

Enrolment and baseline characteristics in the WHO Multicentre Growth Reference Study

WHO MULTICENTRE GROWTH REFERENCE STUDY GROUP^{1,2}

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Abstract

Aim: To describe the WHO Multicentre Growth Reference Study (MGRS) sample with regard to screening, recruitment, compliance, sample retention and baseline characteristics. **Methods:** A multi-country community-based study combining a longitudinal follow-up from birth to 24 mo with a cross-sectional survey of children aged 18 to 71 mo. Study subpopulations had to have socio-economic conditions favourable to growth, low mobility and $\geq 20\%$ of mothers practising breastfeeding. Individual inclusion criteria were no known environmental constraints on growth, adherence to MGRS feeding recommendations, no maternal smoking, single term birth and no significant morbidity. For the longitudinal sample, mothers and newborns were screened and enrolled at birth and visited 21 times at home until age 24 mo. **Results:** About 83% of 13 741 subjects screened for the longitudinal component were ineligible and 5% refused to participate. Low socio-economic status was the predominant reason for ineligibility in Brazil, Ghana, India and Oman, while parental refusal was the main reason for non-participation in Norway and USA. Overall, 88.5% of enrolled subjects completed the 24-mo follow-up, and 51% (888) complied with the MGRS feeding and no-smoking criteria. For the cross-sectional component, 69% of 21 510 subjects screened were excluded for similar reasons as for the longitudinal component. Although low birthweight was not an exclusion criterion, its prevalence was low (2.1% and 3.2% in the longitudinal and cross-sectional samples, respectively). Parental education was high, between 14 and 15 y of education on average.

Conclusion: The MGRS criteria were effective in selecting healthy children with comparable affluent backgrounds across sites and similar characteristics between longitudinal and cross-sectional samples within sites.

Key Words: Child nutrition, growth standards, longitudinal study, socio-economic status, survey methodology

Introduction

The origin of the WHO Multicentre Growth Reference Study (MGRS) [1] dates back to the early 1990s when the World Health Organization (WHO) initiated a comprehensive review of the uses and interpretation of anthropometric references and conducted an in-depth analysis of growth data from breastfed infants [2,3]. This analysis showed that the growth pattern of healthy breastfed infants deviated to a significant extent from the National Center for Health Statistics (NCHS)/WHO international reference [2,3]. The review group concluded from these and other related findings that the NCHS/WHO reference did not adequately describe the physiological growth of children and that its use to monitor the health and nutrition of individual children, or to derive estimates of child malnutrition in populations, was flawed. Moreover, the review group recom-

mended that a standard rather than a reference be constructed, adopting a novel approach that would describe how children *should* grow when free of disease and when their care follows healthy practices such as breastfeeding and non-smoking [1]. The MGRS was launched in 1997 [4] and drew the participation of children from six sites around the world: Brazil (South America), Ghana (Africa), India (Asia), Norway (Europe), Oman (Middle East) and the USA (North America). The growth charts that have been constructed based on the MGRS data are presented in a companion paper in this supplement [5]. The objective of this paper is to provide an overview of the MGRS sample with regard to screening, recruitment, sample attrition, and compliance with the study's feeding and no-smoking criteria. We also provide a description of the baseline characteristics of the study sample.

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Methods

The MGRS (1997–2003) had two components: a longitudinal follow-up in which children were recruited at birth and followed up at home until they were 24 mo of age, and a cross-sectional survey involving children aged 18 to 71 mo. The study populations lived under socio-economic conditions favourable to growth, with low mobility and $\geq 20\%$ of mothers practising breastfeeding [4]. As part of the site selection process in Ghana, India and Oman, surveys were conducted to identify socio-economic characteristics that could be used to select groups whose growth was not environmentally constrained [6–8]. Local criteria for screening newborns, based on parental education and/or income levels, were developed from those surveys. Pre-existing survey data were available from Brazil, Norway and the USA for this purpose [9–11]. A detailed description of the MGRS protocol and its implementation in the six sites has been provided elsewhere [4,9–14].

Longitudinal sample

Infants for the longitudinal component were recruited from selected hospitals and clinics where at least 80% of the subpopulations of interest delivered. Within 24 h of birth, mother–infant pairs were screened for participation in the study. Subjects were enrolled if they met the study’s eligibility criteria: specifically, no environmental or economic constraints on growth, mothers’ willingness to follow the study’s feeding recommendations (i.e. exclusive or predominant breastfeeding for at least 4 mo, introduction of complementary foods by the age of 6 mo, and partial breastfeeding continued to age ≥ 12 mo), gestational age ≥ 37 completed weeks and < 42 wk, single birth, non-smoking mother, and the absence of significant morbidity in the newborn [4]. Due to large numbers of maternity facilities used by the subpopulations targeted for the MGRS in Ghana and India, these sites implemented a two-stage screening procedure. First, newly delivered mothers in Ghana were pre-screened on area of residence and socio-economic status [12], while in India pre-screening took place during pregnancy [13]. The second and final screening stage at both sites was completed within 24 h of birth. Following screening, children were classified as eligible if all criteria had been met or ineligible if one or more eligibility criteria had not been met. The former were invited to participate in the study.

At the first follow-up home visit (2 wk after delivery) mothers were re-screened to confirm eligibility. This enabled study teams to identify “hidden refusals” (those who repealed their decision to participate) and “hidden ineligibles” (e.g. mothers who had not complied with the feeding recommenda-

tions). These infants were dropped from the study and replaced in the sample. Thus, at 2 wk, all children screened for the longitudinal follow-up fell into one of three categories: 1) enrolled subjects; 2) ineligible (including ineligibles identified at first contact and hidden ineligibles); and 3) refusals (those who refused at first contact and hidden refusals). Those who left the study after this point were considered dropouts and were not replaced in the sample [4]. Only children of mothers who complied with the MGRS feeding and no-smoking criteria have been included in the growth standards’ sample [5]. However, regardless of compliance status, the entire cohort was followed up.

Cross-sectional sample

Children aged 18 to 71 mo were targeted for the cross-sectional component, with recruitment strategies varying by site. In Brazil, India and the USA, children were recruited through a door-to-door survey of selected study areas. In Norway and Oman, children were identified through a national or health registry, and in Ghana, from crèches and nursery schools. Details of the sampling procedures employed at each site are provided elsewhere [9–14]. The cross-sectional survey sampling strategy aimed at recruiting children with backgrounds similar to those in the longitudinal sample. Thus, the same exclusion criteria and site-specific socio-economic criteria were applied, with the exception of infant feeding practices, where a minimum duration of 3 mo of any breastfeeding was required for inclusion in the cross-sectional sample [4].

Results

Longitudinal sample

Tables I and II show the enrolment statistics and reasons for ineligibility by study site for the longitudinal component. Out of 13 741 mother–infant pairs screened, 1743 (12.7%) were enrolled in the longitudinal sample (Table I). Overall, about 83% of the subjects screened were ineligible (ranging between 30.9% in the USA and 91.8% in Brazil) and about 5% refused to participate (mainly in the USA, Norway and India). Inability to meet the study’s socio-economic criteria was the main reason for ineligibility in Brazil (54.3%), Ghana (74.2%), India (24.4%) and Oman (47.3%) (Table II). Smoking accounted for 19% and 9.2% of the total ineligibility in Brazil and Norway, respectively. The two main reasons for ineligibility, i.e. residence out of study area and low socio-economic status, together accounted for 71.2% of the exclusions (Table II).

Table I. Enrolment statistics for the longitudinal sample by site.

	Brazil	Ghana	India	Norway	Oman	USA	All
Pre-screened ^a , <i>n</i>		1519	259				1778
Screened, <i>n</i>	4801	538	433	836	4957	398	11963
Ineligibles ^b , <i>n</i> (%)	4407 (91.8)	1681 (81.7)	310 (44.8)	402 (48.1)	4428 (89.3)	123 (30.9)	11351 (82.6)
Refusals ^c , <i>n</i> (%)	84 (1.7)	47 (2.3)	81 (11.7)	134 (16.0)	234 (4.7)	67 (16.8)	647 (4.7)
Enrolled at 2 wk, <i>n</i> (%)	310 (6.5)	329 (16.0)	301 (43.5)	300 (35.9)	295 (6.0)	208 (52.3)	1743 (12.7)

^a The total number of pre-screened subjects in Ghana and India are 2057 and 692, respectively, including 538 (Ghana) and 433 (India) that completed screening at birth.

^b Ineligibles: ineligibles at first hospital contact plus hidden ineligibles at 2 wk.

^c Refusals: refusals at first hospital contact plus hidden refusals at 2 wk.

Overall, 888 (50.9%) mother–child pairs complied with the study’s feeding and no-smoking criteria and completed the 2-y follow-up, ranging across sites from 21.6% in Brazil to 69.3% in Ghana (Table III). The great majority of compliant children (96%) completed the study. Attrition (dropout) rates and reasons for discontinuing participation are summarized in Table IV. Only 11.5% of the enrolled subjects failed to complete the 24-mo follow-up. The main reasons across sites for dropping out were the family moving out of the study area (57.7%) and the parents’ request (33.8%).

The characteristics of the families enrolled in the longitudinal component are shown in Table V. The majority of the families had fewer than three children, the median number of children being two for the entire sample. Parental educational attainment was generally high across sites. About 59% of mothers and 63% of fathers had completed at least 15 y of education, 89% of both parents having completed at least 10 y of education. Mean maternal age for the

entire sample was 29.4 y. As expected, fathers were taller (175.1 cm) than mothers (161.6 cm), Norwegian parents being the tallest and Omanis the shortest among the sites. Household monthly income was standardized by converting to US dollar equivalents based on the exchange rate prevailing at the beginning of the study in each site. In Ghana the exchange rates were different for the longitudinal and cross-sectional components because of local currency devaluation between the starting points of the two components. Over 99% of families in the longitudinal sample had access to piped water, a flush toilet, refrigerator and a gas or electric cooker, and over 93% and 86% had telephones and cars, respectively.

The characteristics of the children in the longitudinal sample (Table VI) indicate about 73% vaginal deliveries, high Apgar scores at 1 and 5 min, and a low prevalence of low birthweight across sites (overall 2.1%). The all-site mean birthweight, length and head circumference were 3.3 kg, 49.6 cm and 34.2 cm, respectively.

Table II. Reasons for ineligibility for the longitudinal sample by site.

	Brazil	Ghana	India	Norway	Oman	USA	All
Total screened (<i>n</i>)	4801	2057	692	836	4957	398	13741
Total ineligible (<i>n</i>)	4407	1681	310	402	4428	123	11351
<i>Reasons for ineligibility^a (%)</i>							
Resides out of study area	24.9	11.4	6.2	14.2	31.2	0.0	22.8
Multiple birth	2.2	0.8	0.0	2.9	1.3	0.8	1.5
Perinatal morbidity ^b	6.1	1.3	1.7	12.2	5.0	5.8	5.1
Gestational age outside range	8.7	1.5	4.5	6.2	6.5	3.3	6.3
Breastfeeding non-compliance	1.0	0.2	6.1	1.2	6.7	14.1	3.6
Mother is a smoker	19.0	0.1	0.4	9.2	0.6	1.5	7.5
Low socio-economic status	54.3	74.2	24.4	0.0	47.3	0.8	48.4
Language difficulty	0.0	0.0	0.0	6.8	14.0	4.3	5.6
Late notification of birth	0.0	1.2	1.2	0.0	0.0	1.8	0.3
Incomplete screening	1.9	0.0	0.0	0.0	0.2	0.0	0.7
Child illness/death	0.0	0.1	0.0	0.5	0.2	1.0	0.2
Moving away	0.1	0.6	0.6	0.1	0.5	0.5	0.4
Other reasons	0.1	0.0	0.0	0.0	0.1	0.0	0.1

^a The ineligibility tally may exceed 100% because of subjects excluded for multiple reasons.

^b High perinatal morbidity in Norway is due to breech births.

Table III. Compliance with feeding and no-smoking criteria in the longitudinal sample by site.

	Brazil	Ghana	India	Norway	Oman	USA	All
Enrolled at 2 wk	310	329	301	300	295	208	1743
Compliant, study completed, <i>n</i> (%)	67 (21.6)	228 (69.3)	173 (57.5)	148 (49.4)	153 (51.8)	119 (57.2)	888 (50.9)
Compliant, study not completed, <i>n</i> (%)	3 (1.0)	6 (1.8)	8 (2.6)	7 (2.3)	4 (1.4)	10 (4.8)	38 (2.2)
Not compliant, study completed, <i>n</i> (%)	220 (71.0)	64 (19.5)	96 (31.9)	114 (38.0)	107 (36.3)	53 (25.5)	654 (37.5)
Not compliant, study not completed, <i>n</i> (%)	20 (6.4)	31 (9.4)	24 (8.0)	31 (10.3)	31 (10.5)	26 (12.5)	163 (9.4)

Cross-sectional sample

Table VII presents enrolment statistics for the cross-sectional component. A total of 21 510 children were screened in the six countries, ranging from 837 in the USA to 5185 in Norway. Of these, 6697 (31.1%) were enrolled in the study. The common reasons for exclusion were low socio-economic status (ranging from nil in Norway to 64.1% in Oman), maternal smoking (0.1% in Ghana to 28.5% in Brazil), gestational age outside range (2.8% in Oman to 16.3% in Norway), child breastfed for less than 3 mo (1.4% in Oman to 28.7% in Brazil) and residence outside the study area (nil in Norway and USA to 23.3% in India). Refusal to participate in the study was lowest in Brazil (0.1%) and highest in Norway (11.8%). The “other exclusions” in Ghana (25.9%) and Norway (18.9%) were for varied reasons, including inability to contact the family, and children who had travelled out of the area or had outgrown the maximum age limit for the study.

Average years of schooling for fathers ranged from about 11 in Brazil to 19 in Ghana, and for mothers from 11 y in Brazil to 17 y in India (Table VIII). For a median number of two children per family (range 1 to 15), the average maternal age of 33 y was high. Average maternal weights were between 62.6 kg in India and 74.5 kg in Ghana. Mothers in Norway were the tallest (167.7 cm) and those in Oman the shortest (156.6 cm), as was the case in the longitudinal sample. Although incomes expressed in US dollars varied widely among sites (lowest in Ghana and highest in Norway), the populations selected for the study in the developing country sites belonged to the upper socio-economic strata, while in Norway and the USA all socio-economic groups were included. Other

socio-economic status markers, as assessed by ownership of material goods, ranged from 91.1% for cars overall to 99.8% for gas/electric cookers and refrigerators (Table VIII).

With regard to the baseline characteristics of enrolled children (Table IX), as was the case in the longitudinal sample, there was a slight predominance of males (51.7%) in the total sample, primarily due to the higher percentage of male children (56.5%) in the Indian sample. Overall, a quarter of deliveries were by caesarean section, with the highest rates in Brazil (55.6%) and India (36.2%) and the lowest rates in Oman, Norway and the USA (12–14%). The average birthweight was 3338 g, infants from Norway being the heaviest at birth (3636 g). The average duration of breastfeeding ranged from 12 mo in Brazil to 17 mo in Oman. Infant formula or other milks were introduced at mean ages ranging from 5.2 mo in Oman to 12.4 mo in the USA, and solids/semi-solids between 4.1 mo in Oman and 5.8 mo in Ghana (Table IX).

Discussion

The MGRS was designed to describe how children should grow under optimal conditions in any setting. To achieve this aim, a prescriptive approach was adopted for the study [4]. This paper summarizes the characteristics of children who were enrolled in the MGRS after application of selection criteria aimed at accessing children with unconstrained growth. Not surprisingly, high rates of ineligibility due to low socio-economic status were reported in Brazil, Ghana, India and Oman. On the other hand, parental refusal to participate in the study was the main reason for

Table IV. Follow-up rate and reasons for dropout in the longitudinal sample by site.

	Brazil	Ghana	India	Norway	Oman	USA	All
Enrolled at 2 wk	310	329	301	300	295	208	1743
Completed 2-y follow-up	287 (92.6)	292 (88.8)	269 (89.4)	262 (87.3)	260 (88.1)	172 (82.7)	1542 (88.5)
Dropouts after week 2	23 (7.4)	37 (11.2)	32 (10.6)	38 (12.7)	35 (11.9)	36 (17.3)	201 (11.5)
<i>Reason for dropout</i>							
Child illness	0	1	1	2	4	0	8
Moved away	10	20	27	26	10	23	116
Unknown or other reason	0	1	0	2	2	4	9
Parents' wish	13	15	4	8	19	9	68

Table V. Baseline characteristics of families in the longitudinal sample by site.

	Brazil (<i>n</i> = 310)	Ghana (<i>n</i> = 329)	India (<i>n</i> = 301)	Norway (<i>n</i> = 300)	Oman (<i>n</i> = 295)	USA (<i>n</i> = 208)	All (<i>n</i> = 1743)
<i>Reproductive history of mother:</i>							
Children born alive; median (range)	2 (1–7)	2 (1–8)	1 (1–3)	1 (1–5)	2 (1–12)	1 (1–5)	2 (1–12)
With < 3 children (%)	81.6	68.7	96.7	87.7	51.4	84.1	78.1
Primiparous (%)	49.0	38.1	53.5	55.0	27.8	53.4	45.7
<i>Parental characteristics:</i>							
Years of education completed							
Mother (mean ± SD)	11.1 ± 3.5	15.1 ± 2.7	17.5 ± 1.5	15.4 ± 2.6	11.9 ± 3.3	16.7 ± 2.1	14.5 ± 3.6
<10 y	33.6	2.7	0	1.3	24.8	0	10.9
10–14 y	41.9	36.9	0.6	31.7	52.2	12.5	30.3
15–19 y	24.5	56.4	90.4	64.0	22.7	75.5	54.5
≥20 y	0	4.0	9.0	3.0	0.3	12.0	4.3
Father (mean ± SD)	10.2 ± 3.6	18.1 ± 3.0	17.4 ± 1.8	15.2 ± 2.8	12.8 ± 3.6	16.9 ± 2.6	15.0 ± 4.1
<10 y	39.4	0.9	0	2.0	19.7	1.5	11.2
10–14 y	44.5	6.5	1	33.3	46.4	14.4	24.9
15–19 y	16.1	65.0	87.0	62.0	33.2	64.9	54.1
≥20 y	0.0	27.6	12.0	2.7	0.7	18.8	9.8
Maternal age (mean ± SD)	28.3 ± 6.3	30.8 ± 4.0	28.9 ± 3.5	30.6 ± 4.4	27.5 ± 4.9	30.8 ± 4.8	29.4 ± 4.9
<20 y	11	0	0	0	3.1	1.4	2.6
20–24 y	15.8	4	11.3	9	24.7	7.2	12.1
25–29 y	29.4	36.2	43.5	30.3	44.1	30.3	35.9
30–34 y	27.7	39.8	38.5	42.3	17.6	37.5	33.8
>35y	16.1	20.0	6.7	18.4	10.5	23.6	15.6
Mother's height (cm) (mean ± SD)	161.1 ± 6.0	161.9 ± 5.2	157.6 ± 5.4	168.7 ± 6.6	156.6 ± 5.5	164.5 ± 6.9	161.6 ± 7.2
Father's height (cm) (mean ± SD)	173.6 ± 6.9	173.0 ± 6.6	172.7 ± 6.3	182.2 ± 6.7	170.4 ± 6.4	178.9 ± 7.4	175.1 ± 7.9
Use of alcoholic beverages by mothers							
Never	85.8	90.2	98.7	68.3	100	78.3	85.0
<1/wk	11.0	9.2	1.3	30.3	–	20.7	13.8
≥1/wk	3.2	0.6	0	1.4	–	1	1.2
<i>Socio-economic factors:</i>							
Family income per month (median)							
Local currency ^a	1100	1 700 000	45 000	48 482	1140	5000	5000
USD	1019	739	957	6296	2938	5000	5000
Piped water	100	100	100	100	100	100	100
Flush toilet	100	98.8	100	100	100	100	99.8
Refrigerator	100	98.5	100	100	100	100	99.7
Gas/electric cooker	100	98.2	100	100	100	100	99.7
Telephone	85.2	81.4	99.0	100	98.3	100	93.4
Car	71	81.4	90.4	83.3	97.3	99.0	86.2

Note: All responses are percentages unless otherwise specified.

^a Local currency (USD equivalent): Real for Brazil (1.08); Cedis for Ghana (2300 in 1999); Rupees for India (47); Kroner for Norway (7.7); Omani Rials for Oman (0.388).

Table VI. Baseline characteristics of children in the longitudinal sample by site.

	Brazil (n = 310)	Ghana (n = 329)	India (n = 301)	Norway (n = 300)	Oman (n = 295)	USA (n = 208)	All (n = 1743)
Male sex, %	52.3	48.9	54.2	53.3	50.2	50.0	51.5
Apgar score							
1 min	8.7±1.1	7.7±1.2	8.3±1.0	8.7±0.9	8.5±0.9	7.9±1.6	8.3±1.2
5 min	9.7±0.5	9.2±0.9	9.1±0.6	9.4±0.6	9.8±0.6	8.9±0.6	9.4±0.7
Mode of delivery (%)							
Vaginal	46.1	72.9	59.5	90.0	85.8	87	72.6
Caesarean	53.9	27.1	40.5	10.0	14.2	13	27.4
Low birthweight, % (<2500 g)	1.9	1.5	4.7	0.7	2.7	0.5	2.1
Birthweight, kg	3.3±0.4	3.3±0.4	3.1±0.4	3.6±0.5	3.2±0.4	3.6±0.5	3.3±0.5
Birth length, cm	49.6±1.9	49.4±1.9	49.0±1.8	50.4±1.9	49.2±1.7	49.7±2.0	49.6±1.9
Head circumference, cm	34.6±1.1	34.3±1.2	33.8±1.2	34.9±1.2	33.4±1.0	34.2±1.3	34.2±1.3

non-participation in Norway and the USA. The fraction of children excluded from the cross-sectional sample was somewhat lower than for the longitudinal sample, but the main reasons for exclusion were the same, i.e. low socio-economic status in Brazil, Ghana, India and Oman, and refusals in Norway and the USA. Overall, the completion rate in the longitudinal component was very high (88.5%) despite the intense follow-up of 21 home visits over the 2-y period. This was largely due to the interest shown by participating mothers in the growth and development of their children.

There were no notable intra-site differences in parental education and height between the longitudinal and cross-sectional samples. Incomes were also largely comparable within sites, except for Ghana where, in local currency terms, the cross-sectional sample's median income was 1.8 times higher than that of the longitudinal sample. In US dollar equivalents, however, the longitudinal sample's median income was almost twice that of the cross-sectional sample, reflect-

ing a dramatic drop in the foreign exchange value of the Ghanaian cedi between 1999 (start of the longitudinal follow-up) and 2001 when the cross-sectional survey began. The higher proportion across sites of primiparous mothers in the longitudinal compared with the cross-sectional sample is consistent with the fact that mothers in the latter were invariably older—by an average of over 3 y—than their counterparts in the longitudinal sample. The all-site ratio of male/female children in the two study components was the same, with slight variations in individual sites. Although some intra-site variation was seen with respect to rates of low birthweight, average weight at birth measured in the longitudinal sample and based on parental records for the cross-sectional sample was equal in all sites. In overall terms, therefore, the longitudinal and cross-sectional samples were taken from the same subpopulation in each site.

The study selected subjects with overall high parental education across sites, notably in Ghana [12] and India [13] where education was applied as

Table VII. Enrolment statistics for the cross-sectional sample by site.

	Brazil	Ghana	India	Norway	Oman	USA	All
Screened, <i>n</i>	2292	4818	3886	5185	4492	837	21510
Enrolled, <i>n</i> (%)	487 (21.2)	1406 (29.2)	1490 (38.3)	1387 (26.8)	1447 (32.2)	480 (57.3)	6697 (31.1)
Refusals, <i>n</i> (%)	2 (0.1)	60 (1.2)	107 (2.8)	614 (11.8)	57 (1.3)	76 (9.1)	916 (4.3)
Ineligibles, <i>n</i> (%)	1803 (78.7)	3352 (69.6)	2289 (58.9)	3184 (61.4)	2988 (66.5)	281 (33.6)	13897 (64.6)
<i>Reasons for ineligibility^a (%)</i>							
Outside study area	5.2	2.3	23.3	0.0	0.2	0.0	5.3
Multiple birth	1.9	1.8	1.8	0.0	0.3	3.0	1.1
Gestational age outside range	9.7	8.3	8.8	16.3	2.8	11.2	9.4
Mother is a smoker	28.5	0.1	1.1	13.6	1.0	4.4	6.9
Low socio-economic status	59.3	36.6	29.6	0.0	64.1	0.5	33.3
Child with disease	2.2	0.9	2.4	5.6	5.3	0.6	3.4
Child breastfed <3 mo	28.7	2.0	12.0	5.3	1.4	15.1	7.8
Language difficulty	0.0	0.1	0.3	8.9	1.1	0.7	2.5
Longitudinal study participant	0.0	2.0	0.0	1.2	0.0	0.0	0.7
Longitudinal study sibling	0.0	0.0	0.0	0.0	0.0	3.9	0.2
Other exclusions	0.6	25.9	0.0	18.9	0.1	0.0	10.4

^a The ineligibility tally may exceed 100% because of subjects being excluded for multiple reasons.

Table VIII. Baseline characteristics of families in the cross-sectional sample by site.

	Brazil (n=487)	Ghana (n=1406)	India (n=1490)	Norway (n=1387)	Oman (n=1447)	USA (n=480)	All (n=6697)
Reproductive history of mother							
Children born alive, median (range)	2 (1-9)	2 (1-10)	2 (1-5)	2 (1-6)	3 (1-15)	2 (1-6)	2 (1-15)
Primiparous (%)	37.6	20.6	41.1	26.3	8.8	23.8	25.2
Years of education, mean \pm SD							
Mother	11.2 \pm 3.5	15.2 \pm 3.1	17.3 \pm 1.8	15.4 \pm 2.7	11.8 \pm 3.5	16.5 \pm 2.2	14.8 \pm 3.6
Father	10.8 \pm 3.7	18.8 \pm 3.2	17.4 \pm 1.8	15.6 \pm 2.8	13.1 \pm 3.6	16.8 \pm 2.6	15.8 \pm 3.8
Maternal age (mean \pm SD)							
	32.0 \pm 6.5	34.6 \pm 4.7	31.9 \pm 4.1	34.9 \pm 4.7	30.8 \pm 5.1	35.3 \pm 5.1	33.1 \pm 5.1
Weight in kg, mean \pm SD							
Mother	63.5 \pm 12.5	74.5 \pm 14.3	62.6 \pm 10.2	66.2 \pm 10.5	66.0 \pm 14.3	66.4 \pm 13.3	66.9 \pm 13.2
Father	79.7 \pm 13.3	78.2 \pm 13.6	76.2 \pm 12.1	83.5 \pm 11.9	77.0 \pm 13.5	83.9 \pm 14.1	78.9 \pm 13.2
Height in cm, mean \pm SD							
Mother	160.0 \pm 6.2	161.9 \pm 5.7	157.6 \pm 5.7	167.7 \pm 6.5	156.6 \pm 5.4	164.3 \pm 6.7	161.0 \pm 7.2
Father	173.2 \pm 7.0	172.6 \pm 6.6	172.1 \pm 6.0	181.2 \pm 7.2	169.2 \pm 6.4	178.0 \pm 7.4	173.8 \pm 7.9
Socio-economic factors							
Family income per month (median)							
Local currency ^a	1400	3 300 000	37 250	56 767	1150	5833	
USD	1296	404	793	7372	2964	5833	
Piped water supply	100	99.9	100	100	100	99.6	100
Own flush toilet	100	97.4	100	100	100	99.6	99.4
Own refrigerator	99.6	99.3	100	100	100	99.6	99.8
Own gas/electric cooker	100	99.4	100	99.9	100	99.6	99.8
Own telephone	97.7	95.2	99.5	99.9	99.9	99.6	98.6
Own car	75.8	83.3	92.7	92.1	98.4	99.6	91.1

Note: All responses are percentages unless otherwise specified.

^a Local currency (USD equivalent): Real for Brazil (1.08); Cedis for Ghana (8172 in 2002); Rupees for India (47); Kroner for Norway (7.7); Omani Rials for Oman (0.388).

a screening criterion. Although family income in US dollar equivalents varied widely across sites, other indicators of socio-economic status, such as availability of basic household amenities, were relatively evenly distributed. The income differences should not be viewed in absolute terms since the cost of living varied from site to site. There were disparities across sites in

the weights and heights of mothers and fathers, and in the mode of delivery, reflecting variations in secular trends of physical growth and cultural differences in birthing choices.

Despite the problems of unreliability inherent in recalled information, the early child feeding practices in the cross-sectional sample (reported) tallied well

Table IX. Baseline characteristics of children in the cross-sectional sample by site.

	Brazil (n=487)	Ghana (n=1406)	India (n=1490)	Norway (n=1387)	Oman (n=1447)	USA (n=480)	All (n=6697)
Male sex (%)	49.7	48.7	56.5	52.4	49.6	52.3	51.7
Mode of delivery (%)							
Vaginal	44.4	71.6	63.8	86.7	87.7	86.0	75.5
Caesarean	55.6	28.3	36.2	13.3	12.3	14.0	24.5
Low birthweight (%)^a							
Birthweight (g)	3423 \pm 458	3316 \pm 524	3113 \pm 448	3636 \pm 455	3187 \pm 443	3582 \pm 457	3338 \pm 507
Breastfeeding duration (mo) ^b	12.0 \pm 10.9	14.3 \pm 5.8	12.6 \pm 8.3	13.1 \pm 6.3	17.0 \pm 7.6	16.8 \pm 10.2	14.3 \pm 7.9
Age in months other milks or formula introduced	11.1 \pm 17.2	5.9 \pm 8.8	6.5 \pm 12.9	10.0 \pm 9.2	5.2 \pm 7.7	12.4 \pm 16.1	7.6 \pm 11.4
Age in months solids/semi-solid food introduced	5.1 \pm 2.2	5.8 \pm 6.0	4.4 \pm 3.5	5.2 \pm 1.3	4.1 \pm 1.3	5.7 \pm 1.8	4.9 \pm 3.5

Note: All figures are mean \pm SD unless otherwise specified.

^a Birthweight <2500 g.

^b Breastfeeding for at least 3 mo was an inclusion criterion in the cross-sectional sample.

with comparable data in the longitudinal sample (observed prospectively). For example, the mean duration of breastfeeding was in between the durations observed in the longitudinal sample's feeding compliant and non-compliant groups in all sites except Oman [15]. This overall pattern is expected given the shorter breastfeeding duration required for inclusion in the cross-sectional sample. The similarity in average age at introduction of complementary feeding was even more striking, being equal in Ghana and within a month of each other in the other sites [16].

The prevalence of low birthweight in the MGRS samples in Brazil, Ghana, India and Oman was much lower than national prevalence rates of 8.5% for Brazil [17], 11% for Ghana, 30% for India and 8% for Oman [18]. This suggests that the selection criteria applied in these sites were effective in excluding most children from low socio-economic status households where the risk of low birthweight is high. The children enrolled in the longitudinal component were quite similar across sites for weight, length and head circumference at birth, and, as described in a companion paper in this supplement, the patterns of linear growth thereafter were strikingly similar among the six sites [19]. Thus, it appears that the selection criteria applied were successful in screening for children who were healthy at birth and with a high probability of experiencing unconstrained growth.

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