

*Original Article***Epidemiology of Genu Varum in Pediatric Patients in Dr. Soetomo General Academic Hospital Surabaya 2010-2018: A Retrospective Study**Rona Nughtho Hidayatullah<sup>1</sup> , Tri Wahyu Martanto<sup>2</sup> <sup>1</sup>Soerojo Hospital, Magelang, Indonesia<sup>2</sup>Department of Orthopedic and Traumatology, Faculty of Medicine, Universitas Airlangga, Dr. Soetomo General Academic Hospital, Surabaya, Indonesia

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**ABSTRACT**

**Background:** Genu varum is the condition of the legs that bend inward, leading to walking disruptions. However, data on genu varum are still lacking to prevent the disease. This study aimed to identify the epidemiology of patients with genu varum in preventing, managing and determining the prognosis and as a source for future research.

**Methods:** This research is a descriptive study using a retrospective research design. The sampling technique used is a total sampling of genu varum patients gained from the Department of Orthopedics and Traumatology database, medical records from Dr. Soetomo General Academic Hospital Surabaya, and patients' home visits. The target population is all genu varum patients from 2010-2018.

**Results:** The total sample was 31 patients, 21 patients were male (67%), and 10 patients were female (32%). The average age of patients was 4.3 years. The first complaint of the disease was, on average, realized at 1.8 years. The birth weight data obtained an average of 3.49 kg. The average body mass index is 26.3. Langenskiold stage I,II,III,IV,V,VI type; 2 (3%), 43 (70%), 2 (3%), 5 (8%), 2 (3%), 8 (13%). Eighteen patients (58%) had bilateral Blount disease and 7 patients (22%) had unilateral Blount disease, and only six patients (20%) had physiologic genu varum. Eighteen patients were carried out conservative methods, and 13 underwent operative methods.

**Conclusion:** Blount disease is the commonest cause of genu varum in Dr. Soetomo General Academic Hospital, specifically infantile. The highest number of patients are male and those who underwent operative treatment.

Keywords: Genu varum; Blount disease; Pediatric; Epidemiology; Human and medicine

**INTRODUCTION**

Genu varum, or bow leg, is the condition of the legs that bend inward, like the letter "O." This typically occurs in infants and toddlers younger than two years. It is necessary to consider whether this abnormality is still within physiological limits or a Blount disease. Blount disease, first introduced in 1937, is a growth disorder of the medial portion of the proximal tibia, epiphysis, and metaphysis.<sup>1,2</sup> This disease is generally associated with varum angulation and internal rotation of the tibia in the metaphyseal area

of the lower leg bone. Although the main pathology presents tibia varum, other lower limb multiplanar deformities may exist, including varum, genu procurvatum (anterior angle angulation), internal rotation, and limb shortening.<sup>3-6</sup> The development of these deformities may lead to gait disruption patterns, lower limb-length discrepancy, and premature knee osteoarthritis.<sup>7</sup>

Globally, in North America, namely the Caribbean, the prevalence of early-onset Blount disease has been estimated at 1/1200 live births. The typical patient is an overweight black African, African-American,



or Afro-Caribbean child.<sup>8</sup> Disease onset is before three years of age. Meanwhile, a study in Iran with 4689 primary school students reported that genu varum was found in 0.09% of four children.<sup>9</sup>

Clinical classification can be distinguished based on limb deformities that develop before and after four years old. Thompson and Carter further classified late-onset Blount disease as juvenile type (onset at 4-10 years of age) and adolescent type (onset after ten years old).<sup>10,11</sup> Blount disease can affect children in their infancy and can be classified into two based on the age of first complaint, namely early-onset or infantile and late-onset or adolescent. Langenskiold described six stages of progressive radiographic changes in the epiphyses and proximal tibial metaphysis of children in the early-onset Blount disease. With increasing age and higher Langenskiold grades (V and VI), irreversible physal changes with permanent inhibition of the medial portion of the tibial growth plate may occur.<sup>12,13</sup>

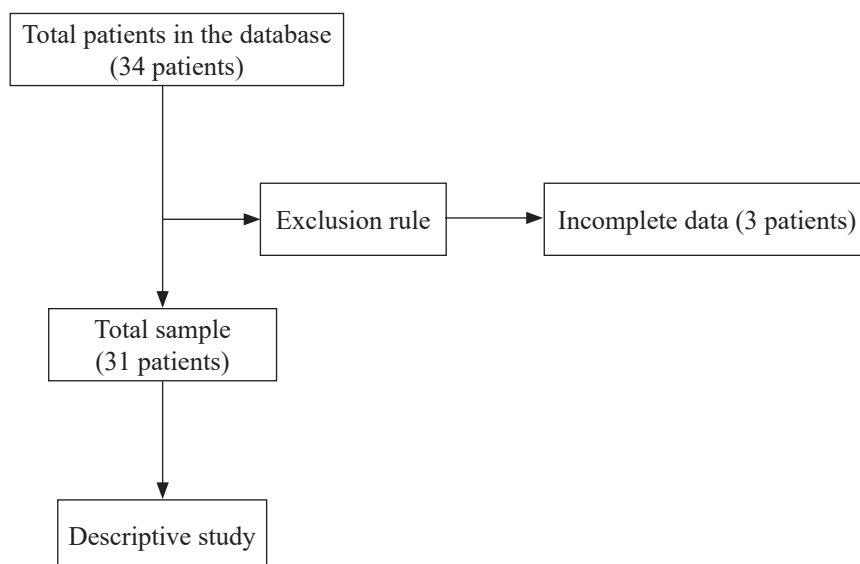
In physiological genu varum, when observed in patients aged 2-3.5 years, the genu varum will decrease. Generally, the knee is slightly valgus at the age of 3.5 years, according to the Salenius graph and Vanka.<sup>14</sup> Management of genu varum can be in the form of observation, braces to surgery. Brace installation is usually used for children less than four years old. The operative method can be in the form of osteotomy and epiphysiodesis.<sup>7,15</sup> However, the data of genu varum are not on track to prevent the disease. This study aimed to determine the epidemiology of patients with genu varum in Dr. Soetomo General Academic Hospital Surabaya to prevent, manage, and determine the prognosis of genu varum and as a source for future research on genu varum.

## MATERIALS AND METHODS

This type of research was a descriptive study using a retrospective research design. This study received ethical clearance information no. 1223/ KEPK/ V/ 2019 issued by the Research Commission of Dr. Soetomo General Academic Hospital Surabaya. This research was conducted at Dr. Soetomo General Academic Hospital, Surabaya, in March 2018. The target population was all genu varum patients from 2010-2018. The sampling technique was a total sampling of genu varum patients gained from the Department of Orthopedics and Traumatology database, Dr. Soetomo General Academic Hospital Surabaya, medical records of Dr. Soetomo General Academic Hospital, and patients' home visits. This study uses secondary data from a database of the division of pediatrics, Department of Orthopedics and Traumatology, Dr. Soetomo General Academic Hospital Surabaya. The database stores data on genu varum patients from polyclinics, emergency departments, and orthopedic and traumatology inpatients at RSUD Dr. Soetomo, which was proposed in the discussion of the pediatrics division. Patient data consist of identity, history, clinical examination, and radiological examination. The following information was collected: sex, age at first arrival, the age for onset of walking, early age of complaint, birth methods of delivery, birth weight, body mass index, MDA of the right and left knee, Langenskiold type, genu varum, and treatment of the patient.

All data were matched according to the exclusion and inclusion criteria. Inclusion criteria included genu varum patients listed in the pediatric division's database. Meanwhile, the exclusion criteria included patients with supporting data from unavailable clinical and radiological examinations completed and patients who could not be evaluated (Figure 1).





**Figure 1.** Data processing flow

## RESULTS

Of the 34 patients with complaints of inward crooked legs (*genu varum*) during this study, three patients had no radiological examination data, hence, those were excluded from this study. A total of 31 patients (21 males and 10 females) met the inclusion criteria. From the data collected (Table 1), the mean age of patients was  $4.3 \pm 3.3$  years (1.3-11). The initial age range of patients of 0-2 years was 12 patients (39%), more than 2-5 years were 11 patients (36%), more than five years-10 years were six patients (19%), and more than 10 years was two patients (6%).

The patient's main complaint was the leg position, bent inward (*genu varum*). On average, this complaint was realized at the age of  $1.9 \pm 1.8$  years (0.8-8). The youngest was nine months old, and the oldest was eight years old. The composition of ages less than one year was 17 patients (57%), one to three years old were nine patients (30%), and over the age of three years were four patients (13%). There was only one patient with a family member with the same complaint, the patient was the fifth child of five siblings, and the fourth brother had a complaint of crooked legs but was not taken

for treatment because he was older and had no complaints. This patient's history of growth and development was normal, according to the achievement of normal children (milestones). The mean age of the patients when they started walking and standing was  $1 \pm 0.2$  years (0.7-1.5). The earliest range was within eight months, and the latest was 18 months. The age of patients less than 12 years was 11 patients (35%), and more than 12 months was 20 patients (65%).

From the antenatal history, the mean gestational age was  $37.4 \pm 1.4$  weeks (34-41), with spontaneous vaginal delivery in 22 patients (69%) and caesarean delivery in 10 patients (31%). The mean birth weight data was  $3.5 \pm 0.6$  kg (2.5-5). Of all the patients, the following distribution for birth weights: weights 2.5 – 3.5 kg consisted of 22 patients (71%), more than 3.5 – 4.5 kg consisted of seven patients (23%), and above 4.5 kg consisted of 2 patients (6%).

Body mass index (BMI) was calculated by taking weight and height measurements from each patient. The average body mass index was  $26.4 \pm 5.3$  (17.5-40.2). The obese patients were 13 (44%), overweight was three (10%), normal weight was 13 (43%), and underweight was one (3%).



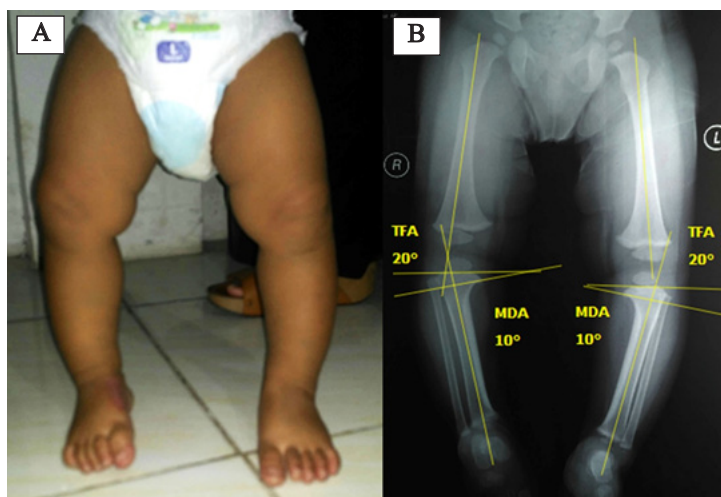
**Table 1.** Comparison of type variables of genu varum patients

Characteristics	Type Variables	Total Patients
Sex	Male	21 (68%)
	Female	10 (32%)
Age at first arrival	Less than 2 years	12 (39%)
	2-5 years	11 (36%)
	5-10 years	6 (19%)
	More than 10 years	2 (6%)
Age for the onset of walking	Less than 12 months	11 (35%)
	More than 12 months	20 (65%)
Early age of complaint	Less than a year	17 (57%)
	1-3 years	9 (30%)
	More than 3 years	4 (13%)
Birth methods of delivery	Spontaneous	22 (69%)
	Caesarean	10 (31%)
Birth weight	2.5-3.5 kg	22 (71%)
	3.5-4.5 kg	7 (23%)
	More than 4.5 kg	2 (6%)
Body mass index	Obesity	13 (44%)
	Overweight	3 (10%)
	Normal weight	13 (43%)
	Underweight	1(3%)
MDA of the right knee	Less than equal to 10°	(32%)
	11-25°	(45%)
	More than 25°	(23%)
MDA of the left knee	Less than equal to 10°	(29%)
	11-25°	(48%)
	More than 25°	(23%)
Langenskiold type	I	2 (3%)
	II	43 (70%)
	III	2 (3%)
	IV	5 (8%)
	V	2 (3%)
	VI	8 (13%)
Genu varum	Bilateral Blount	18 (58%)
	Unilateral Blount	7 (23%)
	Genu varum physiology	6 (19%)
Treatment of the patient	Conservative	18 (58%)
	Operative	13 (42%)

From the radiological examination of the AP and lateral genu, the metaphyseal-diaphyseal angle (MDA) and tibiofemoral angle (TFA) angles were measured on both knees. The mean MDA of the right leg was  $19.2 \pm 13.1^\circ$  (2-60) and on the left leg was  $20.2 \pm 15^\circ$  (2-74). The TFA measurement average was

$29.8 \pm 13.4^\circ$  (14-60) on the right leg and  $27.6 \pm 14.5^\circ$  (0-62) on the left leg. The recurrence of Blount disease was diagnosed when the MDA angle was more than 11 degrees.<sup>16</sup> Figure 2 showed the TFA and MDA measurements on patients who underwent conservative treatment. On the right leg with Blount disease was





**Figure 2.** (A) Clinical photograph and standing anteroposterior radiograph (B) of a 16-month-old male patient with bilateral early-onset Blount disease with conservative treatment



**Figure 3.** 8-year-old male patient with bilateral early-onset Blount disease (left side more bowing) managed with operative treatment. Pre-operative clinical photograph (A) and radiographic (B). Outcome after the restoration of limb alignment with double osteotomy of proximal tibia osteotomy and de-rotation, osteotomy physis, and elevation.

21 knees (67%), and physiological genu varum was 11 knees (33%), meanwhile on the left leg with Blount disease was 22 knees (70%), and physiological genu varum was eight knees (30%). According to Langenskiöld classification of the patient's entire knee (a total of 36

knees) in this sample, the results obtained are as follows: Langenskiöld I was two (3%), Langenskiöld II was 43 (70%), Langenskiöld III was two (3%), Langenskiöld IV was five (8%), Langenskiöld V was two (3%), and Langenskiöld VI was eight (13%).



Eighteen patients had bilateral Blount disease (58%), seven patients (23%) had unilateral Blount disease, and only six patients (19%) had physiologic genu varum. Of the 25 patients diagnosed with Blount disease, eight were late-onset, while the remaining 17 were early-onset. Eighteen patients carried out conservative treatments, while 13 patients were managed by operative treatments. Operative therapy included realignment osteotomy and epiphysiodesis, while conservative therapy was conducted with clinical and radiological observation every six months, weight loss treatment, and the application of Brace Knee-Foot Orthosis. Figure 3 showed an 8-year-old patients with bilateral early-onset Blount disease who underwent operative treatment with double osteotomy of proximal tibia osteotomy and de-rotation, osteotomy physis, and elevation.

## DISCUSSION

The sample of this study was obtained from the Dr. Soetomo General Academic Hospital in Surabaya. The most distant patients come from East Nusa Tenggara. According to the observations administered by the authors, patients were generally referred from city hospitals or health centers with middle to lower economic levels and lower secondary education backgrounds with a lack of knowledge and poor adherence to treatment.

From the sex data, the majority were male, as much as 68%. Compared to the sex and type of Blount disease, there were 10 male patients and six female patients on infantile data, while for the adolescent type, there were eight male patients. Contrasted with the demographic studies in America and Europe with a meta-analysis by Rivero, in the infantile type with Blount disease, the female was dominant (61%,  $p = <0.0001$ ), while in the adolescent type, the male was prone to be in a greater number than female (71%,  $p=0.0001$ ). This is

related to obesity data in America, where at the age of less than two years, females are likely very overweight (11.4%) in contrast to males (5%,  $p = 0.03$ ).<sup>7</sup>

Based on the data from this research, there was an average delay of approximately 28 weeks between when the patient had an initial complaint of genu varum until they came to the hospital for the first time, where the quickest period was six months, and the longest was seven years. Eighteen patients (26%) had a delay of less than one year, while 13 patients had a delay of more than one year (74%). This incidence could be described as insufficiency of the level of understanding of the patient's family about genu varum, or it might be considered as the lack of a referral system from first-level health facilities to hospitals.<sup>17</sup>

From some research, it is stated that there are sporadic genetic factors that predispose to Blount disease. It was stated that there were three families with a pattern of inheritance of genu varum to Blount disease from parents to their children. It is also reported that identical twins suffer from Blount disease while their mother suffers from physiological genu varum.<sup>7,18,19</sup> In this study, we found that only one patient with Blount disease and his older brother also suffered from crooked legs but were not taken for treatment.

One of the etiologies of Blount disease is mechanical factors which are likely overweight, and the age to start walking is less than 12 months.<sup>20-22</sup> The pathology is that standing and receiving excessive weight, especially on the medial side of the tibia, will cause growth disturbances according to Heuter-Volkman's law.<sup>23-26</sup> From the histopathological examination, anatomical and functional disorders of chondrocytes and disorders of ossification of the epiphyseal plate were found. In patients with obesity and genu varum of  $10^\circ$  from the simulation study results walking on one foot, it is enough to disrupt the growth of the physis



plate.<sup>27</sup> In this study, 13 patients (41%) with obese, and 11 patients (35%) started walking aged less than 12 months.

In the United States, the expanding rates of childhood obesity have shown a major health challenge. The incidence may escalate with this trend, although Blount disease is considered a rare illness. According to Klyce et al., the etiology of Blount's disease cannot be explained solely by one factor and tends to be multifactorial. Wide-ranging studies have associated income level with childhood obesity, also race. Therefore, understanding socioeconomic and racial inequalities that influence this disease is highly important in developing effective interventions to prevent Blount disease from the community's and surgeons' perspectives.<sup>28</sup>

According to Langenskiold's classification, six stages of progressive radiographic changes are seen in the early onset of Blount's disease. Patients with Langenskiold's stage II type often have a spontaneous correction, but sometimes it occurs in patients with stage IV. Difficulty distinguishing between normal physiologic tibial varus that resolves spontaneously and infantile (early-onset) Blount disease may occur. Bilateral abnormalities are common, especially in early-onset Blount disease.<sup>11</sup> Based on the study from Birch, this classification's weakness is the extremity's position, which can affect the appearance of the coronal plane on the radiographic image.<sup>29</sup> Moreover, according to Janoyer, these six Langenskiold levels have significant variability between observers, as well as limited relevance to non-white populations in North America and the Caribbean.<sup>8</sup>

In conservative therapy, treatment options include observation with repeat clinical and radiographic inquiry or the use of orthoses. According to Hensinger, patients aged 2-3.5 years with early stages (Langenskiold I and II) report significant and encouraging results with the use of orthoses. Risk factors that can occur in brace therapy are obesity, varus thrust, brace

treatment over three years, bilateral abnormalities, and may experience Langenskiold stage III or higher.<sup>30</sup>

The indications for operative treatment are when varus cannot be conservatively corrected, including the progressive type, the patient is more than three years old, advanced Langenskiold stage II and III, MDA > 14°, and TFA > 15°. Osteotomy performed in patients above four years with Langenskiold stages IV, V, and VI tends to increase the recurrence rate due to a decrease in healing on the physical (growth plate). The operative treatment is managed by varus correction and tibial de-rotation (Langenskiold stage II & III) with valgus over correction of 10° and de-rotation to obtain a thigh-foot angle (+10°). The varus condition in Langenskiold stages IV, V, and VI carried out double-level osteotomy, including valgus-derotation osteotomy and an epiphyseal-metaphyseal elevation osteotomy. Two ways of elevation osteotomy (medial plateau elevation) are transepiphyseal osteotomy on growth plates that are already closed and intra-epiphyseal osteotomy on growth plates that are not closed yet.<sup>12,31,32</sup> In the majority, the operative treatment conducted for patients less than four years old is more effective.<sup>30</sup> Research conducted by Janoyer found the recurrence rate after osteotomy can increase rapidly after the patient is four years old and is highest when the epiphysiodesis bridge is present at the time of surgery.<sup>8</sup> Osteotomy performed at the age above four years old will increase the recurrence rate due to decreasing the healing of the physis (growth plate).<sup>8,11</sup> Complications of surgery that can occur are compartment syndrome, delayed union, non-union, hardware failure, vascular injury, infection, peroneal nerve palsy, and recurrence.<sup>11</sup>

The limitation of the study includes the condition of medical records at the Polyclinic of Dr. Soetomo General Academic Hospital, where the long-term control status of the patients was not archived aptly. The records only



used a status book, were written manually, and then archived in the storage room. Hence, from the search results for the polyclinic status, 17 patients were found, and the status of 14 patients was not found. Additionally, some patients did not come after being asked for observation every six months and often did not comply, reflecting low patient and family compliance. The authors suggest that this research could be done over a long-time range with larger samples in many hospitals for better data. In addition, good documentation for each patient with genu varum is required for the initial examination and at the time of evaluation after therapy to assess the therapy outcome. Moreover, the physician should educate patients' parents better for routine observation.

## CONCLUSION

This study found 31 patients with genu varum in Dr. Soetomo General Academic Hospital from 2010 to 2018, including 25 Blount disease patients and six patients with physiologist genu varum. The patients consisted of 21 male patients (68%) and 10 female patients (32%). Of 25 patients with Blount disease based on age, 17 patients were infantile (early-onset) (68%), and eight patients were adolescent (late-onset) (32%). A total of 13 patients (28%) underwent operative treatment; meanwhile, 18 patients (72%) underwent conservative treatment. However, the prevalence in general society might be diverse.

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