Taylor & Francis
Taylor & Francis Group

Breastfeeding in the WHO Multicentre Growth Reference Study

WHO MULTICENTRE GROWTH REFERENCE STUDY GROUP[1,2]

[1]*Department of Nutrition, World Health Organization, Geneva, Switzerland, and* [2]*Members of the WHO Multicentre Growth Reference Study Group (listed at the end of the first paper in this supplement)*

Abstract

Aim: To document how children in the WHO Multicentre Growth Reference Study (MGRS) complied with feeding criteria and describe the breastfeeding practices of the compliant group. *Methods:* The MGRS longitudinal component followed 1743 mother–infant pairs from birth to 24 mo in six countries (Brazil, Ghana, India, Norway, Oman and the USA). The study included three criteria for compliance with recommended feeding practices that were monitored at each follow-up visit through food frequency reports and 24-h dietary recalls. Trained lactation counsellors visited participating mothers frequently in the first months after delivery to help with breastfeeding initiation and prevent and resolve lactation problems. *Results:* Of the 1743 enrolled newborns, 903 (51.8%) completed the follow-up and complied with the three feeding criteria. Three quarters (74.7%) of the infants were exclusively/predominantly breastfed for at least 4 mo, 99.5% were started on complementary foods by 6 mo of age, and 68.3% were partially breastfed until at least age 12 mo. Compliance varied across sites (lowest in Brazil and highest in Ghana) based on their initial baseline breastfeeding levels and sociocultural characteristics. Median breastfeeding frequency among compliant infants was 10, 9, 7 and 5 feeds per day at 3, 6, 9 and 12 mo, respectively. Compliant mothers were less likely to be employed, more likely to have had a vaginal delivery, and fewer of them were primiparous. Pacifier use was more prevalent in the non-compliant group.

Conclusion: The MGRS lactation support teams were successful in enhancing breastfeeding practices and achieving high rates of compliance with the feeding criteria required for the construction of the new growth standards.

Key Words: *Breastfeeding, child nutrition, growth curves, growth standards, infant feeding practices*

Introduction

Growth charts are essential instruments in the paediatric toolkit. Their value resides in helping determine the degree to which physiological needs for growth and development are being met during the important childhood period. However, interpretation of the adequacy of growth is highly dependent on the reference data used and may be erroneous if the reference used does not adequately represent physiological growth.

The growth reference recommended for international use since the late 1970s—the National Center for Health Statistics/World Health Organization (NCHS/WHO) reference—has been shown to have a number of drawbacks that make it inappropriate for assessing infant growth [1–3]. One of its most important limitations is that it is based on a sample of predominantly formula-fed infants whose pattern of growth has been demonstrated to deviate substantially from that of healthy breastfed infants [4,5]. The divergence between the growth pattern of healthy breastfed infants and other national growth references that are likewise largely based on formula-fed infants has also been documented [6,7].

Recognizing the shortcomings of the NCHS/WHO international growth reference, in 1994 WHO began planning for the development of new standards which, unlike the current reference, would be based on an international sample of healthy breastfed infants and would portray how children should grow in all countries rather than merely describing how they grew at a particular time and place [8,9]. The WHO Multicentre Growth Reference Study (MGRS), undertaken between 1997 and 2003, focused on the collection of growth and related data from 8440 children from widely differing ethnic backgrounds and cultural settings (Brazil, Ghana, India, Norway, Oman and the USA) [10]. As described elsewhere [10], breastfeeding practices were one of the primary criteria used to select study sites. The intention was to choose populations where breastfeeding was commonly practised and provide lactation support to

Correspondence: Mercedes de Onis, Study Coordinator, Department of Nutrition, World Health Organization, 20 Avenue Appia, 1211 Geneva 27, Switzerland. Tel: +41 22 791 3320. Fax: +41 22 791 4156. E-mail: deonism@who.int

mothers enrolled in the study to help them comply with the feeding criteria required to construct the new standards. This paper documents how the children in the MGRS sample complied with the study's feeding criteria in infancy and describes in detail the breast-feeding practices of the feeding-compliant group.

Methods

The MGRS was a population-based study undertaken in the cities of Davis, California, USA; Muscat, Oman; Oslo, Norway; Pelotas, Brazil; and selected affluent neighbourhoods of Accra, Ghana, and South Delhi, India. The MGRS protocol and its implementation at the six sites are described in detail elsewhere [11]. The MGRS combined a longitudinal component from birth to 24 mo of age with a cross-sectional component of children aged 18 to 71 mo. In the longitudinal component, mothers and newborns were screened and enrolled at birth and visited at home at weeks 1, 2, 4 and 6; monthly from 2–12 mo; and bimonthly in the second year. This paper describes infant feeding practices in the longitudinal sample.

The MGRS included three compliance criteria regarding feeding for children to be included in the growth standards sample: 1) exclusive or predominant breastfeeding for at least 4 mo (120 d); 2) introduction of complementary foods between 4 and 6 mo (120 to 180 d); and 3) partial breastfeeding to be continued up to at least 12 mo (365 d). Concerning the first criterion, it is important to note that the MGRS was initiated before WHO's policy on the optimal duration of exclusive breastfeeding changed in 2001 from "4 to 6 months" to "6 months" [12]. Nevertheless, the national policies at three study sites (Brazil, Ghana and India) already recommended 6 mo, and participating mothers in all sites were advised to breastfeed their infants exclusively for as close as possible to 6 mo. For children to be included in the growth standards sample, a fourth criterion, maternal non-smoking, was required.

The MGRS study sites were selected on the basis that a minimum of 20% of mothers in the study's subpopulations were willing to follow the feeding compliance criteria [10]. Mothers were screened at the time of enrolment and those not intending to breastfeed were considered ineligible for the study. In Oman and the USA, screening with regard to child feeding intentions was more stringent: only mothers willing to breastfeed exclusively for at least 4 mo, and to continue breastfeeding up to at least 12 mo of age, were enrolled [13,14].

To ensure a high level of compliance with the three feeding criteria among participating mothers, lactation counselling was made an essential part of the MGRS. Lactation counselling, which was provided by trained lactation counsellors at each site, was designed to help with initiating breastfeeding soon after delivery, preventing and resolving lactation problems, and sustaining exclusive/predominant breastfeeding through 4 mo and partial breastfeeding through at least 12 mo. The first visit by a lactation counsellor took place within 24 h of delivery, and subsequent visits occurred at 7, 14 and 30 d, and monthly thereafter until the sixth month. A 24-h hotline was also made available to mothers for emergency support. Additional visits were carried out whenever feeding problems occurred. Compliance with the feeding criteria was monitored centrally and lactation counselling strengthened as required. Local logistics of the breastfeeding support systems and lactation counselling teams in the six sites are described elsewhere [13–18]. Mothers also received advice on complementary feeding according to locally adapted guidelines. Complementary feeding practices of the MGRS sample are described in a companion paper in this supplement [19].

Exclusive breastfeeding was defined as the infant receiving only breast milk from his/her mother or a wet-nurse, or expressed breast milk, and no other liquids or solids with the exception of drops or syrups consisting of vitamins, mineral supplements or medicines [10]. Predominant breastfeeding consisted of breast milk as the infant's predominant source of nourishment, but the infant could also receive water and water-based drinks (e.g. sweetened and flavoured water, teas, infusions), fruit juice, oral rehydration solution and ritual fluids (in limited quantities) [10].

Compliance with exclusive/predominant breast-feeding was assessed from birth to age 4 mo (visits 1–6) using the cumulative frequency of non-compliant days (i.e. the baby received infant formula or other milk than breast milk and/or more than one teaspoon of solid or semi-solid food). As soon as the number of days of such non-compliance exceeded 12, the child was marked as non-compliant for that and subsequent visits. Timely introduction of complementary foods was assessed from 6 to 12 mo (visits 8–14) on the basis of solid/semi-solid food consumption. Continued breastfeeding until at least 12 mo of age was assessed throughout the first year. Children classified as non-compliant were marked as such for the index and subsequent visits.

Data on feeding practices were collected at each of the follow-up visits [10]. Food frequency reports were used to describe the intake of breast milk, other fluids and milks, and solid and semi-solid foods in the intervals between visits. More detailed data on typical daily feeding were collected by 24-h dietary recalls on what the child ate or drank during each of seven time periods throughout the day. In addition to data collected by follow-up teams, lactation counsellors collected in-hospital information on breastfeeding initiation and at-home information on the

establishment of lactation, problems experienced in the first 2 wk, and practices with potentially adverse influences on continued lactation (e.g. pacifier use) [10].

Results

Table I describes the MGRS sample according to compliance with feeding recommendations and completion of follow-up. Of the 1743 enrolled newborns, 903 (51.8%) completed the 24-mo follow-up and met the three operational criteria for compliance with feeding recommendations. Fifteen other children whose mothers did not comply with the study's no-smoking criterion and six with morbid conditions known to affect child growth were further excluded to obtain the sample ($n=882$) from the MGRS longitudinal component that was used to construct the growth standards [20]. Compliance was highest in Ghana (71.1%), followed by the USA (63.0%), India (60.2%), Norway (55.3%), Oman (53.3%) and Brazil (23.3%). Most of the following analyses focus on the children by compliance group who completed the follow-up.

Table II presents maternal characteristics relevant to breastfeeding choices by compliance group and site. Newborns in all sites were term, single births. Maternal age was not different by compliance group in individual sites; however, when the sample was pooled, the compliant group was significantly older by about 1 y. Maternal education in Norway and Oman was significantly different between compliance groups but in opposite directions. For the overall sample, the compliant group had about 1 y more of education, which was a statistically significant difference. Overall, fewer mothers were employed outside the home in the compliant compared to the non-compliant group. Vaginal delivery was significantly higher, and rate of primiparous mothers significantly lower, for compliers for the overall sample, and no differences were noted in either parity or prevalence of maternal smoking (less than 1% smoked in both groups).

Figure 1 presents compliance with each of the MGRS feeding criteria by site and for all sites together. Overall, 74.7% of infants were exclusively or predominantly breastfed for at least 4 mo, almost all of them (99.5%) were started on complementary foods by the age of 6 mo, and 68.3% were partially breastfed to at least 12 mo of age. Compliance with exclusive/predominant breastfeeding for at least 4 mo was lowest in Brazil (48.6%) and highest in Ghana (89.4%). Norway and the USA also had very high compliance rates for this feeding criterion (86.0 and 82.6%, respectively), and the compliance rates for India and Oman were above 65%. Compliance with the criterion for introduction of complementary foods was above 98% in all sites. Compliance with the third

Table I. Sample classification on overall feeding compliance and completion of follow-up by site.

Compliance/follow-up category	Brazil (n = 310)		Ghana (n = 329)		India (n = 301)		Norway (n = 300)		Oman (n = 295)		USA (n = 208)		All (n = 1743)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Compliant, study completed	69	22.3	228	69.3	173	57.5	159	53.0	153	51.9	121	58.2	903	51.8
Compliant, not completed	3	1.0	6	1.8	8	2.7	7	2.3	4	1.4	10	4.8	38	2.2
Not compliant, study completed	218	70.3	64	19.5	96	31.8	103	34.4	107	36.2	51	24.5	639	36.6
Not compliant, not completed	20	6.4	31	9.4	24	8.0	31	10.3	31	10.5	26	12.5	163	9.4

Table II. Maternal characteristics of compliant and non-compliant subjects.

	Brazil	Ghana	India	Norway	Oman	USA	All
Compliant *n*	69	228	173	159	153	121	903
Non-compliant *n*	218	64	96	103	107	51	639
Maternal age (y), mean±SD							
Compliant	29.1±6.4	30.9±4.0	29.0±3.5	31.2±4.2	28.1±5.4	31.6±4.6	30.1*±4.7
Non-compliant	28.1±6.3	30.4±3.6	29.0±3.6	30.2±4.5	27.2±4.5	31.5±4.0	28.9*±5.1
Maternal education (y), mean±SD							
Compliant	11.9±3.6	15.0±2.7	17.5±1.5	15.9*±2.6	11.3*±3.5	17.0±1.8	15.0*±3.5
Non-compliant	10.9±3.5	15.6±2.2	17.5±1.6	14.7*±2.6	12.7*±3.1	16.8±1.9	13.7*±3.8
Vaginal delivery,%							
Compliant	40.6	76.8	60.7	92.5	88.2	85.1	76.7*
Non-compliant	47.7	71.9	57.3	89.3	85.1	86.3	67.6*
Maternal smoking,%							
Compliant	–	–	–	2.5	–	–	0.4
Non-compliant	0.9	–	–	1.9	–	–	0.6
Maternal employment,%							
Compliant	68.1	84.2	28.9*	79.2	30.1*	58.7	58.9*
Non-compliant	70.6	87.5	47.9*	74.8	64.5*	74.5	68.9*
Type of job, full time,%							
Compliant	–	96.9	88.0	88.1	95.7	52.1*	87.0
Non-compliant	–	96.4	87.0	88.3	97.1	84.2*	91.3
Parity, median (min., max.)							
Compliant	2 (1,6)	2 (1,8)	1 (1,3)	1 (1,4)	3* (1,12)	1 (1,5)	2 (1,12)
Non-compliant	1 (1,7)	2 (1,4)	1 (1,3)	1 (1,5)	2* (1,12)	1 (1,4)	2 (1,12)
Primiparous,%							
Compliant	46.4	36.8	51.4	52.2	18.3*	52.1	42.0*
Non-compliant	51.4	37.5	57.3	58.3	36.4*	51.0	49.5*

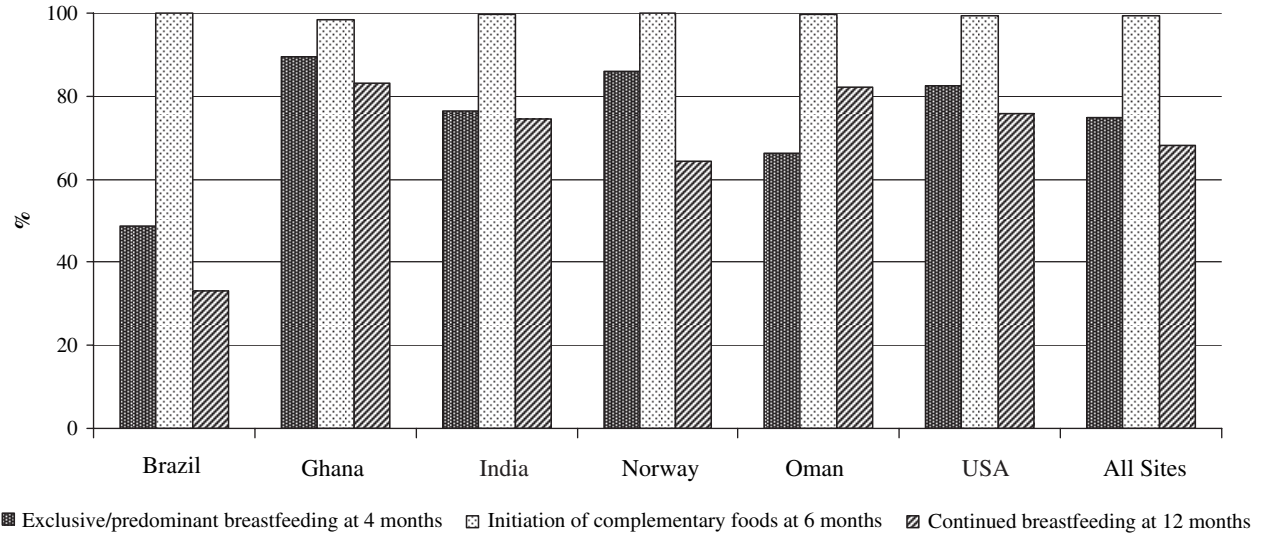*Statistically significant difference (*p*-value <0.05) between the compliant and non-compliant groups.

Figure 1. Compliance with MGRS feeding criteria by site and overall.

feeding criterion (i.e. continued breastfeeding up to at least 12 mo of age) was more variable across sites, with Brazil having the lowest compliance rate (33.2%) and Ghana and Oman the highest (83.1 and 82.3%, respectively). Figure 2 shows the percent of overall feeding compliance by site at each follow-up visit up to 12 mo.

Figure 3 displays the prevalence of exclusive, predominant and partial breastfeeding (with and without solids), and the percent of the overall sample not breastfed, from week 2 to 12 mo of age. This figure shows that children classified in the exclusive/predominant category were mainly exclusively breastfed. Moreover, the proportion of infants exclusively breastfed is somewhat underestimated as the data showed that some children moved back and forth

between the exclusive and predominant categories between visits. However, for the purpose of constructing the figure, the classification ran only one way; that is, once a child had been classified as predominantly breastfed he/she was not classified back to the exclusively breastfed category even if, at the next visit, the child was being exclusively breastfed. The figure also shows that the overall MGRS sample enjoyed high breastfeeding rates, with 68.3% still being breastfed at 12 mo.

Table III summarizes the frequency and volume of 24-h fluid intake at 6, 9 and 12 mo for compliant children. At 3 mo there was very little consumption of any of these fluids. It is noteworthy that Indian mothers tended to supplement with animal milk, while supplementation with formula seems to have
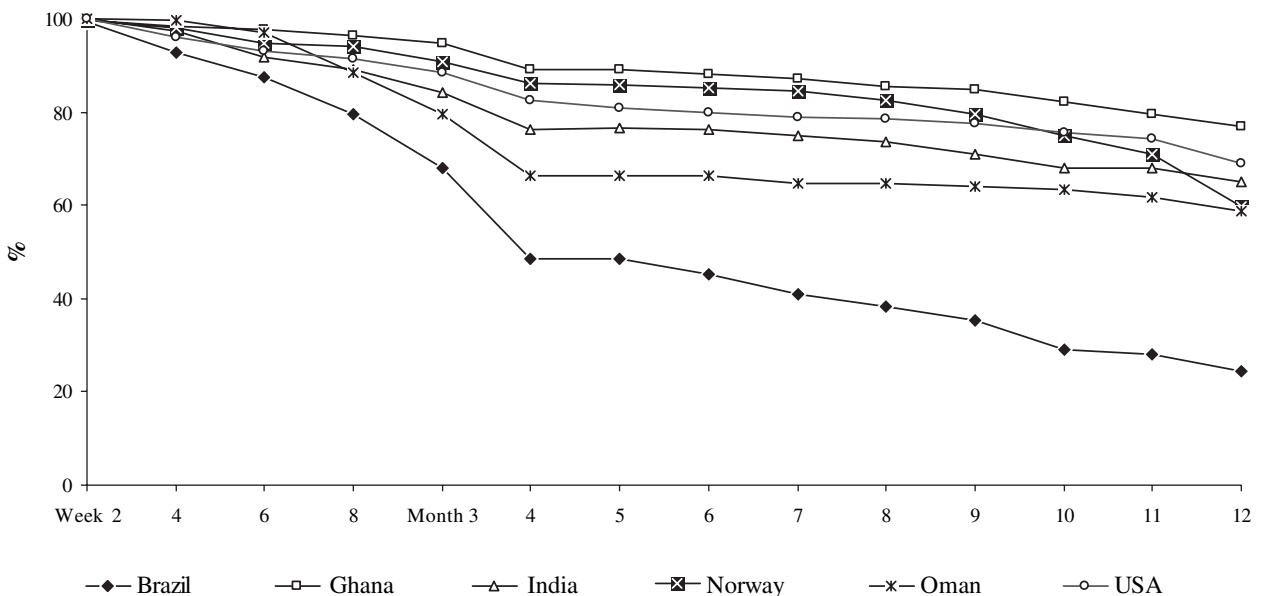

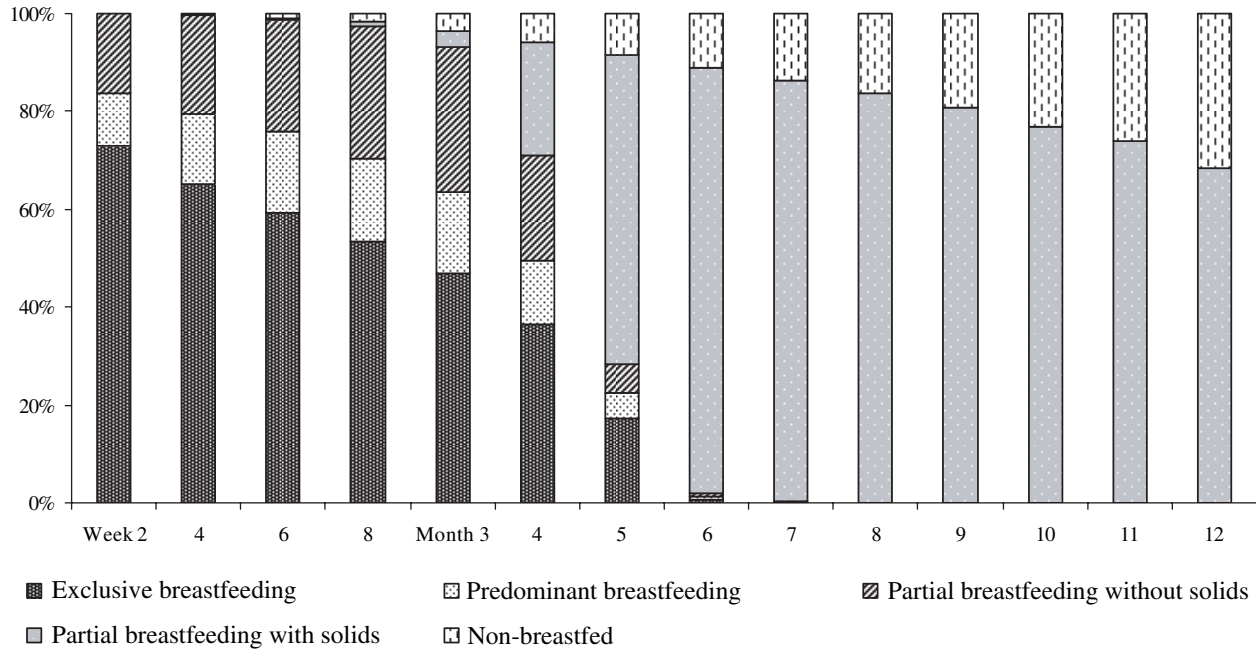Figure 2. Compliance with MGRS feeding criteria in infancy.

Figure 3. Prevalence of exclusive, predominant and partial breastfeeding, and prevalence of non-breastfed infants for overall sample by age.

been more common in Ghana. Tea was much more common in Brazil, and water supplementation was very common in Ghana, India and Oman. Overall, at 6 mo, supplementation with formula was more common than with animal milk, while at 12 mo the opposite was true. Water was more frequently given to children than juice or tea.

Figure 4 shows the median breastfeeding frequency for each country and all sites at 3, 6, 9 and 12 mo (error bars representing the Q1–Q3 range). At any given time, Ghana and Oman had the highest breastfeeding frequency. The overall median breastfeeding frequency among compliant infants was 10, 9, 7 and 5 feeds per day at 3, 6, 9 and 12 mo, respectively.

Table IV presents the median duration of breastfeeding by compliance group and the percent of children still breastfeeding at 24 mo. The overall median duration in the compliant group was 17.8 mo versus 9.3 mo in the non-compliant group. It should be noted that the median duration in the compliant group is underestimated since 16.2% of the children were still breastfeeding when follow-up was completed. Brazil, India and the USA had the largest proportions of compliant children still breastfeeding at 24 mo. In all sites, both the duration of breastfeeding and the percent of children still breastfeeding at 24 mo were significantly lower statistically in the non-compliant group, with the exception of Ghana and Oman for the percent of children still breastfeeding.

Table V presents, by compliance group, the percentage of newborns breastfed within 1 h of birth; median hours after birth a baby was breastfed for the first time; and pacifier use at 2 wk, and 3 and 6 mo. For the overall sample, the use of pacifiers was significantly higher at 3 and 6 mo, and Norway and the USA had the highest prevalence of use. These data were not available for the Brazilian site.

The most important breastfeeding problems reported among compliant mothers at the week 1 visit (data not shown) were sore nipples (27.9%), engorgement (19%), too much milk (6.3%), mastitis (2.0%) and delayed onset of milk production (2.7%). At the week 2 visit, the prevalence of these problems had decreased substantially: 14.6% sore nipples, 9.9% engorgement, 3.8% too much milk and 2.3% mastitis. Mothers in Norway and the USA most often reported having problems. However, it is important to note that these data were self-reported and their collection was not standardized either across sites or among lactation counsellors within sites. Breastfeeding problems reported by non-compliant mothers did not differ significantly from those of compliant mothers.

Discussion

The results presented here document the success of the MGRS lactation support teams in enhancing breastfeeding practices and achieving high rates of compliance with the study's feeding criteria. Overall, 54% of the sample complied with the three feeding criteria, surpassing the expected compliance rate of 30% used to calculate the study's sample size. This result, coupled with a very low dropout rate (96% of compliant children completed the 24-mo follow-up) yielded a sample for the construction of the standards more than double the size required to ensure stable outer percentiles (i.e. 882 vs 400) [10].

Table III. Twenty-four-hour intake of fluids among compliant infants.

	Brazil (n = 69)	Ghana (n = 228)	India (n = 173)	Norway (n = 159)	Oman (n = 153)	USA (n = 121)	All (n = 903)
At 6 mo							
Animal milk, n (%)	2 (2.9)	14 (6.1)	90 (52.0)	0 (0.0)	10 (6.5)	0 (0.0)	116 (12.8)
frequency, median (min., max.)	2 (2,2)	2 (1,5)	2 (1,8)		1.5 (1,2)		2 (1,8)
volume, median (min., max.)	180 (160,200)	40 (10,260)	90 (15,900)		60 (10,150)		75 (10,900)
Infant formula, n (%)	2 (2.9)	112 (49.1)	14 (8.1)	20 (12.6)	48 (31.4)	11 (9.1)	207 (22.9)
frequency, median (min., max.)	1 (1,1)	2 (1,10)	1 (1,5)	1 (1,6)	1 (1,3)	2 (1,5)	2 (1,10)
volume, median (min., max.)	135 (90,180)	150 (30,1180)	152.5 (20,480)	100 (15,600)	45 (10,390)	135 (15,480)	120 (10,1180)
Tea, n (%)	9 (13.0)	1 (0.4)	2 (1.2)	0 (0.0)	6 (3.9)	0 (0.0)	18 (2.0)
frequency, median (min., max.)	2 (1,3)	2 (2,2)	1 (1,1)		1 (1,3)		1 (1,3)
volume, median (min., max.)	50 (18,120)	120 (120,120)	27.5 (10,45)		60 (30,100)		60 (10,120)
Water, n (%)	12 (17.4)	153 (67.1)	118 (68.2)	23 (14.5)	142 (92.8)	26 (21.5)	474 (52.5)
frequency, median (min., max.)	1 (1,5)	3 (1,9)	2 (1,10)	1 (1,3)	3 (1,8)	1 (1,3)	3 (1,10)
volume, median (min., max.)	30 (10,280)	70 (10,360)	47.5 (10,300)	50 (10,200)	75 (10,500)	37.5 (10,135)	60 (10,500)
Juice, n (%)	19 (27.5)	21 (9.2)	34 (19.7)	1 (0.6)	69 (45.1)	4 (3.3)	148 (16.4)
frequency, median (min., max.)	1 (1,2)	1 (1,3)	1 (1,3)	1 (1,1)	1 (1,5)	1 (1,4)	1 (1,5)
volume, median (min., max.)	80 (3,250)	30 (10,240)	50 (10,150)	120 (120,120)	50 (15,250)	52.5 (30,180)	50 (3,250)
At 9 mo							
Animal milk, n (%)	13 (18.8)	64 (28.1)	118 (68.2)	3 (1.9)	29 (19.0)	2 (1.7)	229 (25.4)
frequency, median (min., max.)	2 (1,6)	2 (1,6)	2 (1,20)	1 (1,1)	1 (1,4)	1 (1,1)	2 (1,20)
volume, median (min., max.)	280 (100,960)	50 (10,1000)	150 (10,1075)	50 (10,80)	100 (10,360)	90 (60,120)	100 (10,1075)
Infant formula, n (%)	3 (4.3)	94 (41.2)	6 (3.5)	14 (8.8)	61 (39.9)	24 (19.8)	202 (22.4)
frequency, median (min., max.)	2 (1,3)	2 (1,10)	2.5 (1,6)	1.5 (1,5)	1 (1,5)	2 (1,4)	2 (1,10)
volume, median (min., max.)	160 (150,460)	180 (25,1050)	322.5 (25,600)	150 (80,680)	80 (10,500)	120 (15,420)	120 (10,1050)
Tea, n (%)	10 (14.5)	6 (2.6)	4 (2.3)	1 (0.6)	6 (3.9)	0 (0.0)	27 (3.0)
frequency, median (min., max.)	1 (1,3)	1 (1,1)	1 (1,1)	1 (1,1)	1 (1,4)		1 (1,4)
volume, median (min., max.)	45 (20,150)	75 (10,150)	22.5 (10,90)	5 (5,5)	60 (25,100)	50	50 (5,150)
Water, n (%)	12 (17.4)	174 (76.3)	157 (90.8)	102 (64.2)	149 (97.4)	56 (46.3)	650 (72.0)
frequency, median (min., max.)	2 (1,3)	4 (1,12)	4 (1,24)	3 (1,10)	4 (1,8)	1 (1,6)	4 (1,24)
volume, median (min., max.)	40 (20,150)	175 (20,640)	120 (10,750)	75 (10,400)	160 (15,1050)	60 (15,240)	120 (10,1050)
Juice, n (%)	34 (49.3)	44 (19.3)	27 (15.6)	9 (5.7)	71 (46.4)	25 (20.7)	210 (23.3)
frequency, median (min., max.)	1 (1,3)	1 (1,4)	1 (1,1)	1 (1,4)	1 (1,2)	1 (1,6)	1 (1,6)
volume, median (min., max.)	95 (10,500)	50 (7,240)	50 (15,120)	30 (10,150)	60 (10,200)	60 (10,180)	55 (7,500)

Table III (*Continued*)

	Brazil (n = 69)		Ghana (n = 228)		India (n = 173)		Norway (n = 159)		Oman (n = 153)		USA (n = 121)		All (n = 903)	
At 12 mo														
Animal milk, n (%)	31	(44.9)	107	(46.9)	139	(80.3)	65	(40.9)	41	(26.8)	39	(32.2)	422	(46.7)
frequency, median (min., max.)	3	(1,8)	2	(1,8)	2	(1,9)	2	(1,5)	1	(1,3)	2	(1,5)	2	(1,9)
volume, median (min., max.)	420	(50,1900)	60	(5,480)	240	(25,1575)	100	(10,500)	100	(20,500)	105	(10,600)	120	(5,1900)
Infant formula, n (%)	2	(2.9)	75	(32.9)	5	(2.9)	17	(10.7)	60	(39.2)	21	(17.4)	180	(19.9)
frequency, median (min., max.)	1.5	(1,2)	2	(1,8)	2	(1,3)	1	(1,4)	2	(1,6)	2	(1,5)	2	(1,8)
volume, median (min., max.)	240	(150,330)	180	(30,990)	300	(120,400)	130	(40,600)	105	(10,900)	210	(30,660)	150	(10,990)
Tea, n (%)	5	(7.3)	9	(4.0)	11	(6.4)	2	(1.3)	7	(4.6)	1	(0.8)	35	(3.9)
frequency, median (min., max.)	1	(1,4)	1	(1,5)	1	(1,2)	1	(1,1)	1	(1,1)	1	(1,1)	1	(1,5)
volume, median (min., max.)	90	(20,150)	60	(24,300)	30	(15,100)	35	(20,50)	50	(30,60)	15	(15,15)	50	(15,300)
Water, n (%)	22	(31.9)	184	(80.7)	160	(92.5)	138	(86.8)	150	(98.0)	84	(69.4)	738	(81.7)
frequency, median (min., max.)	1	(1,3)	5	(1,13)	5	(1,13)	3	(1,20)	4	(1,11)	2	(1,9)	4	(1,20)
volume, median (min., max.)	60	(10,220)	240	(20,1000)	150	(20,1000)	130	(10,600)	212.5	(20,1050)	120	(15,480)	180	(10,1050)
Juice, n (%)	36	(52.2)	56	(24.6)	35	(20.2)	20	(12.6)	93	(60.8)	52	(43.0)	292	(32.3)
frequency, median (min., max.)	2	(1,3)	1	(1,6)	1	(1,2)	1	(1,5)	1	(1,3)	1	(1,8)	1	(1,8)
volume, median (min., max.)	150	(30,360)	60	(10,720)	50	(20,200)	50	(10,400)	70	(20,300)	90	(7,480)	72.5	(7,720)

Compliance with feeding recommendations varied across sites depending on the initial baseline levels of breastfeeding and the sociocultural characteristics of each of the study subpopulations. Compliance was highest in Ghana and lowest in Brazil. Many Brazilian paediatricians recommended use of water and tea in the early months, prescribed formula when it was not necessary, and recommended complementary foods before children were 4 mo old [21]. Nevertheless, the efforts of the Brazilian lactation team made a substantial difference to the rates of exclusive/predominant breastfeeding and the duration of breastfeeding, resulting in a remarkable improvement compared to national and local rates [21]. In Ghana, breastfeeding is the norm, although exclusive breastfeeding rates in the general population are low. However, the provision of lactation support to the MGRS mothers increased the exclusive breastfeeding well beyond national levels [22].

Mothers who complied with the MGRS feeding criteria were less likely to be employed outside the home and more likely to have had a vaginal delivery, and fewer were primiparous. Similarly, pacifier use was more prevalent in the non-compliant group. Pacifier use has been associated with early weaning [23] and might partly explain the relatively early termination of breastfeeding in the Norwegian site despite long maternity leave (10 mo with 100% salary or 12 mo with 80% salary). Maternal education differed significantly between compliance groups when all sites were considered simultaneously, i.e. more highly educated mothers were more likely to comply with feeding criteria. However, the relationship went in opposite directions in the individual sites (Norway and Oman) where schooling was statistically different by compliance group. This might suggest cultural differences in the influence of education on breastfeeding practices.

Low rates of exclusive breastfeeding worldwide have raised concerns about the practicality of recommending a diet for children that occurs so infrequently [24]. However, recent evidence demonstrates that community-based breastfeeding counselling is a cost-effective way to increase exclusive breastfeeding rates [25–28]. Experience from the MGRS confirms this observation in six very different settings. The breastfeeding support team at each site served a critical role, particularly in providing lactation support during the first week or two after hospital discharge. Mothers were provided with information about avoiding sore nipples through correct breastfeeding technique, early management of nipple trauma when it occurred, prevention and early treatment of breast engorgement, the disadvantages of early introduction of any food besides human milk, and overall
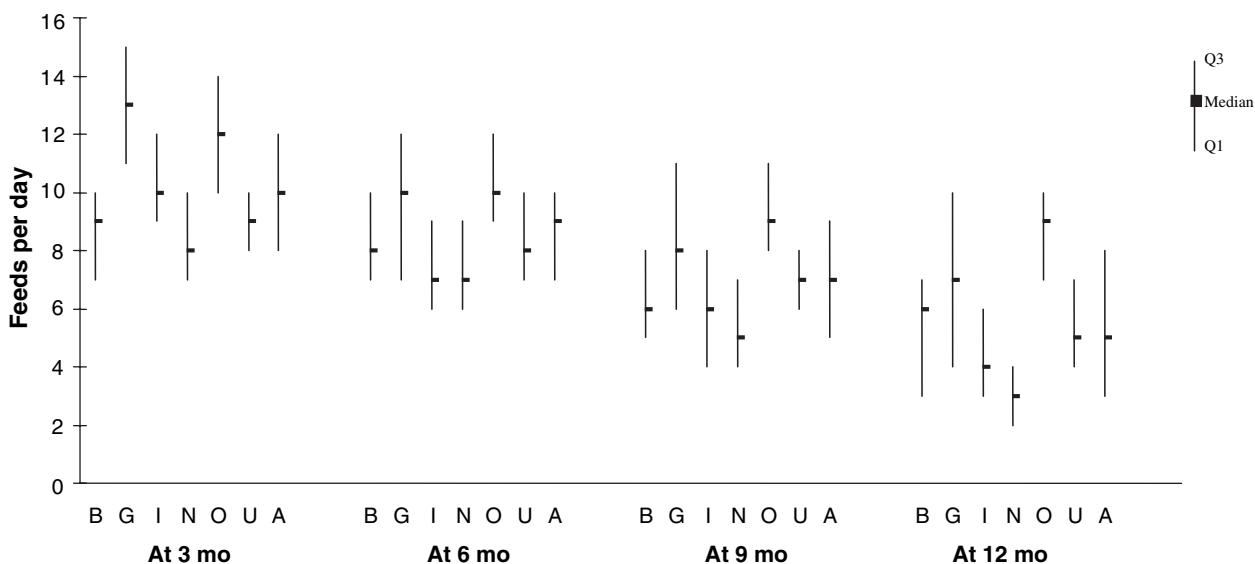
Figure 4. Median breastfeeding frequency among compliant infants by site and overall. B: Brazil; G: Ghana; I: India; N: Norway; O: Oman; U: USA; A: all sites.

Table IV. Median breastfeeding duration and continued breastfeeding at 24 mo by compliance category.

	Brazil	Ghana	India	Norway	Oman	USA	All
Compliant *n*	69	228	173	159	153	121	903
Non-compliant *n*	218	64	96	103	107	51	639
Duration of breastfeeding, median months (min., max.)							
Compliant	19.5*	16.1*	17.8*	15.2*	23.2*	18.3*	17.8*
	(12,24)	(12.1,24)	(12,24)	(12,24)	(12.3,24)	(12,24)	(12,24)
Non-compliant	6.3*	10.3*	9.4*	10.3*	17.4*	10.5*	9.3*
	(0.5,24)	(2,24)	(2,24)	(1,24)	(1.5,24)	(1.4,24)	(0.5,24)
Percent still breastfeeding at 24 mo							
Compliant	33.3*	5.7	23.1*	8.2*	11.8	32.2*	16.2*
Non-compliant	4.1*	1.6	4.2*	1.0*	9.3	5.9*	4.4*

*Statistically significant difference (*p*-value <0.05) between the compliant and non-compliant groups.

Table V. Breastfeeding initiation and pacifier use by compliance category and site.

	Brazil	Ghana	India	Norway	Oman	USA	All
Compliant *n*	69	228	173	159	153	121	903
Non-compliant *n*	218	64	96	103	107	51	639
Baby breastfed within 1 h of birth, %							
Compliant	–	57.1*	23.1	84.9	96.7	77.7	65.7
Non-compliant	–	40.7*	16.7	76.7	95.3	64.7	61.0
Median hours after birth baby breastfed for first time, h (min., max.)							
Compliant	–	5 (1,25)	4 (2,37)	2 (1,21)	2 (2,3)	2 (2,8)	4 (1,37)
Non-compliant	–	6 (2,28)	5 (2,50)	3 (1,20)	2 (1,5)	2 (2,25)	4 (1,50)
Use of pacifier at 2 wk, %							
Compliant	–	3.3	0.6	18.2	0.0	12.4	6.4
Non-compliant	–	1.8	1.0	18.6	0.9	3.9	5.8
Use of pacifier at 3 mo, %							
Compliant	–	3.2	0.6	44.3*	2.0	41.7	16.0*
Non-compliant	–	8.5	1.0	61.0*	2.9	45.1	23.0*
Use of pacifier at 6 mo, %							
Compliant	–	2.4	0.6	47.5	1.3*	41.3	16.3*
Non-compliant	–	1.9	0.0	60.2	5.8*	42.0	22.1*

*Statistically significant difference (*p*-value <0.05) between the compliant and non-compliant groups.

raised consciousness regarding the importance of breastfeeding for mothers and babies. The challenge is to extend this support, including guidance on breastfeeding techniques and ways to resolve problems, ideally as part of routine health services for the entire population.

The MGRS was designed to construct growth standards based on healthy breastfed infants and thereby establish coherence with national [29] and international [12] infant feeding guidelines that recommend breastfeeding as the optimal source of nutrition during infancy. Recognizing the adequacy of human milk to support not only healthy growth [24,29,30] but also cognitive development [31] and long-term health [32,33], the resulting growth standards [20] are recommended for application to all children independently of type of feeding.

Acknowledgements

References

[1] WHO. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. Technical Report Series No. 854. Geneva: World Health Organization; 1995.

[2] de Onis M, Habicht JP. Anthropometric reference data for international use: recommendations from a World Health Organization Expert Committee. Am J Clin Nutr 1996;64: 650–8.

[3] de Onis M, Yip R. The WHO Growth Chart: historical considerations and current scientific issues. Bibl Nutr Dieta 1996;53:74–89.

[4] WHO Working Group on Infant Growth. An evaluation of infant growth. Geneva: World Health Organization; 1994.

[5] WHO Working Group on Infant Growth. An evaluation of infant growth: the use and interpretation of anthropometry in infants. Bull World Health Organ 1995;73:165–74.

[6] Cole TJ, Paul AA, Whitehead RG. Weight reference charts for British long-term breastfed infants. Acta Paediatr 2002;91: 1296–300.

[7] de Onis M, Onyango AW. The Centers for Disease Control and Prevention 2000 growth charts and the growth of breastfed infants. Acta Paediatr 2003;92:413–9.

[8] de Onis M, Garza C, Habicht JP. Time for a new growth reference. Pediatrics 1997;100:E8.

[9] Garza C, de Onis M, for the WHO Multicentre Growth Reference Study Group. Rationale for developing a new international growth reference. Food Nutr Bull 2004;25 Suppl 1:S5–14.

[10] de Onis M, Garza C, Victora CG, Onyango AW, Frongillo EA, Martines J, for the WHO Multicentre Growth Reference Study Group. The WHO Multicentre Growth Reference Study: planning, study design and methodology. Food Nutr Bull 2004;25 Suppl 1:S15–26.

[11] de Onis M, Garza C, Victora CG, Bhan MK, Norum KR, editors. WHO Multicentre Growth Reference Study (MGRS): Rationale, planning and implementation. Food Nutr Bull 2004;25 Suppl 1:S1–89.

[12] Fifty-fourth World Health Assembly. Resolution WHA54.2, Infant and young child nutrition. Geneva: World Health Organization; 2001.

[13] Prakash NS, Mabry RM, Mohamed AJ, Alasfoor D, for the WHO Multicentre Growth Reference Study Group. Implementation of the WHO Multicentre Growth Reference Study in Oman. Food Nutr Bull 2004;25 Suppl 1:S78–83.

[14] Dewey KG, Cohen RJ, Nommsen-Rivers LA, Heinig MJ, for the WHO Multicentre Growth Reference Study Group. Implementation of the WHO Multicentre Growth Reference Study in the USA. Food Nutr Bull 2004;25 Suppl 1:S84–9.

[15] Araujo CL, Albernaz E, Tomasi E, Victora CG, for the WHO Multicentre Growth Reference Study Group. Implementation of the WHO Multicentre Growth Reference Study in Brazil. Food Nutr Bull 2004;25 Suppl 1:S53–9.

[16] Lartey A, Owusu WB, Sagoe-Moses I, Gomez V, Sagoe-Moses C, for the WHO Multicentre Growth Reference Study Group. Implementation of the WHO Multicentre Growth Reference Study in Ghana. Food Nutr Bull 2004;25 Suppl 1:S60–5.

[17] Bhandari N, Taneja S, Rongsen T, Chetia J, Sharma P, Bahl R, et al., for the WHO Multicentre Growth Reference Study Group. Implementation of the WHO Multicentre Growth Reference Study in India. Food Nutr Bull 2004;25 Suppl 1:S66–71.

[18] Baerug A, Bjoerneboe GE Aa, Tufte E, Norum KR, for the WHO Multicentre Growth Reference Study Group. Implementation of the WHO Multicentre Growth Reference Study in Norway. Food Nutr Bull 2004;25 Suppl 1:S72–7.

[19] WHO Multicentre Growth Reference Study Group. Complementary feeding in the WHO Multicentre Growth Reference Study. Acta Paediatr Suppl 2006;450:27–37.

[20] WHO Multicentre Growth Reference Study Group. WHO Child Growth Standards based on length/height, weight and age. Acta Paediatr Suppl 2006;450:76–85.

[21] Albernaz E, Giugliani ER, Victora CG. Supporting breastfeeding: a successful experience. J Hum Lact 1998;14:283–5.

[22] Ghana Statistical Service, Noguchi Memorial Institute for Medical Research and ORC Macro. Ghana Demographic and Health Survey 2003. Calverton, Maryland: GSS, NMIMR and ORC Macro; 2004.

[23] Barros FC, Victora CG, Semer TC, Tonioli Filho S, Tomasi E, Weiderpass E. Use of pacifiers is associated with decreased breast-feeding duration. Pediatrics 1995;95:497–9.

[24] WHO. The optimal duration of exclusive breastfeeding. Report of an Expert Consultation. Geneva: World Health Organization; 2002.

[25] Morrow AL, Guerrero ML, Shults J, Calva JJ, Lutter C, Bravo J, et al. Efficacy of home-based peer counselling to promote exclusive breastfeeding: a randomised controlled trial. Lancet 1999;353:1226–31.

[26] Haider R, Ashworth A, Kabir I, Huttly SR. Effect of community-based peer counsellors on exclusive breastfeeding practices in Dhaka, Bangladesh: a randomised controlled trial. Lancet 2000;356:1643–7.

[27] Albernaz E, Victora CG. Impacto do aconselhamento face a face sobre a duracão do aleitamento exclusivo: um estudo de revisão. Pan Am J Public Health 2003;14:17–24.

[28] Aidam BA, Perez-Escamilla R, Lartey A. Lactation counseling increases exclusive breast-feeding rates in Ghana. J Nutr 2005; 135:1691–5.

[29] American Academy of Pediatrics Policy Statement. Breast-feeding and the use of human milk. Pediatrics 2005;115:496–506.

[30] Harder T, Bergmann R, Kallischnigg G, Plagemann A. Duration of breastfeeding and risk of overweight: A meta-analysis. Am J Epidemiol 2005;162:397–403.

[31] Anderson JW, Johnstone BM, Remley DT. Breastfeeding and cognitive development: a meta-analysis. Am J Clin Nutr 1999; 70:525–35.

[32] Owen CG, Whincup PH, Odoki K, Gilg JA, Cook DG. Infant feeding and blood cholesterol: a study in adolescents and a systematic review. Pediatrics 2002;110:597–608.

[33] Singhal A, Cole TJ, Fewtrell M, Lucas A. Breastmilk feeding and lipoprotein profile in adolescents born preterm: follow-up of a prospective randomised study. Lancet 2004;363:1571–8.