

Nutritional status of breastfed infants in rural Zambia: comparison of the National Center for Health Statistics growth reference versus the WHO 12-month breastfed pooled data set

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Cross-sectional data for breastfed infants in rural Zambia were used to evaluate the effect of applying two different data sets as a reference, i.e. the WHO 12-month breastfed pooled data set and the National Center for Health Statistics (NCHS) growth reference in terms of prevalence of malnutrition (stunting, underweight, and wasting). A total of 518 infants who were attending mother-and-child health clinics were included. Age, weight and length were recorded. Anthropometric Z-scores were calculated in two ways: by applying the NCHS growth reference and by using the WHO breastfed data set. Anthropometric Z-scores calculated using the breastfed data set were lower during the first 6–7 months of life compared with those calculated by applying the NCHS growth reference. This resulted in a higher proportion of children aged 0–6 months being classified as stunted and underweight using the breastfed data set versus the NCHS growth reference. After the age of 7 months, similar prevalences of stunting or underweight were observed. Relatively few infants were classified as wasted. In order to adequately assess the prevalence of stunting and underweight in breastfed infants, it is recommended that a new growth reference be developed, as has been initiated by WHO.

Keywords: Zambia; nutritional status; breastfeeding; infants; World Health Organization; data collection, methods; reference standards; comparative study.

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Introduction

WHO currently advises the use of the NCHS growth reference data for monitoring the growth of children worldwide (1, 2). However, in accord with others (3, 4) a WHO Working Group recognizes that the NCHS growth reference may be inadequate, particularly for assessing the growth of breastfed infants (5). For children in the first 24 months of life, NCHS reference data were derived from the Fels Longitudinal Study, which has several important limitations. It cannot really be considered representative for infant growth in general, since the sample consisted predominantly of middle-class, Caucasian children who were fed primarily with infant formula. Further, there is a methodological constraint, since measurements were

only taken at 3-month intervals. Concerns that the current growth reference curves do not reflect the growth of healthy breastfed infants prompted WHO to evaluate growth patterns of infants following WHO feeding recommendations (5, 6). Based on published literature, a data set was compiled which consisted of 226 infants who were breastfed for at least 12 months, and exclusively or predominantly breastfed for at least 4 months, and referred to as the “12-month breastfed pooled data set” (referred to in this report as the breastfed data set). From these growth data it was concluded that breastfed infants grow more rapidly in length and weight during the first 2 months of life compared with the current NCHS reference. From the age of 3 months onwards, the growth curve of breastfed infants lies below that of the NCHS curve, and this variance is more apparent in terms of weight than length. The WHO Working Group on Infant Growth recognizes the limitations of the breastfed data set, which is based on a rather small sample of Caucasian infants, showing low variance of growth (5). Therefore, it advises considering this breastfed data set as research findings only, and does not recommend its use in programmes.

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The growth of infants from several test populations was evaluated by the WHO Working Group against both the breastfed data set and the NCHS growth reference data (5). The results show that, especially in malnourished populations, larger proportions of infants are classified as stunted or underweight during the first 6 months, using the breastfed data set, as opposed to applying the NCHS growth reference. In addition, they show that use of the breastfed data set leads to the diagnosis of growth faltering in test populations at a later age (5 months) than with the NCHS growth reference (3 months). These observations prompted WHO to initiate the development of a new growth reference, reflecting the growth of children following the current feeding and health recommendations (7).

We performed a cross-sectional study on the nutritional status of children aged 0–12 months in Samfya District, northern Zambia. Children in this population are breastfed up to at least 12 months of age (8). The aim of our study was to evaluate the effect of applying two different data sets as a reference, i.e. the WHO breastfed data set and the NCHS growth reference, in terms of prevalence of malnutrition (stunting, underweight, and wasting). The test populations evaluated by the WHO Working Group were from Asia, Latin America, and a multicountry study. Although African infants were included in the latter study, it is important to examine these issues explicitly as well in an African test population.

Methods

Study area

The study was conducted in Samfya District, a rural area in north-east Zambia, which covers an area of 10 329 km² with 107 486 inhabitants (9). A large part of the district is situated adjacent to Lake Bangweulu. This lake borders a swamp area in the south-east, whereas the mainland of the district, with woodland vegetation and marshy flood plains, is located on the western side. The main sources of food and income for the majority of the people are (subsistence) farming and fishing (10). Quality of health care facilities is poor, illustrated for instance by an infant mortality rate of 149 per 1000 births in Luapula Province (11), in which Samfya District is situated. Out of a total of 85 villages in the district, where mother-and-child health (MCH) clinics are held, 11 were selected randomly: 6 villages on the mainland and 5 from the swamps. Since the selected villages provided more than the desired minimum number (500) of children aged 0–12 months, the study was confined to these 11 villages.

Design and procedures

Through a cross-sectional design, children aged 0–12.5 months were recruited during May–June 1993. The study team consisted of the principal investigator, two nurses, and one nutritionist, who

had been trained for their respective tasks. Anthropometric measurements were taken from all children, and from breastfeeding mothers of every fourth child entering the study.

Study subjects

All children in the age group described who were attending the mobile MCH clinics in selected villages during the study period were eligible for participation in the study ($n = 561$). Communications with the mothers or carers of the children were carried out by local staff of the study team, who were fluent in the local language, Cibemba. After having received explanations about the objectives of the study by a member of the study team, mothers were asked to give their informed consent for participation of the child in the study.

Excluded were children who lacked NCHS reference data (not available for lengths <49 cm, $n = 23$). Children who lacked reference data with respect to the breastfed data set were also excluded: these were not available for length-for-age for children below 1 month of age ($n = 5$); for male subjects of height <50.0 cm or >78.5 cm ($n = 3$); or for female subjects of height <50.0 cm or >76.5 cm ($n = 12$) (12). Because of the small sample size ($n = 5$), data for the 0-month age group are not shown. Finally, a total of 518 infants remained in the analysis. A representative subsample ($n = 95$) of infants aged 0–12 months was breastfed throughout this period (8). A total of 10% of the children aged 0–3 months and 65% of the children aged 3–6 months received supplementary feeding. A population-based study on other children (aged 6–9 months), from the same district, showed that intake of energy, iron, vitamin A, and calcium was less than the recommended daily intakes (13). Of the children described in this article, 85% had fever in the 2 weeks preceding the interview, 69% had cough, and 44% had diarrhoea during the same 2-week period, as reported by the mother or carer of the children (8). Another population-based study on children aged 6–9 months, living in the same district, showed that around 50–70% of these children had increased serum concentrations of acute phase proteins (C-reactive protein and α_1 -glycoprotein), and around 80% had malaria parasitaemia (14).

Anthropometry

Anthropometric measurements were performed by the study team according to standard procedures (15). Members of the study team were trained intensively in order to minimize interobserver variation in measurements. The weight of each child, wearing light clothes only, was measured to the nearest 0.1 kg using a portable hanging weighing scale (Salter England, West Bromwich, England, model 235 6S, 0–25 kg). The scale was calibrated daily with standard weights. Recumbent length of the children was measured to the nearest 0.1 cm, using a horizontal measuring board with a sliding foot piece. Dates of birth of the children were either copied from

the clinic card (after verbal verification), or, in the case of unknown dates of birth, ages were estimated by comparison with age mates with known date of birth.

The weight of each mother was measured using bathroom scales with 0.5-kg accuracy. Standing height was measured to the nearest 0.1 cm using a length-measuring rod with a sliding head bar fixed against a wall. Both recumbent length as well as height were measured barefoot and after removal of any headgear. Mothers with a body mass index (BMI) <18.5 kg/m² were considered to have chronic energy deficiency (16).

Data analysis

Length-for-age (LAZ), weight-for-age (WAZ), and weight-for-length (WLZ) Z-scores were calculated using two different reference populations. First, we applied the NCHS growth reference (2), with Epi Info version 5.01b (17). Second, we used the breastfed data set (12), with SPSS for Windows, version 7.5.2. (SPSS, Chicago, IL, USA), which was also used for further analysis. For the calculation of the Z-scores using the NCHS reference, reported age was used to calculate LAZ and WAZ, and measured length to calculate WLZ. For the calculation of Z-scores using the breastfed data set, age was rounded to the nearest month for calculation of LAZ and WAZ, and length was rounded to the nearest 0.5 cm for calculation of WLZ. Infants were classified as stunted, underweight, or wasted if their corresponding Z-score was less than or equal to -2 of that of the reference population.

Results

The demographic and anthropometric characteristics of the infants and mothers are presented in Table 1. Infants were nearly evenly distributed over the different age groups. In the sample of the mothers, 12% were classified with chronic energy deficiency (BMI <18.5 kg/m²).

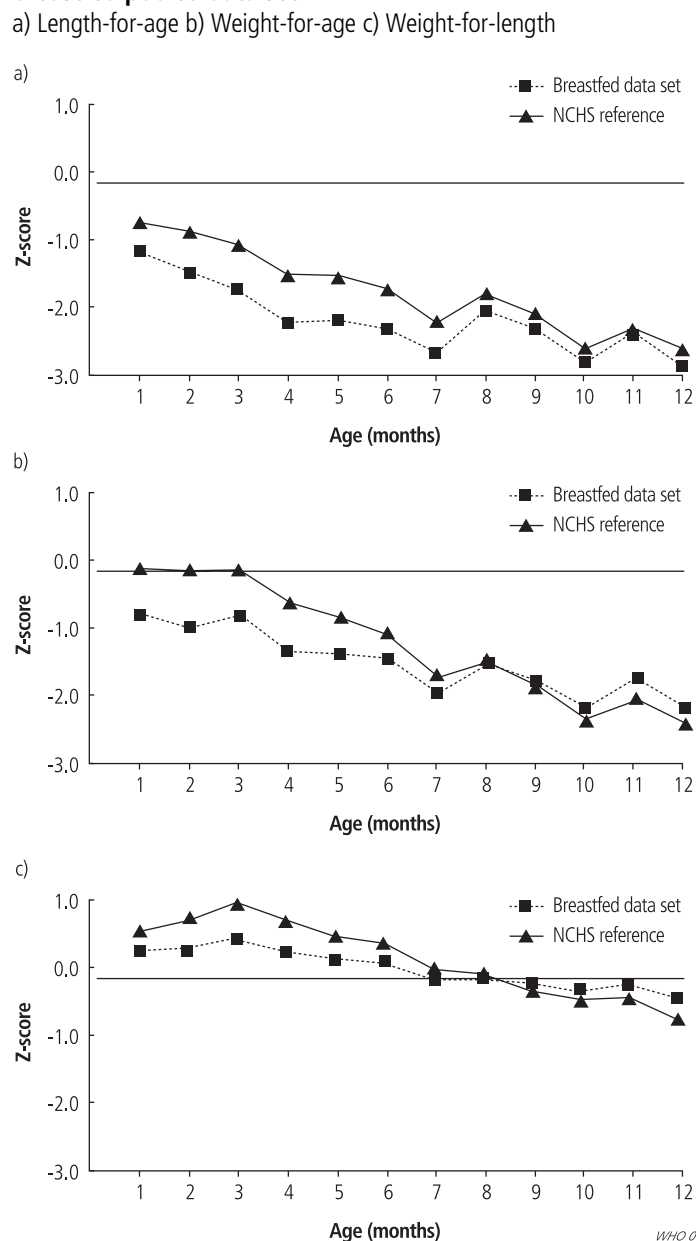
The mean anthropometric Z-scores by age are presented in Fig. 1. Note that the data were collected cross-sectionally. The two lines illustrate the Z-scores as they were calculated using the NCHS growth reference and the breastfed data set. Regardless of the basis for comparison used, the shapes of the curves were generally similar. With increasing age, the Z-scores continued to decline, whereas the deviations between the NCHS reference and breastfed data set became much smaller. During the first 7 months of life, the mean NCHS reference Z-scores were higher than the breastfed data set Z-scores. Thereafter, the mean Z-scores were relatively similar using either basis for comparison, particularly for LAZ and WAZ.

Irrespective of the reference used, the mean LAZ-scores (Fig. 1a) were low from the first month onwards (approximately -1), showing a downward trend throughout the first 10 months. During the first 3 months, the mean WAZ-scores (Fig. 1b) remained

Table 1. Demographic and anthropometric characteristics of a group of infants (n = 518) by age, and maternal characteristics of a subgroup (n = 124), Samfya District, Zambia

| Infants | n | Sex (n) Female/male | Anthropometry (mean ± SD) | |
|--------------------|-----|------------------------|---------------------------|-------------|
| | | | Height (cm) | Weight (kg) |
| Age group (months) | | | | |
| 1-3 | 152 | 82/70 | 55.4 ± 3.5 | 4.9 ± 1.0 |
| 4-6 | 120 | 64/56 | 60.6 ± 3.2 | 6.1 ± 1.0 |
| 7-9 | 134 | 76/58 | 64.3 ± 3.2 | 6.7 ± 1.1 |
| 10-12 | 112 | 55/57 | 67.1 ± 3.6 | 7.2 ± 1.2 |
| Maternal | 124 | - | 155.5 ± 5.8 | 51.1 ± 6.5 |

Fig. 1. Cross-sectional, anthropometric Z-scores for a group of infants (n = 518), Samfya District, Zambia, calculated by applying the NCHS growth reference and by using the WHO 12-month breastfed pooled data set



at a constant level, declining suddenly thereafter. Initially, the mean WLZ-scores increased during early infancy, particularly using the NCHS reference; however, a decline began at 3 months of age (Fig. 1c). After the age of 7 months the mean WLZ-scores remained constantly above -1.

The prevalences of stunting, underweight, and wasting in the study population, by age group, are shown in Fig. 2. Use of the NCHS growth reference would result in a lower proportion (11–37%) of children being classified as stunted during the first 6 months, in comparison with the breastfed data set (40–54%). By 12 months the prevalence estimates were similar (ca. 65%). During the first 6 months, the proportion of children classified as underweight was

lower (3–15%) applying the NCHS growth reference as compared with the breastfed data set (19–28%). After 9 months the situation was reversed, and by 12 months the proportion of children underweight was higher (59%) applying the NCHS growth reference as opposed to the breastfed data set (50%). Only a few children were classified as wasted. Nevertheless, throughout the first year of life, 1–3% of infants were classified as wasted applying the NCHS growth reference, whereas no infants were classified as wasted using the breastfed data set.

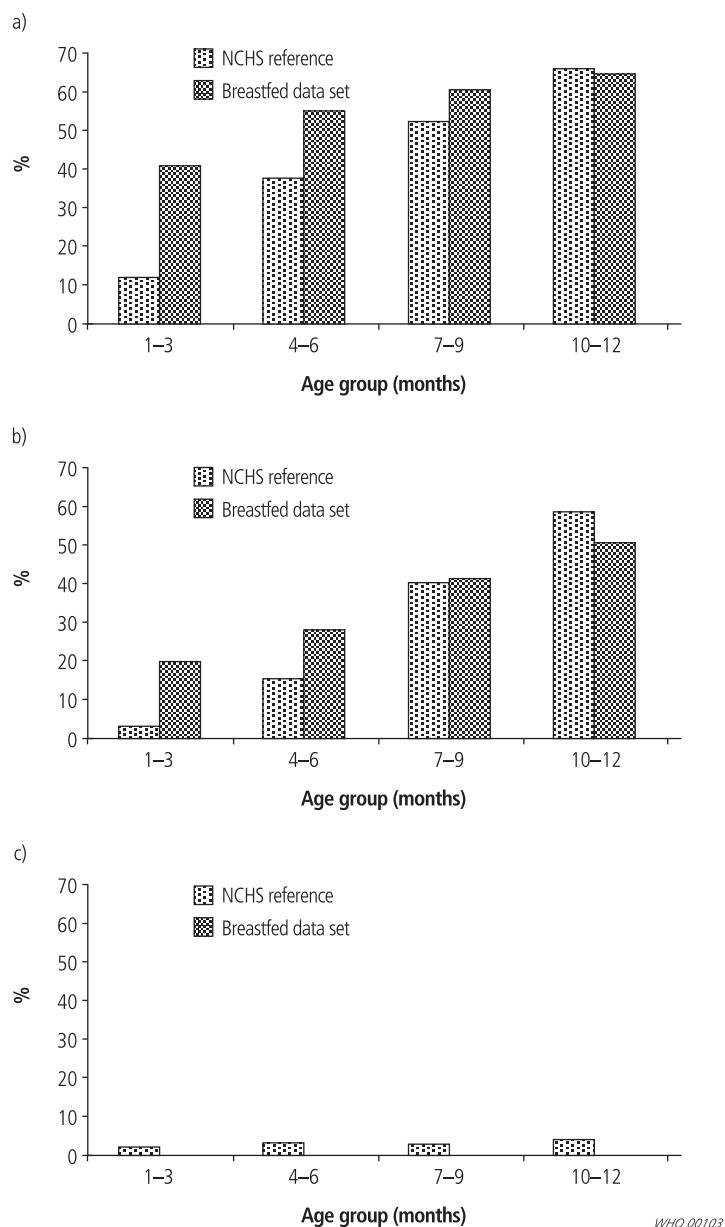
Discussion

In this study of rural Zambian infants from Samfya District, we demonstrated that anthropometric Z-scores calculated by using the breastfed data set were lower during the first 6–7 months of life compared with those calculated applying the NCHS growth reference. This resulted in a higher proportion of children being classified as stunted or underweight using the breastfed data set. Beyond the age of 7 months, the anthropometric Z-scores were comparable using either basis for comparison, resulting in a similar classification of stunting or underweight. Only a few infants were classified as wasted using any of the two data sets, the NCHS reference and the breastfed data set.

Infants enrolled in this study were recruited through MCH clinics, and therefore sampling procedures were dependent on the attendance of mothers or carers with their children to these clinics. According to data from the Zambian Ministry of Health, this study enrolled approximately 92% of the children under the age of 1 year in the catchment area of each village. Since prevalence of stunting, underweight, and wasting of the children studied corresponds well with data from the entire Luapula Province (11), it is assumed that the group of children studied is representative for the catchment areas of the villages and for the whole of the district. Data based on a subsample of the infants studied ($n = 95$) suggest that all of them were breastfed (8). These findings are in good agreement with those reported in the Zambian National Demographic Health Survey (11), which suggests that around 97% of all Zambian infants are breastfed for at least 1 year. It is therefore assumed that all children in our sample are breastfed.

In the analysis stage, a small number of infants were excluded ($n = 6$) because of lack of reference data for lengths below 50.0 cm, with respect to the breastfed data set. If these infants had been included in the study, length-for-age Z-scores might have been less than 0.5 lower at 1 month of age with respect to the NCHS growth reference. Similar observations may be expected using the breastfed data set; thus the comparison would not have been significantly affected. For calculation of the breastfed data set Z-scores, the data were rounded to the nearest month with regards to age or the nearest 0.5 cm with regards to length. However, since we may expect that

Fig. 2. Prevalence (%) of a) stunting b) underweight, and c) wasting for a group of infants by age group ($n = 518$), Samfya District, Zambia, calculated by applying the NCHS growth reference and by using the WHO 12-month breastfed pooled data set



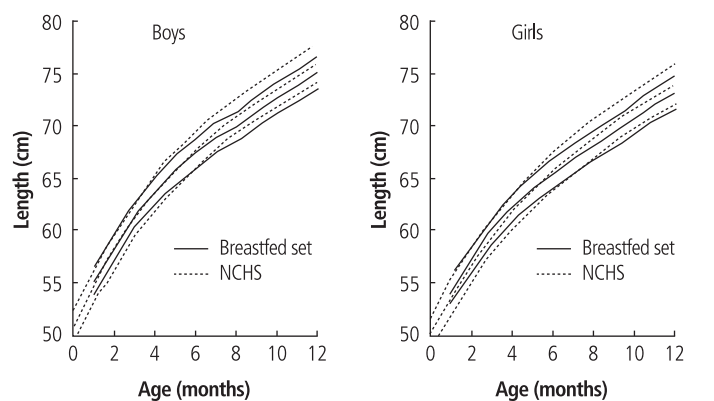
rounding up and down occurred equally frequently, it is assumed that the rounding procedure did not affect the overall results.

During the first 6–7 months of life, the Z-scores for the breastfed data set were more negative than those for the NCHS reference set. This arose because the medians of the breastfed data set for length-for-age, weight-for-age, and weight-for-length were higher than those for the NCHS growth reference during the first 6–7 months. After the age of 6–7 months, the length and weight of optimally breastfed children were lower than those for the study group of the NCHS growth reference, as were the median values for the breastfed data set. We would therefore have expected that the Z-scores for the breastfed data set would be higher than those for the NCHS growth reference after the age of 6–7 months. However, our results suggest otherwise. The LAZ and WAZ scores are similar for both the breastfed data set and the NCHS growth reference. A plausible explanation may be the age at which the reference curves of the two data sets cross. The length and weight quartiles of the breastfed data set and of the NCHS growth reference, as compiled by the WHO Working Group on Infant Growth (12), clearly demonstrate that the age of cross-over is dependent on which particular percentile is being considered; for the lower quartile, the curves cross at a later age than they do for the upper quartile. This phenomenon is shown in Fig. 3 for the length quartiles (weight quartiles are not shown, but show the same pattern). Since the mean Z-scores in our study population lie predominantly in the extreme lower percentiles, the cross-over of these percentiles is expected to occur at a later age.

The smaller variance of the breastfed data set is reflected by its percentile curves being less spread than those for the NCHS data. Before the age of cross-over of the medians, this would result in higher values of percentiles below the median. This is true in particular for the fifth percentile (P5), which is roughly equal to the $-2SD$ cut-off value, thus rendering a greater proportion of infants below $-2SD$ compared with applying the NCHS reference data. In addition to this impact of smaller standard deviations, the prevalence of stunting and underweight depends on the median of whichever of the two reference data sets is being used. Since the value of the median of the breastfed data set is higher for the age group 0 to 6–7 months, the higher prevalence of stunting and underweight was partly due to the smaller variance, and partly due to the higher median of the breastfed data set during that specific age period.

Children who are stunted are at risk of concurrent and later delay in psychomotor development, and at risk of reduced working capacity during adulthood; women face increased obstetric risks (18). Applying the breastfed data set for these children will

Fig. 3. Length quartiles of infants (boys and girls) of the breastfed data set compared with the NCHS growth reference



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Source: ref. 12.

diagnose stunting at an early age, and therefore give more timely possibilities for interventions. The functional outcome of these children when they reach adulthood will be the ultimate test of the adequacy of applying a breastfed data set.

We conclude that using the WHO 12-month breastfed pooled data set for assessing the nutritional status of infants living in rural Zambia will result in higher proportions being classified as stunted or underweight during the first 6 months of life compared with using the NCHS growth reference. More important, using the breastfed data set during the first 6 months of life would detect a larger proportion of children to be at risk of enduring the concurrent and later detrimental effects of being stunted or underweight. This is of great concern for local and national organizations that are involved in the nutritional management and support of these infants. Our findings strongly support the recommendation of WHO to develop a new growth reference reflecting the growth of infants following current health and feeding recommendations, to diagnose realistically infancy malnutrition (stunting and underweight). ■

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Résumé

Etat nutritionnel des enfants nourris au sein dans les régions rurales de Zambie : comparaison entre le système de référence du NCHS pour la croissance et la série OMS de données sur l'allaitement maternel pendant 12 mois

L'échantillon ayant servi à l'établissement des courbes de croissance de référence du National Center for Health Statistics (NCHS) étant majoritairement constitué d'enfants de race blanche appartenant à la classe moyenne, principalement nourris avec des laits maternisés, on ne peut le considérer comme représentatif de la croissance des nourrissons en général. En prenant une série de données relatives à des enfants nourris au sein pendant au moins 12 mois, un Groupe de travail de l'OMS est arrivé à la conclusion selon laquelle la courbe de croissance de ces enfants s'écarte sensiblement de la courbe de croissance de référence actuelle du NCHS. Dans la présente étude, on s'est servi des données d'une enquête transversale sur l'allaitement au sein dans les régions rurales de Zambie pour évaluer l'effet qu'aurait l'application de ces deux systèmes de données de référence différents, à savoir les données de l'OMS relatives aux enfants nourris au sein pendant 12 mois et les courbes de croissance de référence du NCHS, sur la prévalence de la malnutrition (retard de croissance, déficit pondéral et émaciation). Au total, 518 nourrissons dont les mères consultent dans les dispensaires de santé maternelle et infantile de 11 villages du district de Samfya en Zambie ont été inclus dans l'étude. Leur âge, leur poids et leur taille ont été enregistrés. Les valeurs du Z (anthropométrie) ont été calculées de deux façons : en se servant des courbes de croissance de référence du NCHS et en utilisant les données de l'OMS relatives à l'allaitement au sein. Dans le second cas, ces valeurs ont été inférieures à celles obtenues en appliquant le système de référence du NCHS pour les 6 à 7 premiers mois. En utilisant ces données relatives à l'allaitement au sein, on a obtenu une proportion plus élevée d'enfants âgés de

0 à 6 mois présentant un retard de croissance (40-54 %) qu'avec la courbe de référence du NCHS (11-37 %). La même tendance a également été observée pour la prévalence du déficit pondéral. Quelle que soit la base de comparaison employée, les valeurs du Z ont montré peu de différence après 7 mois, donnant des prévalences analogues pour le retard de croissance ou le déficit pondéral. Relativement peu de nourrissons ont été considérés comme émaciés, quelle que soit la courbe de référence utilisée. Les valeurs de prévalence du retard de croissance, du déficit pondéral et de l'émaciation chez les nourrissons étudiés ayant été les mêmes que dans le reste de la province, nous considérons avoir étudié un groupe de nourrissons représentatifs de la région. La proportion plus élevée d'enfants présentant un retard de croissance ou un déficit pondéral au cours des 6 à 7 premiers mois de leur vie est en partie imputable à la faible variance des valeurs obtenues avec l'allaitement maternel, mais aussi à la médiane plus élevée de cette série de données à ces âges-là. Ainsi, en utilisant la série de données OMS, au cours des 6 premiers mois, on détecterait un pourcentage plus élevé d'enfants risquant de supporter les effets néfastes d'un retard de croissance ou d'un déficit pondéral à plus ou moins long terme. Ainsi, les résultats de cette étude vont tout à fait dans le sens de la recommandation de l'OMS selon laquelle il faut élaborer de nouvelles courbes de croissance de référence, qui soient le reflet de la croissance de nourrissons auxquels sont appliquées les recommandations actuelles en matière de santé et d'alimentation, afin de diagnostiquer la malnutrition infantile de façon réaliste (retard de croissance et déficit pondéral).

Resumen

Estado nutricional de los lactantes alimentados al pecho en la Zambia rural: comparación del patrón de crecimiento del NCHS y del conjunto de datos de la OMS para lactantes amamantados durante 12 meses

Dado que la población de muestra del actual patrón de crecimiento del Centro Nacional de Estadísticas Sanitarias (NCHS) de los Estados Unidos está constituida ante todo por niños caucásicos de clase media alimentados fundamentalmente con preparaciones para lactantes, dicho patrón no puede considerarse representativo del crecimiento de los lactantes en general. Usando un conjunto de datos sobre lactantes alimentados al pecho durante al menos 12 meses, un grupo de trabajo de la OMS concluyó que el crecimiento de los niños amamantados se desvía marcadamente del actual patrón de crecimiento del NCHS. En el presente estudio se utilizaron datos transversales sobre lactantes amamantados en la Zambia rural para evaluar el efecto de la aplicación de dos conjuntos de datos distintos como referencia — a saber, el conjunto de datos de la OMS para lactantes amamantados durante 12 meses y el patrón de

crecimiento del NCHS — en la prevalencia de malnutrición (retraso del crecimiento, peso inferior al normal y emaciación). El estudio abarcó en total a 518 lactantes asistidos en dispensarios maternoinfantiles de 11 aldeas del distrito zambiano de Samfya, de los cuales se registraron la edad, el peso y la estatura. Se calcularon los valores Z antropométricos de dos maneras: aplicando el patrón de crecimiento del NCHS, y utilizando el conjunto de datos de la OMS para lactantes amamantados. Los valores Z antropométricos calculados mediante el conjunto de datos para los 6-7 primeros meses de vida fueron inferiores a los calculados aplicando el patrón de crecimiento del NCHS. Debido a ello, la proporción de niños de 0-6 meses a los que se clasificó como afectados por un retraso del crecimiento fue mayor al emplear el conjunto de datos para amamantados (40%-54%) que al aplicar el patrón de crecimiento del

NCHS (11%-37%). La prevalencia de peso inferior al normal mostró esa misma tendencia. Los valores Z antropométricos obtenidos con las dos referencias apenas difirieron a partir de la edad de 7 meses, obteniéndose así prevalencias similares tanto del retraso del crecimiento como del peso inferior al normal. Fueron relativamente pocos los lactantes clasificados como emaciados, tanto con el patrón de crecimiento del NCHS como con el conjunto de datos para amamantados. Dado que los resultados sobre la prevalencia de retraso del crecimiento, peso inferior al normal y emaciación de los lactantes estudiados fueron similares a otros obtenidos en la misma provincia, suponemos que hemos abarcado a un grupo de lactantes representativo de la zona. La mayor proporción de niños clasificados como afectados por un retraso de crecimiento o un peso inferior al normal

durante los primeros 6-7 meses de vida se debió en parte a la baja varianza del conjunto de datos sobre lactantes amamantados, pero también a la elevada mediana que presenta ese conjunto de datos durante esos meses concretos de la vida. Durante los primeros 6 meses de vida, usando ese conjunto de datos se detectaría una mayor proporción de niños expuestos al riesgo de sufrir los efectos concurrentes, y más tarde perjudiciales, de un retraso del crecimiento o un peso inferior al normal. Así pues, los resultados de este estudio respaldan claramente la recomendación de la OMS de elaborar un nuevo patrón que refleje el crecimiento de los lactantes con los que se siguen las actuales recomendaciones sobre salud y alimentación, a fin de poder diagnosticar de forma realista los signos de malnutrición (retraso del crecimiento y peso inferior al normal) entre los lactantes.

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