Scientific Research Publishing

Open Journal of Pediatrics, 2025, 15(4), 601-613
https://www.scirp.org/journal/ojped
ISSN Online: 2160-8776
ISSN Print: 2160-8741

Staturo-Weight Growth at 12 Months in Macrosomic Newborns at the Mother and Child University Hospital Center Foundation Jeanne Ebori from 2022 to 2023

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How to cite this paper: Lembet Mikolo, A.M., Maniaga, R.K., Kama, E.M.M., Mekame, A., Grodet, A.M., Kiba, L., Koumba, A.M., Tsafack, J., Nzila, G., Loulouga, P., Mbadinga, I.B.B., Kamgaing, E.K. and Ategbo, S. (2025) Staturo-Weight Growth at 12 Months in Macrosomic Newborns at the Mother and Child University Hospital Center Foundation Jeanne Ebori from 2022 to 2023. *Open Journal of Pediatrics*, **15**, 601-613.
https://doi.org/10.4236/ojped.2025.154057

Received: June 1, 2025
Accepted: July 25, 2025
Published: July 28, 2025

Abstract

Introduction: Fetal macrosomia is a public health problem because of the significant morbidity and mortality it causes, particularly in sub-Saharan Africa. Objective: To evaluate the staturo-weight growth of macrosomic newborns in the short and medium term at the Foundation Jeanne Ebori mother-child university hospital (CHUME-FJE) in Libreville from 2022 to 2023. **Patients and methods:** This was a prospective, longitudinal, analytical cohort study conducted over a period of 18 months. Patients were included if they had a birth weight (BW) greater than the 90th percentile of the reference curves, regardless of term. Statistical analysis was performed using R software version 3.4. The significance threshold was defined as $p < 0.05$. **Results:** 100/1389 deliveries had a birth weight above the 90th percentile (frequency of 7.2%). The mean GA was 39.1 ± 1.8 SA with a sex ratio of 2.3 and a mean birth weight of 4081.5 g ± 391.2 g. From birth to 12 months, growth in stature, weight, staturo-weight and head circumference was normal. At 12 months, height was normal (100%), 35.0% of infants remained obese and 51.7% had macrocrania. **Conclusion:** Macrosomia is a public health problem. Much remains to be done to reduce the frequency of macrosomia and improve survival, particularly by raising awareness of the risks associated with obesity, diabetes and conception at an advanced age, and of the advantages of family planning, improving preg-

nancy monitoring and the quality of care.

Keywords

Macrosomia, Growth, Obesity, Newborn, Libreville

1. Introduction

Macrosomia is defined as a term birth weight greater than or equal to 4000 grams and/or a birth weight greater than the 90th percentile of reference curves [1] [2]. Fetal growth is a complex, multifactorial process involving genetic and environmental factors. In recent decades, there has been a marked increase in the frequency of macrosomia worldwide, ranging from 2.30% to 10.92% [3]-[12]. In Gabon, a study carried out at the CHU de Libreville (CHUL) found a prevalence of 3.85% [3]. It should be emphasized that prevalence may vary from one region to another within the same country. Macrosomia is a public health problem, due to the high morbidity and short- and long-term mortality it causes, for mothers, newborns and children alike, particularly in sub-Saharan Africa [1]-[3] [8]-[10] [13]. Today, there is a resurgence of non-communicable diseases (NCDs) such as hypertension, obesity and diabetes. Fetal macrosomia remains one of the risk factors for developing these conditions in adulthood [14]. In the light of these data, and with a view to achieving the Sustainable Development Goals by 2030, which in its objective number 3 aims to give every individual the means to lead a healthy life and to contribute to the well-being of all at all ages [15]. We proposed to carry out this study with the aim of contributing to the improvement of the care of macrosomic newborns in our structure. Specifically, the aim is to determine the prevalence of macrosomia and to describe the weight evolution of macrosomic newborns in the short and medium term at CHUME-FJE from 2022 to 2023.

2. Patients and Method

2.1. Study Design

This was a prospective, longitudinal, descriptive cohort study. It ran from 1 May 2022 to 03 June 2024, i.e., a period of two (2) years. The study took place in the municipality of Libreville with an estimated population of 703,939 and an area of 654.42 km^2 [16]. The study setting was the neonatal medicine department of the CHUME-FJE in Libreville. This is a level 3 hospital dedicated to maternal and child health. The study population consisted of all macrosomic newborns born at the CHUME-FJE during the study period. We included newborns with a birth weight (BW) greater than the 90th percentile of the reference curves whatever the term; patients for whom we obtained informed consent from the parents. We did not include stillbirths, neonates whose parents did not give consent, neonates with excess extracellular fluid (such as hydrocephalus and/or hydrops), neonates with

sacro-coccygeal malformations or tumours, or congenital neck cysts. Excluded neonates were those lost to follow-up and those whose parents withdrew after inclusion.

2.2. Source, Data Collection Technique, Sampling

Data were collected from delivery room registers, maternity ward medical records, neonatal medicine department medical records and outpatient clinic records. They were then collected on a pre-established standardised form completed during outpatient follow-up at regular intervals (1 month, 3 months, 6 months, 9 months, 12 months). Our sample size for statistically significant analysis (N = 57) was determined using the Schwartz formula with a prevalence of 3.85% [10]. The number of macrosomic newborns was 118. We included 100 newborns meeting the criteria. Of these, 60 patients were included in the study, 28 of whom refused to participate and 12 of whom were lost to follow-up. The excluded newborns (18) had malformations affecting weight.

2.3. Variables Studied

In the newborn: gestational age, sex, route of delivery, Apgar score, anthropometric parameters, feeding of the newborn, kinetics of changes in anthropometric parameters.

2.4. Managing Bias

To avoid bias and ensure the validity of our results, we used the following methodology. To avoid selection bias, each patient was recruited when birth weight was above the 90th percentile of the Lubschenco curves. To avoid information bias, patients were followed-up in the presence of the same paediatrician. Weight was measured using the same device (SOEHNLE brand). The same measuring tape was used to measure height, and the same tape measure was used to measure head circumference. Finally, to avoid confounding bias, we excluded from the study newborns with malformations (hydrocephalus, sacrococcygeal tumors, congenital neck cysts, hydrops, etc.). In fact, these anomalies will lead to an increase in weight, without true growth.

2.5. Conduct of the Study

The study began in the delivery room. After obtaining informed consent, the newborn was recruited as soon as the weight relative to the Lubchenco growth curve was above the 90th percentile. The variables were collected on a pre-established standardised form. After discharge from hospital, outpatient follow-up was carried out at regular intervals (1 month, 3 months, 6 months, 9 months, 12 months) in the presence of the outpatient paediatrician. It was based on a physical examination of the newborns, monitoring of the growth curve (control of anthropometric parameters: weight, head circumference, height), and the search for any pathologies occurring during growth.

2.6. Evaluation Method

During the follow-up, anthropometric measurements: height, weight and head circumference were taken in order to assess the weight and height development of the newborns in relation to their age. At each visit with the paediatrician, we measured weight using a baby scale (SOEHNLE), cranial perimeter using a tape measure, and height using a measuring tape. These various anthropometric parameters were then collected and projected onto growth curves using WHO Anthro software in order to compare each child with the norms for his or her age and sex [17]-[19]. The Z-score thresholds were chosen because they are the growth charts used in the department from 1 month of age for staturo-ponderal growth and the nutritional status of children.

2.7. Statistical Analysis

Statistical analysis was performed using R software version 3.4. Quantitative variables were expressed as mean and standard deviation, and qualitative variables as number and frequency. The various anthropometric parameters collected during follow-up were projected onto growth curves using WHO Anthro software in order to compare each child with the WHO norms for age and sex [17]-[19].

2.8. Ethical and Regulatory Aspects

We obtained all the necessary administrative authorisations to carry out our work at the centre. The informed consent of the parents had been obtained. Confidentiality and anonymity were respected throughout our work.

3. Results

During the study period, 1389 births were recorded, including 100 macrosomic newborns (frequency 7.2%). The mean GA was 39.1 SA ± 1.8 (median 39 SA; extremes 30 SA and 40 SA). The sex ratio was 2.3. Mean birth weight was 4081.5 g ± 391.2g (extremes 2600 g and 5230 g). The median was 4002 g (Q1 = 3900 g and Q3 = 4200 g. (**Table 1**). At birth, 13.3% (n = 8) were admitted to hospital and 86.7% (n = 52) were transferred to the maternity ward to be reunited with their mothers. All newborns were fed within the first hour after birth. Of these, 21.7% (n = 13) received breast milk. No deaths were recorded in this cohort.

3.1. Weight Growth as a Function of Age

At birth, 18.3% of newborns were obese. At 1 and 3 months, growth was normal in 80.0% and 78.3% respectively. At 3 and 6 months, overweight infants accounted for 20% and 31.7% respectively. At 9 months, the weight growth curve was declining (69.3%). At 9 and 12 months, infants remained obese at 28.3% and 23.3% respectively (**Table 2**). At the age of 12 months, the infants had a weight growth curve above the WHO reference curve (**Figure 1**).

Table 1. Characteristics of macrosomic newborns.

Characteristics of Newborns	Effective (n)	Percentage (%)
Gestational age		
<37 SA	2	3.3
≥37 SA	53	88.3
>41 SA+6j	5	8.4
Sex		
Masculine	42	70.0
Feminine	18	30.0
Birth weight		
<4000 g	20	33.3
4000 - 5000 g	39	65.0
>5000 g	1	1.7
Apgar to the 1st mn		
<7	5	8.3
≥7	55	91.7
Apgar to the 5th mn		
<7	1	1.7
≥7	59	98.3

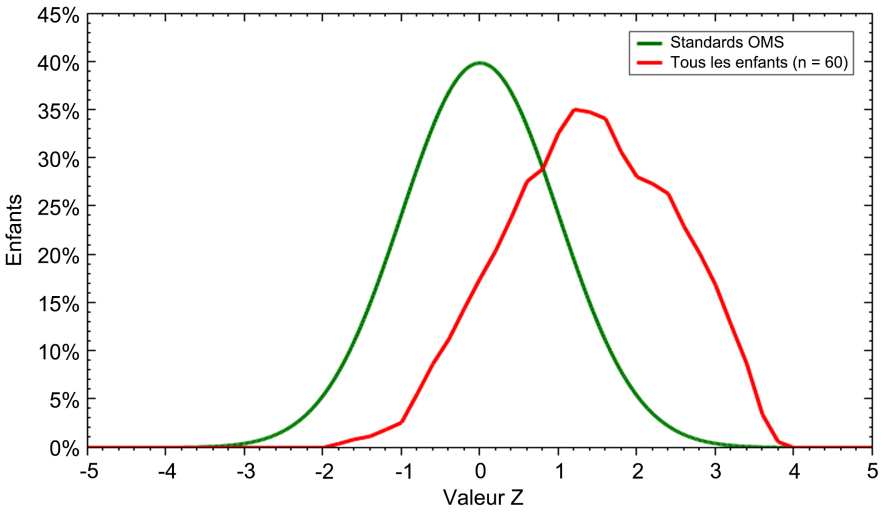

Figure 1. Weight evolution of newborns at the age of 12 months.

Table 2. Distribution of growth in height and weight and head circumference from birth to 12 months.

	0 month		1 month		3 months		6 months		9 months		12 months	
	N	%	N	%	N	%	N	%	N	%	N	%
Weight/Age												
>2 Z-score	11	18.3	12	20.0	12	20.0	19	31.7	17	28.3	14	23.3
>1 Z-score	42	70.0	23	38.3	14	23.3	10	16.7	21	35.0	26	43.3
Median	06	10.0	25	41.7	31	51.7	31	51.6	19	31.7	19	31.7
<−1 Z-score	01	01.7	00	00.0	02	03.3	00	00.0	02	03.3	01	01.7
<−2 Z-score	00	00.0	00	00.0	01	01.7	00	00.0	01	01.7	00	00.0
<−3 Z-score	00	00.0	00	00.0	00	00.0	00	00.0	00	00.0	00	00.0
Size/Age												
>2 Z-score	16	26.7	05	08.3	12	20.0	04	06.6	07	11.7	04	06.7
>1 Z-score	20	33.3	12	20.0	16	26.6	12	20.0	11	18.3	11	18.3
Median	24	40.0	40	66.7	27	45.0	26	43.3	26	43.3	44	73.3
<−1 Z-score	00	00.0	01	01.7	02	03.3	10	16.7	09	15.0	01	01.7
<−2 Z-score	00	00.0	02	03.3	03	05.0	07	11.7	06	10.0	00	00.0
<−3 Z-score	00	00.0	00	00.0	00	00.0	01	01.7	01	01.7	00	00.0
IMC/Age												
>2 Z-score	09	15.0	14	23.3	13	21.7	22	36.7	18	30.0	21	35.0
>1 Z-score	26	43.3	25	41.7	13	21.7	14	23.3	24	40.0	16	26.7
Median	22	36.7	20	33.3	30	50.0	24	40.0	15	25.0	20	33.3
<−1 Z-score	03	05.0	01	01.7	03	05.0	00	00.0	03	05.0	03	05.0
<−2 Z-score	00	00.0	00	00.0	00	00.0	00	00.0	00	00.0	00	00.0
<−3 Z-score	00	00.0	00	00.0	01	01.7	00	00.0	00	00.0	00	00.0
PC/Age												
>2 Z-score	12	20.0	25	41.6	21	35.0	36	60.0	26	43.3	31	51.7
>1 Z-score	23	38.3	18	30.0	17	28.3	11	18.3	13	21.7	13	21.7
Median	22	36.7	15	25.0	13	21.7	07	11.7	16	26.6	16	26.6
<−1 Z-score	02	03.3	01	01.7	00	00.0	01	01.7	01	01.7	00	00.0
<−2 Z-score	01	01.7	01	01.7	08	13.3	03	05.0	01	01.7	00	00.0
<−3 Z-score	00	00.0	00	00.0	01	01.7	02	03.3	03	05.0	00	00.0

3.2. Distribution of Statural Growth by Age

From birth to 12 months, infants showed normal statural growth. At 3, 6 and 9 months of age, stunted statural growth was observed in 5.0% (n = 3), 13.4% (n = 8) and 11.7% (n = 8) respectively (Table 2). At 12 months, statural growth was normal (Figure 2).

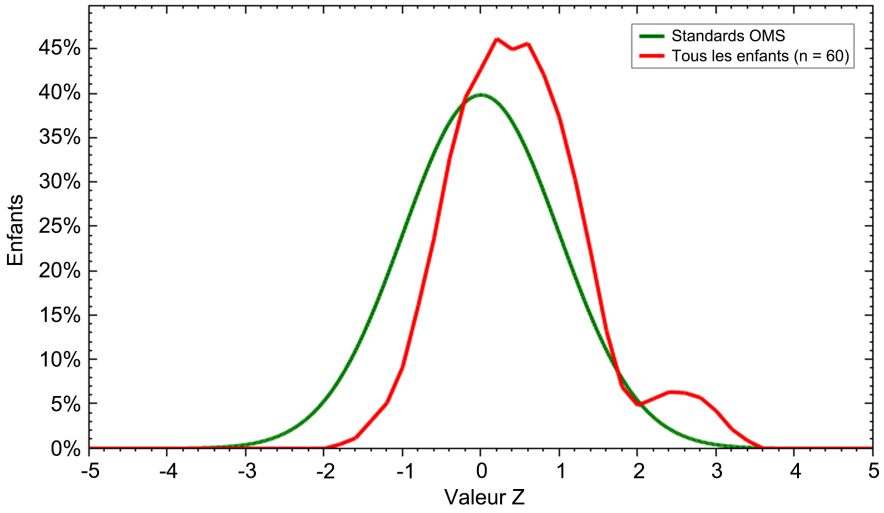

Figure 2. Growth in height of newborns at the age of 12 months.

3.3. Growth in Height and Weight (BMI)

At birth and at 1 month, the newborns were obese (15.0% and 23.3%). At 3, 6 and 9 months of age, staturo-weight growth was normal (76.7%, 63.3% and 65.0% respectively). Obesity was found in 21.7%, 36.7% and 30.0% of cases respectively. At 9 and 12 months, an increase in staturo-weight growth was observed, with a mean z-score of 1.5 ± 1.6 (median 1.5) and 2.2 ± 1.2 (median 2.1) respectively (Table 2). At 12 months, 35.0% of infants remained obese (Figure 3).

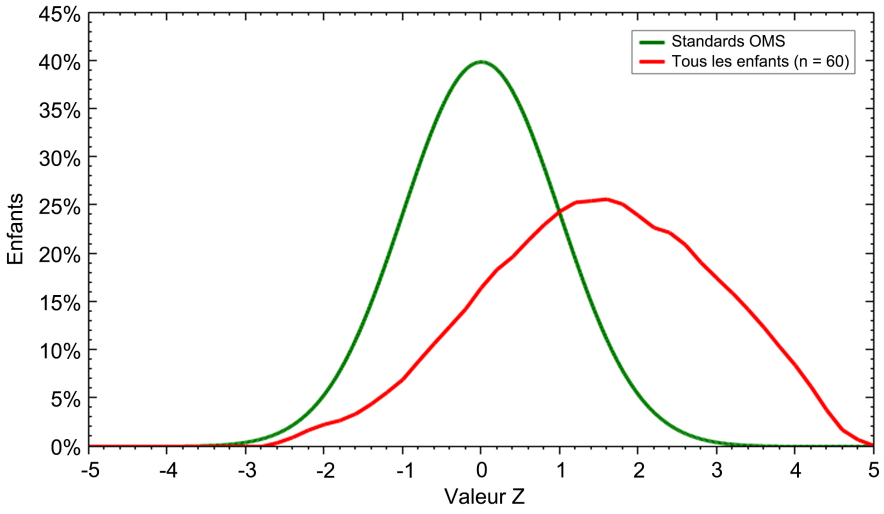

Figure 3. Growth in height and weight at 12 months.

3.4. Distribution of Head Circumference Growth

From birth to 12 months, infants had normal head circumference growth (78.3% and 50%). Macrocrania was observed in 20.0% and 41.5%. At 3 months of age, 15.0% (n = 9) had delayed head circumference growth, with catch-up at 12 months (Table 2) (Figure 4).

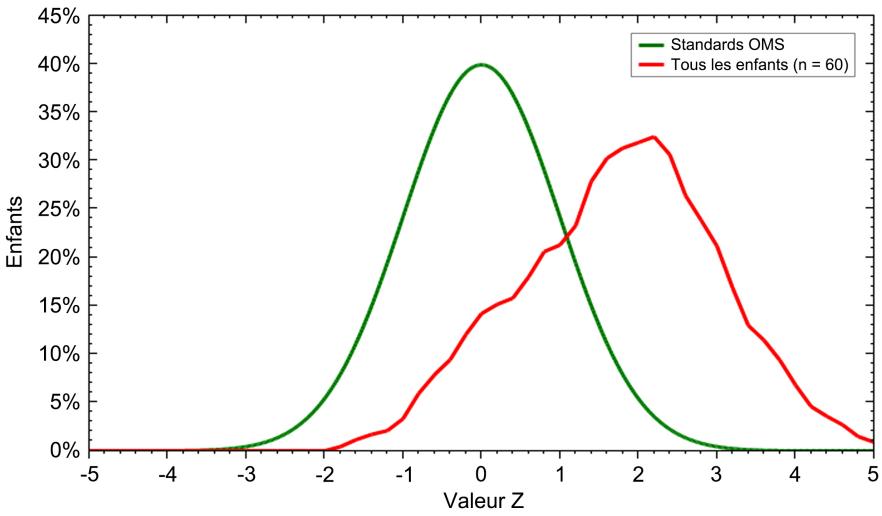

Figure 4. Growth of head circumference at 12 months.

4. Discussion

4.1. Limitations

A number of biases need to be taken into account when validating the results obtained, so as to be cautious in interpreting them: not all eligible patients were included, although the participation rate was 60%; the monocentric nature of the study; low parental participation in the study (28 refusals). However, this study, although hospital-based, has the advantage of being carried out in a referral hospital dedicated to the care of children of all ages.

4.2. Prevalence

The hospital prevalence of macrosomia was 7.2%. This incidence is corroborated by most of the data in the literature, which varies between 4 and 10.0% [1]. This result is lower than that found by Ridha *et al.* in Tunisia (10.9%) and Bakkali *et al.* in Morocco (14.3%) [2] [8]. It is comparable to that found by Usta et al in Turkey (8.6%) [6]. This rate remains higher than that found in Gabon (3.89%), the DRC (5.7%) and Guinea-Conakry (5.8%) [1] [3] [13]. This difference may be explained by the type of methodology used and the level of health structure. The high rates in the Maghreb could be explained by the socio-demographic nature of this region. Indeed, the incidence of foetal macrosomia varies from one region to another and within the same region according to ethnic origin, race and environmental factors [3]. North Africa is one of the regions with the largest increase in the number of diabetic patients, mainly type 2 [20]. According to the International

Diabetes Federation (IDF), projections for 2045 put the incidence of diabetes in North Africa at 110% [21].

4.3. General Characteristics of Macrosomic Newborns

The mean gestational age was 39.1 ± 1.8 SA. This result is comparable to that of Usta *et al.* (39.2 ± 1.5) and Ridha *et al.* (40.2) [6] [8]. Macrosomic newborns were born at term (88.3%) and post term (8.4%). This result differs from that reported in the literature. Most authors find a positive correlation between gestational age and fetal macrosomia [1] [3] [22]. Fetal macrosomia is thought to favour prolongation of term through fetal-pelvic disproportion. It thus disturbs the spontaneous onset of labour by modifying the mechanical components [3].

The sex ratio is 2.3. As shown in most studies, there is a clear predominance of males [1] [3] [13] [23]. Male sex has been described as a risk factor for macrosomia [9] [24] [25]. However, no argument has yet been put forward to explain this trend. On the other hand, studies have shown that male sex is a predictor of macrosomia [1] [6].

The mean birth weight was 4081.5 g ± 391.2 g. This mean birth weight is lower than that found by Yao *et al.* in France, Camara et al in Mali, Diallo et al in Guinea Conakry, and Luhete *et al.* in the Democratic Republic of Congo, who reported respectively 4249.8 g; 4557.5 g; 4255 g and 4207.3 ± 297.8 [1] [5] [13] [23]. This difference may be linked to the inclusion criteria. In our study, we included all newborns with a birth weight greater than the 90th percentile of the reference curves. In the study carried out by the aforementioned authors, the inclusion criterion was any newborn with a birth weight greater than or equal to 4000 g. The incidence of macrosomia is reported differently according to racial, ethnic and regional differences [13].

4.4. Changes in Anthropometric Parameters in Our Study Population

In our study, weight and statural growth and head circumference were assessed progressively from birth to 12 months.

- **Growth in height and weight**

Fetal macrosomia predisposes to childhood obesity. The metabolic and cardiovascular risk of this obesity is debated [26]. Macrosomia occurring in the context of maternal diabetes exposes the baby to a significantly high risk of developing early metabolic syndrome. This metabolic syndrome predisposes to cardiovascular disease in adulthood and implies the development of precursor signs of these diseases in childhood or adolescence [14]. In the Sustainable Development Goals adopted by the United Nations General Assembly in 2015, the fight against non-communicable diseases is considered to be one of the health challenges for the 2030 Agenda for Sustainable Development [27] [28]. Among the risk factors for non-communicable diseases, overweight and obesity are of particular concern and could jeopardise many of the health gains that have contributed to longer life ex-

pectancy [28]. The Global Action Plan on No communicable Diseases 2013-2020 calls for a halt to the increase in adolescent obesity. The comprehensive implementation plan for maternal, newborn and young child nutrition sets a target of no increase in the percentage of overweight children by 2025 [28]. Several factors may be involved in childhood obesity:

- **The concept of 1000 1st days**

This is the period from conception (270 days) to two years of life (730 days). Over thirty years ago, Barker, a British epidemiologist, showed that undernutrition during pregnancy was the cause of low birth weight and increased the risk of myocardial infarction in adulthood. Following Barker's work, a number of researchers have confirmed that the environment to which the embryo, foetus and newborn are exposed influences the onset of certain chronic diseases in adulthood, such as obesity, diabetes and high blood pressure. These studies are now grouped under the concept of DOHaD (Developmental Origins of Health and Diseases) [29] [30]. In the case of foetal macrosomia, early exposure to high concentrations of insulin and leptin leads to excessive weight gain. Diabetes, obesity and excessive gestational weight gain can "programme" trajectories of adiposity and metabolic health throughout life [30]. It is now well accepted that the first years of life are decisive for long-term health. In particular, nutritional intake during this critical period of development (the first 1000 days) appears to have long-term effects on the health of future adults [26].

- **Adiposity rebound**

On average, BMI increases rapidly in the first year of life. It then falls, reaching a minimum around the age of 6, before rising again steadily until the end of growth. The point at which BMI reaches its minimum value before a second increase is called the 'adiposity rebound'. A large number of studies that have examined the predictive value of adiposity rebound have shown that an early rebound is associated with subsequent overweight [31]. On average, the rebound occurs around the age of 6, but individual trajectories show that it may occur earlier or later [32]. Most children who are overweight at the start of life will return to the average after a late rebound (after the age of 6), while others will remain fat after an early rebound [32]. The age at which adiposity rebounds is much earlier in the obese, suggesting the influence of early intervening factors [32].

This justifies the importance of monitoring macrosomic infants. Indeed, the 35.0% of infants in our study who were obese at 1 year of age need to be monitored regularly in order to prevent long-term complications.

5. Conclusion

The delivery of a macrosomic newborn is at high risk for both the mother and the fetus. Macrosomia represents a risk factor for the onset of obesity in children and adults. The prevalence of macrosomic newborn delivery is not negligible (7.2%). At 12 months, 35.0% of infants remained obese. Obese infants are at greater risk of remaining so in adulthood and developing non-communicable diseases (diabe-

tes, hypertension, obesity). It is imperative to emphasize strategies aimed at combating these diseases.

Acknowledgements

We thank Dr. Tsafack Jules for the trust granted to carry out this work.

Contributions to Authors

All authors contributed to this work, from conception to the writing of the final article.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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