; there were 3 cases of pellagra, one case of scurvy, and in 6, the cheilitis was probably secondary to, or concomitant, with various infectious processes.

The ribs showed prominent costochondral junctions in 59 cases (28 percent), pigeon's breast in 2. One was a case of tuberculosis of the spine and the other a case of severe malnutrition. Flaring of the ribs (Harrison's groove) was present in 15 cases (7.5 percent); frontal bosses were seen in 8 patients (4 percent), and temporal

bosses in 3 (1.5 percent). There was an apparent enlargement of the epiphysis at the wrist in 24 cases (14 percent). Not a single case of coxa vara or genu valgum was observed.

Such a high incidence of prominent costochondral junctions would seem to point towards a correspondingly high incidence of rickets, but one should remember that this finding is not pathognomonic of rickets. It can also be found in scurvy or vitamin C deficiency and in other states of malnutrition; only a small proportion of clinically positive cases of rickets can be confirmed radiologically. Furthermore, as will be seen later on, there is not enough radiological evidence of rickets in infancy to account for the large number of the so-called 'rachitic rosary' seen in later years.

The gums were found definitely spongy and bleeding in 6 cases. One of them showed signs of bismuth poisoning and of acute hepatitis; the other 5 were undoubtedly cases of active scurvy. In 12 cases (6 percent) the gums were definitely spongy but not bleeding, and in 81 additional cases (41 percent) the gums were found only slightly spongy. No other corroborative sign of scurvy was observed in this last group.

The large number of children showing sponginess of the gums can, in part, be explained by the fact that the author used the loupe and not the naked eye for examination of the gums, tongue, and skin lesions. In some of the scorbutic children the gingiva was examined by the biomicroscope as well. Of course, improper oral hygiene explains some of these findings.

There was observed only one case of atrophic glossitis similar to that seen in acute sprue in an extremely anemic under-developed idiotic girl of 16. A magenta-colored tongue with a mushroom appearance of the papillae, presumably due to riboflavin deficiency, was noted in 2 cases; one was suffering from cirrhosis of the liver and the other from tuberculous adenitis. A scarlet red tongue of nicotinic acid deficiency was seen in 4 patients; 2 were cases of pellagra, and the other 2 were cases of malnutrition plus bronchopneumonia. A glossitis limited to the tip was observed in 7 cases: one of nephrosis, another of intestinal intussusception, 2 of malnutrition, and 3 of enteritis. There were also 2 cases of aphthous stomatitis in one child suffering from hepatitis and in another suffering from a parotid abscess. There was, therefore, a total of 16 cases showing abnormal states of the tongue. Of these, 6 were simple cases of nutritional deficiency, the rest having some other inciting factor.

Examination of the eyes: color and vascularity. Grossly, the conjunctiva was found to be bluish-white in 52 cases (26 percent), while

in 138 cases (69 percent), muddy brown in 8, and icteric in 2. The normal bluish-white, almost avascular smooth conjunctiva was observed exclusively in infants and the muddy brown, in older children. The plica semilunaris was normally pink in 163 cases (81 percent) and in 37 cases (19 percent), it was seen slightly or moderately edematous or engorged. The conjunctival vessels were normal in 83 cases (41 percent) but showed a slight increase in vascularity in 18 (9 percent), a moderate increase in 72 (36 percent), a definite increase in 23 cases (12 percent), and a marked conjunctival injection in only 4 cases (2 percent). Although 59 percent of the children showed an increase in conjunctival vascularity of varying degree, not one complained of any subjective symptoms, such as itching, burning, or photophobia.

Slit-lamp examination. For this examination the Bausch and Lomb hand slit-lamp, with an ocular magnifier of 7.5 x power, was utilized. A few doubtful cases were studied with the Poser biomicroscope, and cases showing pronounced congestion of the limbic plexus were examined before and after the instillation of a 2 percent fluorescein solution into the conjunctival sac.

Pigmentation. Pigmentation was absent in 85 cases (42 percent) and present in varying degrees of intensity, especially at the circumcorneal region, in 115 cases (58 percent). According to Berliner,[3] "conjunctival pigmentation is not a common finding in the white race, except at the limbus and caruncle. In the colored races a considerable amount of conjunctival pigmentation is usually present and in many instances flecks of pigment may be seen in the bulbar conjunctiva." In our own studies 29 out of 39 colored children (73 percent) and only 51 of a total of 161 white children (31 percent) showed pigmentation.

Thickened conjunctiva. The conjunctiva was found normal in appearance and thickness in 126 cases (63 percent), but the thickness in the superficial layer appeared to increase with the age of the patients. There was only a slight increase in 23 cases (11 percent), a moderate increase in 30 cases (15 percent), and a pronounced increase in 21 cases (10 percent), the latter in children over 10 years of age. The thickened epithelium was more obvious at the horizontal meridian of the eye and usually more evident on the nasal than on the temporal side of the conjunctiva.

Bitot's spots. In determining the presence or absence of Bitot's

3. M. L. Berliner, Biomicroscopy of the Eye (New York and London: Paul B. Hoeber, Inc., 1944).

spots, we have adhered to Kruse's[4] description rather than to that given by Berliner.[5] Small Bitot's spots were found in 12 cases (6 percent) only, more often on the nasal than on the temporal side of the bulbar conjunctiva. Children in whom the heaping up of the thick and wrinkled conjunctiva formed a triangular elevated spot, with its base towards the corneoscleral junction (Bitot's spots), varied in age between 7 and 14 years. Not a single infant showed Bitot's spots.

Limbic vessels. The Conference on Methods and Procedures for Nutritional Survey[6] also stated that "characteristic invasion of the cornea is an index of riboflavin deficiency, and it is recommended that this examination (slit-lamp and biomicroscopic examination) be used in group assessments of nutritional status."

In our investigations of the limbic plexus, we followed McCreary, Nicholls and Tisdall's[7] classification, dividing the findings into four stages:

Stage 0, in which the blood-containing vessels did not extend beyond the sclera proper into the transition zone,

Stage I, in which the blood-containing vessels extended into the transition zone but not into the cornea proper,

Stage II, in which the blood-containing vessels extended into the transition zone with twigs into the cornea proper,

Stage III, in which the blood-containing vessels extended into the cornea proper with the formation of loops in this structure.

We found normal arcade and occasional palisade formation of the limbic vessels not extending beyond the sclera proper in 168 cases (84 percent). The remaining 32 (16 percent) showed not only engorgement of the limbic plexus but also the formation of twigs and arcades into the transition zone, though not invading the cornea proper. In our series, 84 percent of the cases could therefore be included in Stage 0 and 16 percent in Stage I. There were no cases of the more advanced Stages II and III.

Of the 32 cases showing twigs or arcades of the limbic plexus in the transition zone of the corneoscleral junction, only 4 showed a concomitant angular cheilitis: a child of nine suffering from Laennec cirrhosis of the liver, another 2 years old suffering from nutritional

4. H. D. Kruse, Medical evaluation of nutritional status. IV. Ocular manifestations of avitaminosis A, with special consideration of the detection of early changes by biomicroscopy. The Milbank Memorial Fund Quart., 19:207–240, 1941.

5. M. L. Berliner, *op. cit.*

6. Report of a conference on methods and procedures, *op. cit.*

7. J. F. McCreary, J. V. V. Nicholls, and F. F. Tisdall, Further studies on the relationship of corneal vascularization to riboflavin deficiency. Canad.M.A.J., 51:106–110, 1944.

edema, a third one of 2 years showing all the signs of pellagra and, lastly, one of nine with a congenital deformity of the skeleton. The other 28 children with evident invasion of the transition zone by the limbic vessels did not exhibit any other of the manifestations presumably due to riboflavin inadequacy.

With one exception, the cornea was found normal in all cases even after the instillation of fluorescein solution. The one single case showing interstitial keratitis was of tuberculous origin.

"It seems," McCreary, Nicholls and Tisdall state, "that a uniform peripheral corneal vascularization is not a safe basis for a diagnosis of riboflavin deficiency existing at the time of the examination." It is well-known that any irritant, such as soap, seawater, dust, wind, and so forth may cause collapsed, afunctional blood vessels in the cornea, transitional zone, and conjunctiva to become engorged.

Goldsmith[8] reported 40 percent with definite evidence and 67 percent with probable evidence of niacin or riboflavin deficiency, or of both combined, in a study of 200 patients admitted to the medical services of a charity hospital in Louisiana. Changes in the tongue were the most common abnormal findings, while lesions of the skin, eyes, and lips occurred in that order of frequency. Her study of an adult hospital population, as contrasted with our pediatric hospital population, is so markedly different that we are inclined to consider either her estimate as overgenerous or ours as too conservative.

X-ray studies. The roentgenographic studies of the long bones of 263 infants and children revealed the presence of 6 cases of scurvy (2.2 percent), 5 of which were active and one in the process of healing; there were 4 cases (1.5 percent) of rickets. The disease was diagnosed radiologically in 5 cases, but we have excluded one from the Pediatric Service of the University Hospital—a cretin 23 years old with a physical development of a boy of 5. Two cases, originally classified as healed rickets, were diagnosed as Blount's disease by Golden of the Presbyterian Hospital and by Caffey of the Babies Hospital, both of New York City, to whom 19 of our films were sent for interpretation.[9] Osteoporosis was present in 62 cases (23.5 percent); 68 cases (29.6 percent) showed transverse lines at the epiphyses; 28 cases (10.6 percent) had both osteoporosis and transverse lines, and only 2 cases (0.7 percent) showed bony changes characteristic of congenital lues.

8. G. A. Goldsmith, The incidence and recognition of riboflavin and niacin deficiency in medical diseases. South.M.J., 36:108–116, 1943.

9. Blount's disease, according to Dr. John Caffey, is "a sort of aseptic necrosis analogous to Perthes' disease, osteochondrosis of the tibia and femur."

Rickets. Eliot and Jackson,[10] in their exhaustive roentgenologic and clinical study of 584 Puerto Rican children, seemed to prove that rickets is a rare disease on the Island, only 5 cases of rickets (less than 1 percent) being then detected (1933). One of them was born and lived in New York City for 21 of her 25 months of life. It was held, as an accepted fact, that the rarity of the disease in Puerto Rico was due to the protective influence of sunlight, since the study was undertaken on "a group of infants and young children who had lived continuously in a tropical climate, exposed the year around to intense sunlight." However, we must state that with but few exceptions children in Puerto Rico, especially infants, are not exposed to intense sunlight the year around. On the contrary, they are usually protected from direct sunlight and kept in the house or in shaded places, when out-of-doors. But we must admit that the amount of ultraviolet radiation, which they receive, is sufficient in most cases to prevent the development of severe rickets with deforming bony changes.

For the development of rickets, there must exist a combined deficiency of the ultraviolet radiation in the atmosphere and of calcium in the diet. The deprivation of vitamin D reduces the absorption of calcium from the alimentary tract which results in an insufficient supply of lime salts to the skeleton of the growing child.

The four cases of radiologically positive rickets were:

A–607. A four-month-old white baby suffering from hydrocephalus and secondary anemia with a negative serology. X-ray diagnosis was "relapsing rickets."

L–3. A seven-month-old white baby suffering from pyogenic dermal infection. X-ray diagnosis was "healed rickets."

A–194. A three-year-old white child suffering from scurvy and severe secondary anemia. X-ray diagnosis was "severe scurvy with active rickets."

L–10. An underdeveloped white child of four showing marked ascites. X-ray diagnosis was "completely healed rickets."

Our series, although too small to have any statistical value, gives a somewhat higher incidence for rickets than that reported by Eliot, especially when we consider that of the 263 children studied radiologically, less than 20 percent were in the age group between 3 and 18 months.

10. M. M. Eliot and E. B. Jackson, Bone development of infants and young children in Puerto Rico. Roentgenographic and clinical study with special reference to rickets, osteoporosis and transverse lines in radius and ulna. Am.J.Dis.Child., 46:1237–1262, 1933.

The study points definitely to an abnormal calcification of bone. Osteoporosis, sufficiently pronounced in some cases to be considered as bone atrophy, was present in 62 children (23.5 percent) alone, or in combination with transverse lines. Osteoporosis was present in infants and young children as well. Was it due to low calcium in the diet or to an inadequate vitamin D intake? Since rickets is primarily a disturbance of the nutritional processes, might not this osteoporosis be a manifestation of mild, subclinical rickets? We are not yet in a position to answer the questions but believe that the clinical conception of rickets should undergo some modification applicable to the tropics. We further believe with the British Pediatric Association[11] that a disturbance of calcification, demonstrable radiologically but not clinically, may need a new terminology.

Transverse lines of dense bony tissue crossing the spongiosa at the end of the shafts were seen in 68 cases (29.6 percent). These lines are supposed to be evidence of periodic or interrupted growth. Dr. Eliot reported transverse lines in nearly one half of the Puerto Rican children over one year of age and a similar incidence (48 percent) for children of New Haven between 3 and 6 years. Of 72 highly undernourished Puerto Rican children, she found 39 (over 50 percent) showing transverse lines, and of 332 apparently well-nourished, only 25 percent showed them.

The lines are most conspicuous at the sites of rapid bony growth: the distal end of the femur, both ends of the tibia, and the distal end of the radius. Golden[12] says that transverse lines are seen following infections, in nutritional diseases, in anemias, and in certain phases of rickets and scurvy. Caffey, according to Golden,[13] is not inclined to pay any attention to the so-called transverse lines.

Anatomicopathological data. In going over 1,411 autopsies, performed by the Department of Pathology of the School of Tropical Medicine, we found a total of 364 children from stillbirth to the age of 12. There were 239 whites and 83 Negroes; 138 were females and 217 were males.

There were 93 infants in the age group of greatest activity for rickets (3 to 18 months), but not a single case was reported among them. There was only one case reported in the entire series (Autopsy No. 500), a child of 3 who had lived in New York City up to 6 months before death and who had died of pulmonary tuberculosis with

11. British Pediatric Association, Report on the incidence of rickets in war-time. Rep.Pub. Health and Med.Subjects, No. 92 (London: H. M. Stationary Office, 1944).
12. Ross Golden, Diagnostic Roentgenology (New York: Thomas Nelson and Sons, 1941).
13. Personal communication.

"adolescent rickets" as a secondary finding. It appears from these data that rickets is not a cause of death in Puerto Rico.

Pellagra appeared as a cause of death in 4 instances. There is one mention of riboflavin deficiency. Vitamin A deficiency was present in 3 cases. One was a pure case of avitaminosis A with xerophthalmia, nutritional edema, and chronic enterocolitis in a child of 7 (Autopsy No. 693); another one occurred as a complication of congenital lues (Autopsy No. 1,016). This was in an infant 4 months of age, showing typical luetic osteochondritis affecting the femur and ribs plus squamous metaplasia of the renal pelvis. The last one was in a child of 4 (Autopsy No. 803), who died of pellagra, suffered from night blindness, and showed early squamous metaplasia of the bronchiolar epithelium.

The most typical case of avitaminosis A occurring in Puerto Rico was that reported by Rivera Lugo[14] in a 5½-year-old child, breast-fed for two years, and suffering from chronic diarrhea, ascariasis, and xerophthalmia. The characteristic squamous metaplasia was found throughout the body, including such rare regions as the renal tubules and gastric mucosa.

Undoubtedly, malnutrition, as such, is a relatively important cause of death, since it was found in 27 (7 percent) of the 364 autopsies, 6 cases of nutritional edema or hypoproteinemia being included. This can be contrasted with congenital lues, which was reported only in 7 instances (1.9 percent), including one stillborn and one baby 6¼ hours old.

SUMMARY AND CONCLUSIONS

We have presented a study of vitamin deficiency based on physical and biomicroscopic examinations and X-ray studies of the long bones of 310 Puerto Rican infants and children of the low-income group. Our conclusions are based, therefore, on purely clinical grounds.

There were 22 cases (11 percent) of the so-called nutritional edema or hypoproteinemia.

Signs of vitamin A deficiency were absent altogether in infants and young children. Only 6 cases (3 percent) of follicular hyperkeratosis and 12 cases (6 percent) of Bitot's spots were found in older children. The part played by climate and sunlight in the tropics on the color, vascularity, and thickness of the conjunctiva, and in the production of Bitot's spots remains unanswered.

14. I. Rivera Lugo, A fatal case of avitaminosis A, with post mortem study. Bol.Asoc.méd. de Puerto Rico, 36:62, 1944.

Pellagra was found relatively frequent. There were 7 cases (3.5 percent) of typical generalized pellagrous dermatitis.

Angular cheilitis was observed in 14 cases (7 percent), but other signs of riboflavin inadequacy were rare. For instance, there were only 2 instances of the presence of sebaceous plugs at the nasolabial folds, and 2 cases of magenta-colored tongue, and although the limbic plexus was often seen engorged, no case of superficial vascularization of the cornea was observed with the slit-lamp.

Scurvy was present in six cases (2.2 percent).

We agree with Eliot and Jackson that severe rickets with deforming bony changes is extremely rare in Puerto Rico; we found radiological evidence of rickets in only 4 cases (1.5 percent). On the other hand, clinical evidence suggestive of rickets, such as enlarged costochondral junctions, delayed closure of the fontanelles, delayed dentition, retarded skeletal and muscular development, and so forth, are not at all rare.

This study seems to prove that multiple deficiencies, including inadequacy in proteins and the various food factors, are not rare among the children belonging to the low-income groups of the Island.

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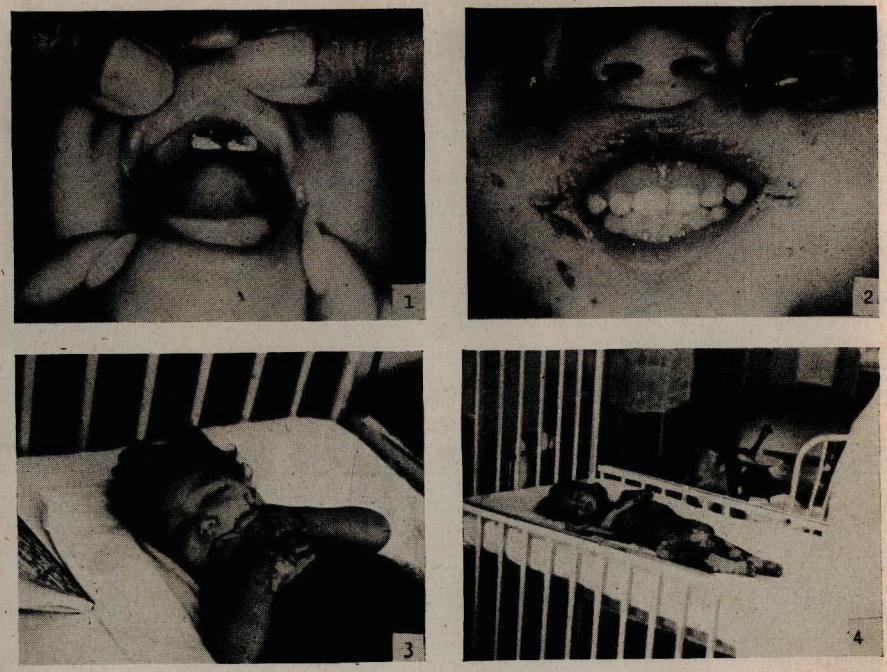

PLATE I

Fig. 1. C. I. N. (1 yr. 3 mos.) Infant at the Municipal Hospital, suffering from scurvy and gingival signs that cleared up after 48 hours' treatment with ascorbic acid.

Fig. 2. A. L. N. (2 yrs.) Boy at the Bayamón District Hospital showing typical angular cheilitis.

Fig. 3. A. L. N. (2 yrs.) Boy at the Bayamón District Hospital showing pronounced nutritional edema, pellagra, and angular cheilitis.

Fig. 4. C. A. M. Girl at the Bayamón District Hospital showing a severe state of malnutrition, with generalized pellagrous dermatitis.

LÁMINA I

Grab. 1. C. I. N. (1 año 3 meses) Niño en el Hospital Municipal con escorbuto y gingivitis, cuyos signos desaparecieron en 48 horas; tratamiento con ácido ascórbico.

Grab. 2. A. L. N. (2 años) Niño en el Hospital de Distrito de Bayamón con signos típicos de queilitis angular.

Grab. 3. A. L. N. (2 años) Niño en el Hospital de Distrito de Bayamón con edema nutricional pronunciada, pelagra y queilitis angular.

Grab. 4. C. A. M. Niña en el Hospital de Distrito de Bayamón en estado grave de malnutrición y dermatitis pelagroide generalizada.

PLATE II

Fig. 1. L–3 Healed rickets.

Fig. 2. A–607 Relapsing rickets.

Fig. 3. R–194 Active rickets and scurvy.

Fig. 4. 2876 Blount's Disease.

LÁMINA II

Grab. 1. L–3 Raquitismo curado.

Grab. 2. A–607 Raquitismo recurrente.

Grab. 3. R–194 Raquitismo agudo y escorbuto.

Grab. 4. 2876 Enfermedad de Blount.