BREASTFEEDING AND GROWTH OF HEALTHY INFANTS FOLLOWED FROM BIRTH TO 18 MONTHS

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ABSTRACT

Optimal nutrition and regular growth assessment are essential components of healthcare for all children in order to detect early problems related to their nutritional status before they are seriously compromised. The objective of our study was to describe the feeding and growth of healthy breastfeeding infants (0-18 months) in North East of Algeria. A prospective and descriptive study of the observational type was conducted, in the service of maternal and child protection at the public health establishment of Skikda (Algeria). The population constituted mothers and their infants (1-3 months) who presented for the first or second immunization visit and were followed up to 18 months. Data were collected by interviewing mothers using an adapted WHO (2004) questionnaire according to visits of the Algerian vaccination calendar (1st, 3rd, 4th, 5th, 9th and 18th months). Children were monitored for breastfeeding, complementary feeding and growth. Monitoring growth from birth (1, 3, 4, 5, 9 and 18 months) was done by taking anthropometric measurements (weight, height and head circumference), the evaluation of motor development and the calculation of anthropometric growth indices according to WHO standards (2006, 2007): weight/age (W/A), height/age (H/A), weight/height (W/H), body mass index/age (BMI/A) and head circumference/age (HC/A). A total of 159 infants were enrolled, including 83 (52.2%) girls, giving a sex ratio of 0.92. From 1 to 5 months, exclusive and predominant breastfeeding did not differ by sex ($p>0.05$). Exclusive breastfeeding was observed in 15.7% of infants at the first month versus 7.5% at 5 months. Predominant breastfeeding increased from 84.3% in the first month to 92.5% at 5 months, while complementary feeding started from four months. All mothers continued partial breastfeeding for up to one year. All children had normal motor development. Weight status (4-18 months) did not differ by sex ($p>0.05$). At the end of the study, 5.8% of the infants showed body wasting, lean (4.8%), stunted (2.7%) while 83.8% were within the normal weight range. To improve the nutritional status of Algerian infants, the promotion of exclusive breastfeeding and management of their diet is necessary by provision of a diversified complementary diet, which includes all macro and micronutrients, meets all energy and nutritional needs and teaches them good eating habits and behaviors.

Key words: Infants, breastfeeding, weight, height, BMI, monitoring, growth, complementary feeding, Algeria

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INTRODUCTION

The World Health Organization (WHO) recommends exclusive breastfeeding (EBF) for the first 6 months of life and partial breastfeeding (PBF) for up to 2 years [1]. Beyond 6 months, breast milk is insufficient to cover the infant's needs. Dietary diversification is the transition from exclusive milk diet to a diversified diet [2]. Worldwide, 95% of infants received breastfeeding with great variability in duration [3]. From 1990 to 2004, EBF increased from 15% to 30% in sub-Saharan Africa, and from 4% to 20% in Western and Central Africa [4]. Despite this upward trend, EBF remains low and represents a public health priority in several countries of the world [5]. In Algeria, 26% of infants younger than six months follow the EBF advice, though it is more practiced in the North-east (38%) than in the center of the Highlands (11%) [6]. The new growth and development standards for infants [7] are based on breastfeeding as the biological norm and on the breastfed infant. They help advocate for the protection and promotion of breastfeeding and complementary feeding (CF) [8]. During visits, growth monitoring consists of measuring weight, height, head circumference and correctly interpreting the profile [9]. The assessment of growth and development is done based on nutritional status resulting from the balance between food consumption and its use by the body [10]. The nutritional status of children reflects their general state of health. When children have access to adequate food, they reach their growth potential and are considered well nourished [6]. Malnutrition is one of the health problems in Africa [11]. In Algeria, boys (13%) seem more likely than girls (11%) to experience stunted growth. Infants under 6 months of age registered body mass wasting (13%) and underweight (7%). Overweight (18%) affects those aged one year and older [6]. However, in Algeria, studies of young children have been cross-cutting. Longitudinal monitoring of infant weight, growth, diet and nutritional status of infants has not been studied. In order to manage this problem, a prospective descriptive study was conducted whose objective was to describe the dietary profile and growth of a model population of healthy Algerian infants, based on WHO feeding recommendations (2004), and followed from birth to 18 months in the city of Skikda. This model population had optimal nutrition (breastfeeding, complementary feeding), lived in an optimal environment (appropriate hygienic conditions, environment favorable to growth) and had optimal health prevention (immunization, pediatric routines).

MATERIALS AND METHODS

This was an observational type of descriptive prospective study over 3 years (2014-2017).

It was conducted in the Maternal and Infant Protection (MIP) unit of Public Health Establishment of Proximity in Skikda. The sample consisted of mothers and their infants (1-3 months) who presented for the 1st or 2nd vaccination visit. The survey was conducted according to visits of the Algerian vaccination calendar at 1st, 3rd, 4th, 5th, 9th and 18th months [12]. The sample was random but the mother-infant pairs included in the study had to meet the following inclusion criteria [13]: consent of the mother to participate; compliance with recommendations for breastfeeding and CF: EBF or predominant breastfeeding (water, herbal teas) for 4 months and continuation of the PBF for at least 1

year; residence in Skikda; single birth; absence of morbidity; gestational age between 37 and 42 weeks of amenorrhea (WA); medium or high socio-economic level; complete follow-up of the infant in the same MIP; full contact details. The adapted WHO questionnaire [13] was used and the mothers were interviewed. The data collected concerned infant health, diet and growth. Concerning the mother, information on the obstetric-gynecological history and the difficulties encountered during breastfeeding were recorded. Anthropometric measurements were performed according to WHO standards [14]. The weight (W, g from 0- 9 months) was measured using a SECA baby weighing scale (reach 15kg, accuracy 100g) and at 18 months (SECA, reach 25kg, precision 100g). The height (H, cm) in the supine position [15] was measured with a horizontal board (length 150cm, graduation and accuracy 1 mm) and the head circumference (HC, cm) with a non-elastic flexible measuring tape (length 150cm, graduation, accuracy 1 mm). Birth measurements were taken from the health records. The current Weight and Height of mothers were registered following their declarations.
Data Analysis

Data were entered and processed using the Excel 2007 spreadsheet. The socio-economic status was defined by the calculation of the Living Standard Score (LSS) [16]. The mothers' ages were classified into 4 classes [17] and their body mass index (BMI) [14] was calculated. Gestational age was determined from the dates of the last menstruation and up to delivery. Our results were presented according to the dates of vaccination. Birth weight (BW) was classified into 3 categories: $\geq$ 2500g = normal, <2500g = hypotrophy and $\geq$ 4000g = hypertrophy [18]. Anthropometric indices such as weight/age (W/A), height/age (H/A), weight/height (W/H), body mass index/age (BMI/A) and head circumference/age (HC/A) were calculated using the Anthro software version 3.2.2 [19] and expressed in standard deviation score (SD). Prevalences (underweight, stunting, wasting, leanness, overweight and microcephaly) were calculated [20, 21]. Comparisons and differences were made using tests (Chi-2, Student, Fisher) with software R [22] version 3.4.1 at the significance level of 5%.

Ethical aspects
In order to obtain verbal consent for the mother to participate, we explained the purpose of the study to her and clarified that her refusal to participate did not result in any measures with regard to the vaccination of the infant.

The mother must commit and follow our recommendations regarding breastfeeding until the end of her participation. The data were collected and analyzed anonymously.

RESULTS AND DISCUSSION

Description of the study population
Infants
A total of 159 infants, including 83 (52.2%) girls, were all breastfed for up to a year. The sex ratio was 0.92. Mean gestational age was 39.2±1.2 WA. No infants were hypotrophic and 13.8% were hypertrophic.

Boys had a higher weight and stature ($p<10^{-3}$) for up to 3 months. The boys'HC was higher (1, 3 months) ($p<10^{-3}$). BMI was not related to sex except at 3 months, where that of girls was lower ($p<10^{-3}$) (Table 1).

The study described feeding and growth of infants (0-18 months). They were healthy, breastfed, full-term and had a normal BW in general [23].

Mothers
The average age was 32.6±5.2 years with a minimum of 17 years and a maximum of 47 years. The age class (30-40 years) was more predominant. Sixty mothers (37.7%) had caesarean section, 12% were primiparous and 36.5% had an obstetrical history. Sixtyfour of the mothers (40.3%) had a higher level of education; 1.9% were illiterate; 33.3% worked.

They came from a medium (76.1%) or high (23.9%) living standard score households. Their mean of W, H and BMI were 73.7±11.8kg; 1.6±0.05m and 28±4.5kg/m^2, respectively (Table 2).

Description of the diet
Types of breastfeeding (0-5 months)
At one month, predominant breastfeeding was common in 134 infants (84.3%) while 25 (15.7%) had EBF. At 5 months EBF was continued by 12 infants only since birth (7.5%). Mothers'ages appeared to be related to EBF (0-5 months). Mothers who breastfed more frequently were older mothers. Older women were breastfeeding more than others and longer in time (months) ($p<10^{-3}$). The duration of EBF was significantly longer for several months in older women.

Mother's level of education, parity and gender were not determinative ($p>0.05$) (Table 3). Mothers respected the recommendations of breastfeeding [7] for its benefits on the health of the child and the mother [5].

Infants should have EBF during the first 6 months for optimal development [1]. The Algerian study Multiple Indicator Cluster Survey (MICS) [6] showed that 26% of children (<6 months) had EBF and 18.3% had an average of 7 days according to Aouichat [24]. According to the EPIFANE study [25], 35% of infants (1 month) had EBF, this rate dropped to 5% at 4 months.

The positive influence of the mother's age on the choice of EBF was a frequent finding in the literature [26]. The ELFE study [27] concluded that older mothers were breastfeeding more.

There was no significant relationship between maternal education, parity, and choice of breastfeeding method ($p>0.05$). The educational level of the mothers in the study and parity did not determine the choice of EBF and its continuation, which is similar to the results reported by Kadi*et al.* [28]. Some Studies have concluded that primiparous

women breastfeed more often [29], others showed that breastfeeding will be extended especially since the mother has been multiparous [30].

Introduction of complementary feeding

In total, 16.1% of infants started complementary feeding (CF) at 4 months and 22.7% at 5 months with no significant difference by sex (*p*>0.05).

The Living Standard Score (LSS), age, education, and profession of the mother were not related to the age of introduction of CF (*p*>0.05).

At 4 months, 105 (66.0%) of the infants consumed infant flour, 86 (54.0%) little swiss cheese, 25 (16.0%) infant milk, 22 (14.0%) vegetables, while 16 (10.0%) ate cheese. At 5 months, 29 (18.1%) and 4 (2.8%) consumed meat products and eggs, respectively. According to a WHO study [13], CF in infants started at 4 months, LSS did not influence the age of introduction of CF (p> 0.05) whereas Vilain*et al*. [31] showed its positive effect.

Continuation of partial breastfeeding

All infants were breastfed up to one year and 123 (77.4%) mothers continued breastfeeding for up to 18 months (Fig.1). The cessation of PBF after one year was practiced by 36 (22.6%) mothers while 10 (27.8%) were due to the occurrence of a new pregnancy.

Women that had caesarean delivery (37.7%) and those with other obstetrical history (36.5%) continued PBF at one year. Breast pain was cited as the most common difficulty by 112 (70.4%) of the women.
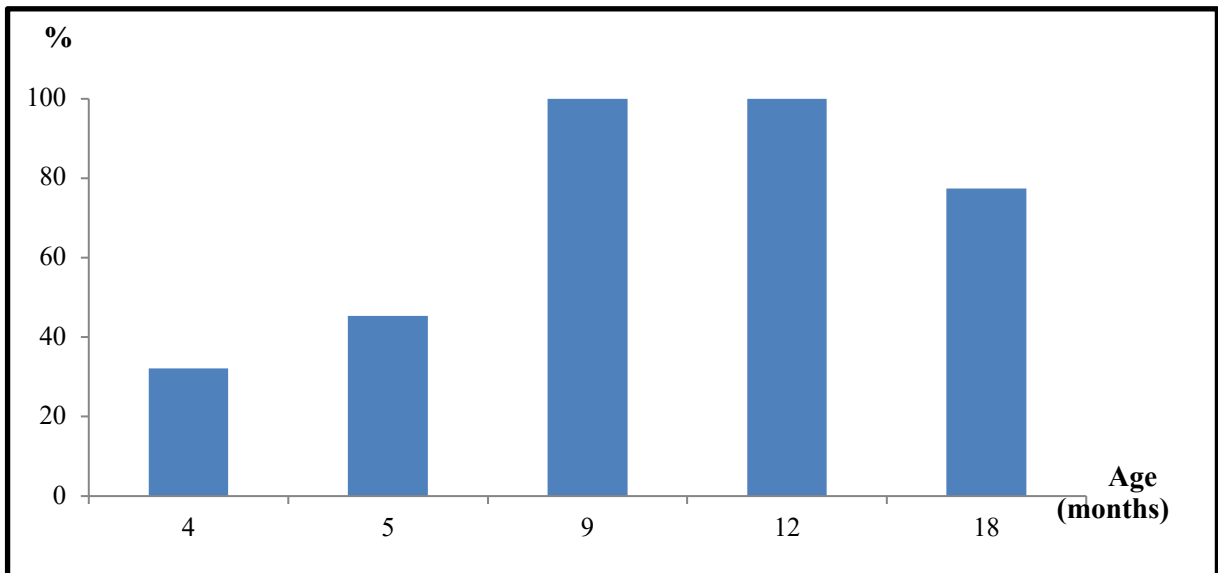

Figure 1: Distribution of breastfed infants 4 to 18 months

Studies have shown that cesarean delivery is a significant weaning factor [29] and our result showed that all women in this category (37.7%) continued PBF for one year.

Description of Growth
Motor development
All stages of general infant motor development were completed:

At 5 months: sitting alone (34%), hands and knees crawling (4.4%), standing and walking with help (1.9%);

At 9 months: sitting alone (99.4%), hands and knees crawling (79.9%), standing with help (66.7%), walking with help (45.3%), standing up (6.3%) and walking alone (3.1%); At 18 months: all the infants were seated, walked, spoke their first words and wanted to eat alone.

Anthropometry
During the follow-up, the mean values of the Z-scores of boys and girls were respectively:
W/A = 0.50 ± 1.14 vs. 0.78 ± 0.99 ($p<10^{-3}$);
H/A = 0.68 ± 1.43 vs. 1.02 ± 1.49 ($p<10^{-3}$);
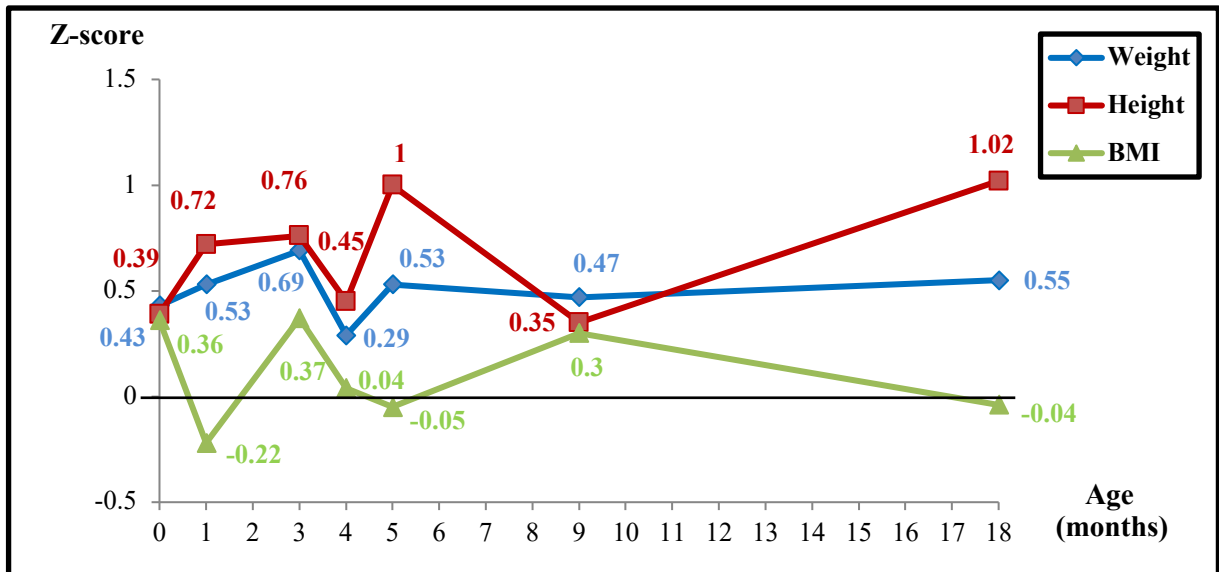BMI/A = 0.16 ± 1.37 vs. 0.30 ± 1.25 ($p>0.05$).

The values of W, H and BMI by age and sex were compared with the WHO (2006) growth standards (Fig. 2).
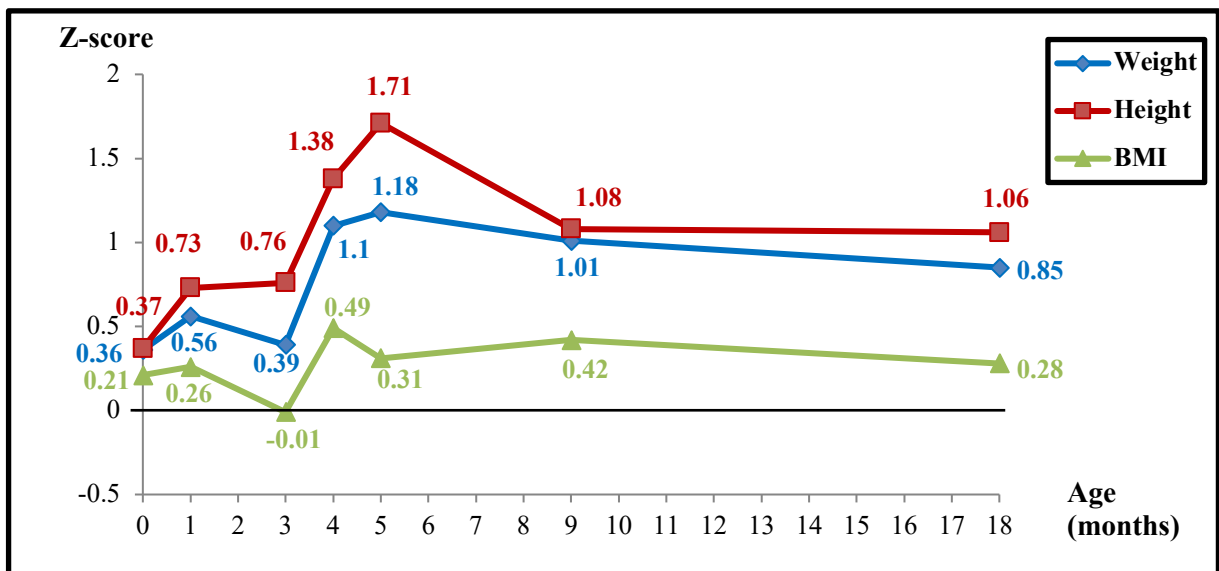
For boys, the values of W and H varied with positive Z-scores and reached a maximum of +0.69 SD (W) at 3 months and +1.02 SD (H) at 18 months. The average Z-scores of BMI were close to the standards (0-18 months).

For girls, W and H increased from 3 to 5 months with maximum Z-scores, respectively of +1.18 SD and +1.71 SD, which then decreased gradually after 5 months. The average values of BMI Z-scores were also close to the standards.

Microcephaly involved 4 (2.5%) infants at 3 months and 5 (3.1%) at 9 months, while a severe case affected 1 infant (0.6%) (1st and 4th month).

a- Boys

b- Girls

Figure 2: Mean W, H and BMI Z-scores of infants 0 to 18 months compared to WHO standards (2006)

Nutritional status

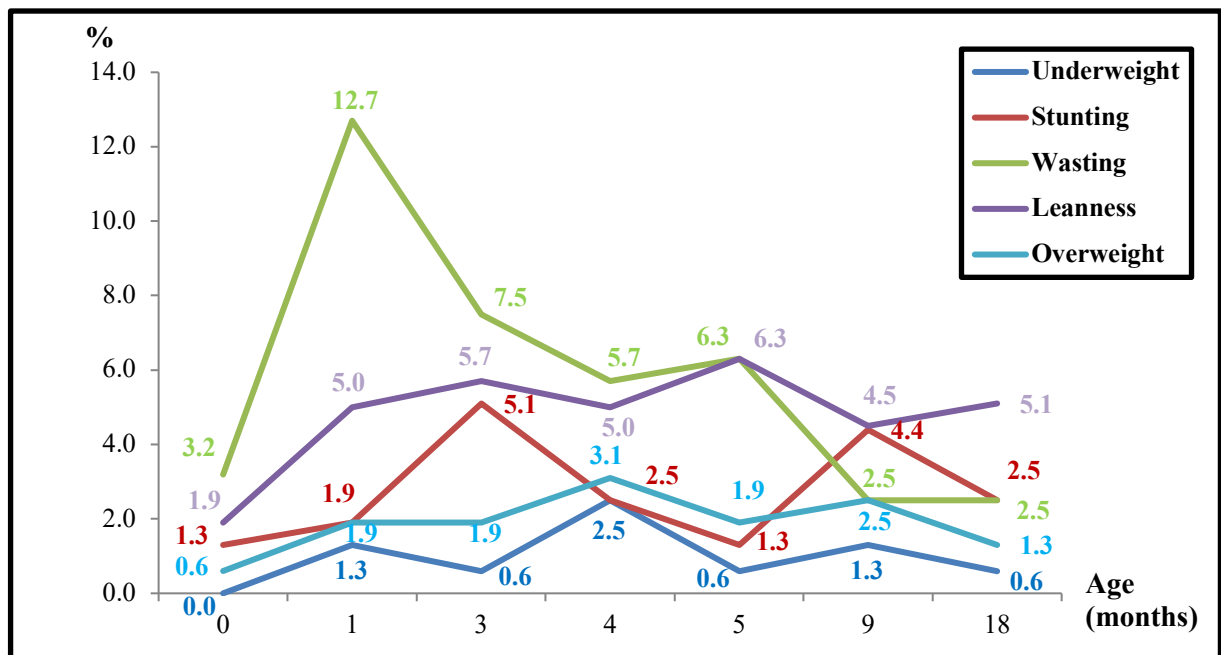The proportion of malnutrition (WHO, 2006) was presented in Figure 3.

Figure 3: Malnutrition (WHO, 2006) of infants by age

Infants 0-5 months
In this age group, a total of 82.8% of infants were of normal weight, 7.1% had body wasting, 4.8% were lean and 3.1% overweight at 4 months with no significant difference by sex ($p>0.05$). The nutritional status was not different ($p>0.05$) whatever the type of breastfeeding or the age of introduction of CF.

Infants 9-18 months
In this age group, a total of 86.4% of infants were of normal weight, lean (4.8%), stunted (3.5%), wasted (2.5%) and 2.5% overweight at 9 months with no significant difference by sex ($p>0.05$).

Growth standards can be used to monitor nutritional status and alert practitioners and decision makers to adverse nutritional developments, as several authors have pointed out [7]. They make it possible to detect the double burden of malnutrition [9].

During our follow-up, infants had low rates of prevalence of under nutrition before the first six months compared to studies. The prevalence of stunting was estimated at 2.4% compared to 10% according to the Algerian MICS study [6] and 12.2% in Morocco [32]. This low statural delay could be due to simple aspects: small family heights or constitutional and small heights secondary to a small birth height [33].

We found a dominance of body wasting, which represented 7.1%. The Algerian MICS study [6] suggested that the North East of Algeria has the highest rate of body wasting with a percentage of 6%, which is similar and confirms our result.

Overweight at 4 months (3.1%) could be attributed to stunting in parallel at 3 months (5.1%).

The overweight (1.9%) was very low for the 0-5 and 9-18 months, while it was 18% in north western Algeria [6].

At 18 months, 83.8% of the infants in the study were of normal weight. Those who practiced EBF for 4 months had a lower weight gain than those who were bottle-fed [34]. This may be due also to prolonged breastfeeding (77.4% at 18 months) whose preventive effect on childhood obesity is often cited [35]. The infants had a satisfactory nutritional status; this can be explained by the choice of the sample and the protocol of the study [7].

CONCLUSION

At the beginning, the study involved a sample of healthy Algerian infants who complied with the WHO (2004) feeding recommendations for breastfeeding and complementary feeding followed up from birth to 18 months. This longitudinal study made it finally possible to give an overview of the nutritional situation that healthy Algerian infants followed from birth to 18 months. We were able to describe their nutritional and growth profiles.

Our results showed a decrease in the rate and duration of exclusive breastfeeding (7.5% only up to 5 months) as well as a satisfactory nutritional status as that of the reference population (WHO, 2006). During the follow-up of our infant population from 0 to 18 months, we noted at the end of study that 83.8% of infants had normal weight while 13.3% suffered from under nutrition. This is mainly due to a predominance of wasting (5.8%), leanness (4.8%) and stunting (2.7%). The overweight existed slightly at 4 months (3.1%) and at 9 months (2.5%), which will have, during this phase of life, repercussions on the adult state. It is, therefore, essential that the health services concerned implement the means necessary to prevent this nutritional state and reduce its prevalence. Parents'awareness of the benefits of exclusive breastfeeding should continue. It is also important to properly identify all the determinants of its continuation for up to six months and the risk factors of its early cessation, in order to be able to intervene and propose effective strategies to promote it. Parents should be encouraged to continue partial breastfeeding for up to two years. Strictly, more regular surveillance should be imposed during growth monitoring (especially outside vaccination visits) and sensitization of parents will be necessary during growth monitoring to quickly detect and act instantly on the various problems encountered at different ages.

Health professionals and parents must collaborate before the nutritional status or health of the child is seriously compromised on the one hand, and on the other hand, in order to make appropriate decisions to control the scourge of malnutrition in younger children.
The children have optimal growth and normal motor development, which shows the interest of mothers in their children in breastfeeding and overall feeding.

A detailed study is necessary to quantitatively and qualitatively assess the daily food intake of these children and see if they meet all their energy and nutritional needs, by comparing it to standard nutritional recommendations.

CONFLICT OF INTEREST
The authors have no conflicts of interest.

Table 1: Anthropometric characteristics of infants by sex

Age (months)	Weight (g) Mean ± SD (min- max)		Height (cm) Mean ± SD (min- max)		Body Mass Index (kg/m^2) Mean ± SD (min- max)		Head Circumference (cm) Mean ± SD (min- max)	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
0	**3576.6±410.9***	**3411.8±413.5***	**50.6±1.5***	**49.8±1.6***	13.9±1.2	13.7±1.4	35.3±1.4	35±1.2
	(2500-4650)	(2600-4300)	(47-55)	(44-54)	(10-16.4)	(10.8-19.6)	(32-39)	(32-39)
1	**4817.1±632.4***	**4522.9±499.1***	**56.1±2.3***	**55±2.8***	15.3±1.7	15±1.9	**38.1±1.5***	**37.6±1.6***
	(3000-6700)	(3300-5500)	(50-61)	(49-62)	(11.9-20)	(9.1-20)	(32-41)	(34-47)
3	**6950±833.7***	**6170.5±685.1***	**63.1±3.4***	**61.4±2.9***	**17.5±2.2***	**16.4±1.8***	**41.3±1.5***	**40.2±1.1***
	(4200-9000)	(4700-8000)	(54-74)	(55-70)	(12.3-22.1)	(12.6-20.3)	(38-45)	(38-42)
4	7300.5±1078.9	7426.5±912.5	64.8±3.2	65.1±3.3	17.4±2.2	17.6±2.1	42.1±1.5	42±1.5
	(5000-10000)	(5700-10000)	(57-73)	(58-75)	(11.8-24.4)	(13.1-23.8)	(39-47)	(39-47)
5	8028.9±1099.1	8049.4±1066	68±3.3	68±3.7	17.4±2.2	17.4±2.1	43.1±1.5	43.2±1.5
	(5500-11000)	(6100-10800)	(60-76)	(60-79)	(13.3-23)	(12-23.2)	(40-48)	(40-48)
9	9450±1284.8	9403.6±1169	72.8±3.7	73±3.6	17.9±2.5	17.7±2.1	45.3±1.8	45.2±1.7
	(7100-12600)	(7200-13000)	(64-81)	(64-82)	(12.6-27.3)	(14.1-26.5)	(42-50)	(41-50)
18**	11.716±14.153	11.492±14.148	85±3.9	83.8±4.9	16.2±1.5	16.5±2.6	48±1.6	47.6±1.6
	(8.500-15.500)	(8.200-15.800)	(45-95)	(65-93)	(13.1-19.8)	(11.9-32.4)	(45-84)	(44-51)

*: $p<0.05$ (significant difference by sex)

**: Weight in kg

Table 2: Socio-demographic characteristics of mothers

Age classes	N	(%)
≤ 20	01	0.6
[21 – 30 [	45	28.3
[30 – 40 [	97	61.0
≥40	16	10.1
Parity		
Primipare	19	12.0
Multiparous	140	88.0
Two children	54	34.0
Three children	38	24.0
Four children and more	48	30.0
Level of education		
Illiterate	03	1.9
Primary	07	4.4
Middle	41	25.8
Secondary	44	27.6
Higher	64	40.3
Profession		
Employed	53	33.3
Unemployed	106	66.7
LSS		
Medium	121	76.1
High	38	23.9
Mode of delivery		
Low way	99	62.3
Caesarean	60	37.7

Table 3: Distribution of infants (1-5 months) by type of breastfeeding

Age (months)	Exclusive breastfeeding			Predominant breastfeeding		
	Boys n (%)	Girls n (%)	Total n (%)	Boys n (%)	Girls n (%)	Total n (%)
1	10 (13.2)	15 (18.1)	25 (15.7)	66 (86.8)	68 (81.9)	134 (84.3)
3	8 (10.5)	16 (19.3)	24 (15.1)	68 (89.5)	67 (80.7)	135 (84.9)
4	7 (9.2)	11 (13.3)	18 (11.3)	69 (90.8)	72 (86.7)	141 (88.7)
5	5 (6.6)	7 (8.4)	12 (7.5)	71 (93.4)	76 (91.6)	147 (92.5)
1 - 5	30* (9.9)	49* (16.8)	79 (12.4)	274* (90.1)	283* (85.2)	557 (87.6)

*: $p > 0.05$ (not significant difference by sex)

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