

Similarities and differences in child development from birth to age 3 years by sex and across four countries: a cross-sectional, observational study



Ilgi Ozturk Ertem, Vibha Krishnamurthy, Mphelekedzeni C Mulaudzi, Yanina Sguassero, Hakan Balta, Ozlem Gulumser, Burcu Bilik, Roopa Srinivasan, Benjamin Johnson, Geliang Gan, Lisa Calvocoressi, Veronika Shabanova, Brian W C Forsyth



Summary

Background Knowledge about typical development is of fundamental importance for understanding and promoting child health and development. We aimed to ascertain when healthy children in four culturally and linguistically different countries attain developmental milestones and to identify similarities and differences across sexes and countries.

Methods In this cross-sectional, observational study, we recruited children aged 0–42 months and their caregivers between March 3, 2011, and May 18, 2015, at 22 health clinics in Argentina, India, South Africa, and Turkey. We obtained a healthy subsample, which excluded children with a low birthweight, perinatal complications, chronic illness, undernutrition, or anaemia, and children with missing health data. Using the Guide for Monitoring Child Development, caregivers described their child's development in seven domains: expressive and receptive language, gross and fine motor, play, relating, and self-help. Clinicians examining the children also completed a checklist about the child's health status. We used logit and probit regression models based on the lowest deviance information criterion to generate Bayesian point estimates and 95% credible intervals for the 50th percentile ages of attainment of 106 milestones. We assessed the significance of differences between sexes and countries using predefined criteria and regions of practical equivalence.

Findings Of 10246 children recruited, 4949 children (48.3%) were included in the healthy subsample. For the 106 milestones assessed, the median age of attainment was equivalent for 102 (96%) milestones across sexes and 81 (76%) milestones across the four countries. Across countries, median ages of attainment were equivalent for all play milestones, 20 (77%) of 26 expressive language milestones, ten (67%) of 15 receptive language milestones, nine (82%) of 11 fine motor milestones, 14 (88%) of 16 gross motor milestones, and eight (73%) of 11 relating milestones. However, across the four countries the median age of attainment was equivalent for only two (22%) of nine milestones in the self-help domain.

Interpretation The ages of attainment of developmental milestones in healthy children, and the similarities and differences across sexes and country samples might aid the development of international tools to guide policy, service delivery, and intervention research, particularly in low-income and middle-income countries.

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Introduction

Research from various fields of science has established the importance of early childhood development on health and productivity across the lifespan.¹ Nevertheless, 43% of children younger than 5 years in low-income and middle-income countries (LMICs) are estimated to be at risk of not reaching their full developmental potential.² Such estimates have been used to calculate loss of adult productivity and increased health expenditures in LMICs.³ These estimates, however, are indirect measures, based on the proportions of children with stunting and those living in poverty. To guide early childhood development policies, research is underway to substantiate these estimates by creating population indicators of early childhood development based on assessment of children's development.⁴ Two other pressing needs require methods of assessing child development across LMICs. The first is

for health-care systems to be able to assess the development of individual children and identify the need for interventions.⁵ The second is for research tools to be able to measure the effect of interventions on child development.⁶ All measurements of early childhood development, whether they are population-based indicators, individual assessments, or research tools, must incorporate information on early developmental milestones. To guide the development of universally applicable tools, it is first necessary to establish when healthy children attain milestones, and which milestones are similarly attained across sexes and countries.

Whether child development is similar across sexes and populations is a question that is of fundamental importance for understanding and promoting human development.^{4–7} One of the UN Sustainable Development Goal indicators is “the proportion of children under

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Department of Paediatrics, Division of Developmental and Behavioural Paediatrics, School of Medicine, Ankara University, Ankara, Turkey (Prof I O Ertem MD, H Balta MD, O Gulumser MD, B Bilik MSc); Ummeed Child Development Center, Mumbai, India (V Krishnamurthy MD, R Srinivasan MD); Department of Paediatrics and Child Health, Kalafong Hospital, University of Pretoria, Pretoria, South Africa (M C Mulaudzi MD); Perinatal Study Centre of Rosario, Rosario, Argentina (Y Sguassero MD); and Yale Center for Analytical Science, School of Public Health (B Johnson MSc, G Gan PhD, L Calvocoressi PhD) and Department of Pediatrics, School of Medicine (Veronika Shabanova PhD, Prof B W C Forsyth MBChB), Yale University, New Haven, CT, USA

Correspondence to: Prof Ilgi Ozturk Ertem, Department of Paediatrics, Division of Developmental and Behavioural Paediatrics, School of Medicine, Ankara University, Ankara, Turkey ertemilgi@yahoo.com

Research in context

Evidence before this study

The absence of information about when healthy children attain developmental milestones and which milestones are attained similarly across sexes and countries that are culturally different remains an important barrier to addressing developmental difficulties and supporting early childhood development within health-care systems in low-income and middle-income countries (LMICs). The Guide for Monitoring Child Development (GMCD) has been identified as an instrument that meets both psychometric properties and feasibility criteria in LMICs for monitoring child development in seven domains: expressive language, receptive language, fine motor, gross motor, relating, play, and self-help. We did a background search which we began on Jan 11, 2007, for the original manuscript describing the GMCD and the WHO book *Developmental Difficulties in Early Childhood: Prevention, Early Identification, Assessment and Intervention in Low and Middle-Income Countries*. The search has been updated to July 31, 2017. We searched PubMed, PsychINFO, and Google from inception to July 31, 2017, for original research articles and systematic reviews pertaining to assessment of early childhood development in LMICs. The search terms we used included: "development", "screening", "monitoring", "surveillance", "instruments", "milestone", "early intervention", "disability", "delay", "disorder", "risk", "psychosocial", "anemia", "nutrition", "prematurity", "chronic illness", "low birth weight", "depression", "poverty", "gender", "country", "low and middle-income", and "high-income". Previous research on sex and country differences for early childhood development is inconclusive as a result of several methodological issues. The largest previous study led by WHO, done in the 1990s, concluded that child development could not be compared

across countries. More recently, the WHO Motor Development Study for the first time used a healthy sample to assess six motor milestones in five countries and in 2006 concluded that these milestones were attained at similar ages across sexes and countries. However, no study has used a sample of healthy children to examine the ages of attainment of milestones in multiple domains across different country samples.

Added value of this study

We enrolled a large sample of healthy children in four countries with different demographic, cultural, and linguistic characteristics, and showed that most developmental milestones in early childhood are attained at similar ages. Across countries, the age of attainment of milestones was most similar in the play domain, whereas the largest differences in age of attainment were found in the self-help domain. To the best of our knowledge, our study is the first to provide the ages of attainment of more than 100 milestones in multiple domains in healthy children from four different countries, and to examine the differences between sexes and countries using predefined criteria and regions of practical equivalence.

Implications of all the available evidence

Our study provides information about the age of attainment of early developmental milestones and about the specific milestones that are attained at similar ages across sexes and countries, which fulfils an essential need in addressing children's health and development in LMICs. Further development of assessment tools that incorporate these milestones could potentially enhance services and development of policies and contribute to intervention research that benefits the development of children internationally.

5 years of age who are developmentally on track in health, learning and psychosocial well-being, by sex".⁸ The UNICEF Multiple Indicator Cluster Survey⁷ has incorporated questions to assess the development of children aged 3–5 years at the population level. What is considered developmentally on track in the first 3 years and whether it can be measured universally, however, remains unclear. Previous research^{9–11} has shown that children attain developmental milestones at substantially different ages across sexes and cultures. This conclusion is derived from studies that had a number of methodological problems, one of the most important being that little attention was given to children's health and the extent to which this might affect their development. The largest international study⁹ on the attainment of developmental milestones in children, led by WHO, included sites where children's health-related risks were likely to be different. This study also applied different assessment tools across the populations. Other studies have examined narrow age ranges or few domains of development, and have based their

conclusions on statistical significance, but not necessarily clinical significance.^{10,11} On the basis of the conclusion that child development is different across countries, many countries have had to devote substantial resources to the re-standardisation of instruments for the measurement of child development or have been left without methods to assess children.^{5,12} The WHO Motor Development Study¹³ examined for the first time a healthy sample of children and found that ages at which children achieve six gross motor milestones were similar across sexes and five diverse countries. Whether the ages of attainment of milestones in other developmental domains vary in healthy children across different countries has not been established.⁵

The aim of our study was to ascertain when healthy children of both sexes and in four countries that are geographically, culturally, and linguistically different attain key developmental milestones, to establish which milestones are attained at similar ages across sexes and countries, and to identify those milestones for which important differences exist.

Methods

Study design and participants

We did this cross-sectional, observational study in Argentina, India, South Africa, and Turkey. We recruited children between March 3, 2015, and May 18, 2015, from 22 health clinics and identified a subsample of healthy children for generating milestone curves to examine similarities and differences among sexes and countries in ages of attainment of developmental milestones.

The study was done in clinics providing routine health care, which, in Argentina, South Africa, and Turkey, were in the Ministry of Health community health centres in the greater urban and peri-urban regions of Rosario (Argentina), Pretoria (South Africa), and Ankara (Turkey). In Mumbai (India), in addition to similar clinics, children were also recruited at private physicians' offices to ensure that an adequate number of healthy children were recruited. We aimed to recruit children at typical health-care clinics, but did not aim for country-representative sites. The sites are referred to by country name because multiple sites were included within each country.

The study was approved by the institutional review board at each site (Ankara University School of Medicine Ethics Committee [Ankara], Centro Rosarino de Estudios Perinatales Comite de Etica Independiente, Comite de Etica en Investigacion Secretaria de Salud Publica [Rosario], Kasturba Hospital [Mumbai], University of Pretoria Faculty of Health Sciences Research Ethics Committee [Pretoria]), and by Yale University School of Medicine Human Investigation Committee [New Haven, CT]). The research assistants obtained written informed consent from the children's caregivers.

Children aged 0–42 months and their caregivers who were seen for either routine care or minor illnesses were recruited. Children aged between 37 and 42 months were included to ensure that we correctly identified a median age of attainment for children nearing 36 months of age. A subsample of healthy children was identified by excluding any children who fulfilled one or more of the following criteria: birthweight less than 2500 g; perinatal complications requiring neonatal interventions, prolonged hospital stay or readmission; undernutrition (weight for age, length for age, or weight for height Z score of less than -2 on the WHO Child Growth Standards),¹⁴ or history of undernutrition; history of chronic health or developmental problems according to medical records or physical examination at the time of the study (eg, congenital heart disease, HIV infection, or autism); or history of anaemia or haemoglobin concentration of less than 105 g/L at the time of the assessment. Children with missing health data were also excluded. Little information is available about the sample size needed to assess differences and similarities between ages of milestone attainment. In each country, we aimed to recruit 50 healthy children per 1, 2, and 3 monthly intervals in the 0–6, 7–12, and 13–42 month age groups, respectively.

Procedures

We used the developmental monitoring component of the Guide for Monitoring Child Development (GMCD)¹⁵ to assess the ages of attainment of milestones. The GMCD is an open-ended, pre-coded interview (10 min duration) with the caregiver, which assesses child development in the domains of expressive and receptive language, fine and gross motor functioning, relating, play, and self-help. The theoretical construct and components of the GMCD have been described previously.^{15–18} The development of the GMCD over 10 years in Turkey involved developing the open-ended questions and probes, determining milestones that caregivers provided as responses to the questions, examining face validity to assure that the milestones were robust indicators of children's functioning by selecting milestones that existed in other well used instruments and consulting with international experts, and doing reliability, standardisation, validity, and feasibility studies. The GMCD has received demand internationally, and service providers from over 20 countries have been trained in its use.¹⁸

The GMCD was considered appropriate for use in this study because the open-ended interview technique avoids common problems associated with testing children, such as children not complying with tests in unfamiliar circumstances, and questionnaires that pose closed questions (ie, yes or no questions), which might result in socially desired answers. Furthermore, the GMCD has been identified in a comprehensive review³ as one of three developmental screening instruments that meet psychometric and feasibility criteria appropriate for LMICs. All 125 original GMCD milestones were used, including 89 that had been standardised and validated for children aged 2 years and younger in Turkey, and 36 milestones for older children (aged 25–42 months) that had been piloted and assessed for face validity.

We complied with guidelines for translation and adaptation of instruments.^{19,20} In Rosario and Ankara, the GMCD was applied using the predominant languages of Spanish and Turkish; in Pretoria using isiZulu, sePedi, seTswana, and English; and in Mumbai using Marathi, Gujrathi, Hindi, and English. The original Turkish GMCD was translated to English, checked for quality by two experienced translators, and independently back-translated to Turkish. The remaining translations were done from the English version and back-translated to English.

All research staff were fluent in English in addition to their native languages. One author, IOE—developer of the GMCD—trained the research staff on how to use the GMCD in English. To ensure high inter-rater reliability, each research assistant's scoring on English speaking cases was compared with IOE's scoring after training. Agreement with IOE on at least 95% of all scored milestones for ten consecutive GMCD interviews was required of each research assistant. Inter-rater reliability

Panel: Omitted milestones**Milestones that could not be elicited reliably from caregivers**

- 1 Facial expressions change with different emotions
- 2 Expresses eagerness in facial expression
- 3 Uses words or sentences to communicate feelings (eg, “baby angry” or “I’m scared”)
- 4 Understands simple questions (eg, “where is mommy?”)
- 5 Shows interest in and wants to interact with new people or children
- 6 Reaches for people or objects with arms
- 7 Holds with fingers the top or middle end of a pencil or stick and draws
- 8 Jumps with both feet off the ground
- 9 Shows progression in toilet training by having some dry days

Milestones for which 50th percentile point estimates for the total sample occurred at older than 36 months

- 1 Uses plurals (birds, dogs)
- 2 Understands complex words (easy, hard)
- 3 Understands complex words (good, bad)
- 4 Walks up and down stairs alternating feet, without holding caregiver’s hand or rail
- 5 Draws identifiable figures (circle, square, triangle, or other shape)
- 6 Draws human or animal figures with identifiable body parts
- 7 Articulates how other people are feeling
- 8 Takes turns and plays simple games with rules (eg, hide and seek)
- 9 Washes hands without assistance
- 10 Brushes teeth without assistance

thereafter was checked and corrected monthly in the native languages by the co-investigators who had high inter-rater reliability with IOE and quarterly by IOE through the review of videotapes of interviews that were in English, Spanish (using interpreters when needed), or Turkish. For quality assurance, each research assistant was observed doing two interviews each month. To ensure that caregivers could comprehend the questions and respond, the translated GMCD questions and milestones were piloted in samples of 100 children with different languages and age ranges at each site. Subsequently we omitted nine milestones from the study that caregivers did not report spontaneously and when probed stated that they were unclear whether the child had obtained the milestone (panel).

An international advisory committee comprised of experts in child development and representatives from WHO and UNICEF provided feedback on the appropriateness of the milestones and interpretation of the results.

The research assistants interviewed caregivers using the GMCD, and obtained data on household socio-demographics. Anonymity was maintained by excluding identifying information from all data. Anthropometry was done using standard methods¹⁴ and haemoglobin was measured using HemoCue.²¹ The clinicians examining the children completed a checklist with information on the child’s health status on the basis of their clinical assessments, health records when available, and physical examination results.

Statistical analysis

To estimate the distribution of ages of attainment across sexes and countries, we calculated the ages of the children in months by dividing their age in days by 30. The data consisted of binary measurements (ie, attain and non-attain) and thus logistic and probit regression models—suitable for binary outcomes—were used to provide estimates of the cumulative distribution of the age of attainment for each milestone. Selection between logit and probit models was based on the lowest deviance information criterion for each milestone.²²

To assess the ages of attainment of milestones across sexes and countries, and to allow comparison between the results of our study and previous studies,⁹ we used the 50th percentile age of attainment of milestones. Bayesian point estimates and corresponding 95% credible intervals (CrIs) were generated for the 50th percentile ages of attainment for girls, boys, each country, and the total sample. The CrIs were generated from the 2·5th and 97·5th percentiles of the posterior distribution of the median age at milestone attainment. In Bayesian inference, the probability of attaining a milestone by a particular age (posterior probability) was estimated by modelling the logit or probit of an outcome of interest after the data were collected, and by incorporating the non-informative or neutral previous information on the contribution of each predictor (eg, sex, age, or country) on the logit or probit. We used the Markov Chain Monte Carlo package (MCMCpack)—which contains the MCMClogit function—to output the posterior distribution of the children’s age variable corresponding to the 50th percentile (cumulative probability) of each milestone. No standard definition is available to calculate significant differences when comparing ages of attainment of milestones. Within our large sample, small differences were likely to be statistically significant. We therefore applied criteria to assess the clinical significance of the magnitude of the difference by defining a region of practical equivalence.²³ Milestones were considered to be attained at equivalent ages if the absolute difference was 1·5 months or less, 2·5 months or less, 3·5 months or less, and 4·5 months or less, for milestones with 50th percentile point estimates between ages 0 and 6, 7 and 12, 13 and 24 months, and 25 and 36 months, respectively, and if the observed 95% CrIs of the differences were within the region of practical equivalences. Milestones with 50th percentile point estimates of more than 36 months were omitted (panel).

We did statistical analysis using R statistical software (version 3.3.1) and the MCMCpack and BEST statistical packages.

Role of the funding source

The funder had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data

in the study and had final responsibility for the decision to submit for publication.

Results

Of the 10 246 children recruited, 281 (2.7%) had missing health data and were excluded. From the remaining sample, 5016 children (806 [36%] of 2223 in Turkey, 1065 [43%] of 2480 in Argentina, 1518 [56%] of 2733 in India, and 1627 [64%] of 2529 in South Africa) were excluded. Of the 9965 children with health data, the most frequent reasons for exclusions were anaemia (2468 [25%]) and undernutrition (2461 [25%]). The final sample of healthy children included 4949 (48.3%) of the 10 246 children recruited. Of the 4949 children included in the final sample, 1417 (29%) were enrolled in Turkey, 1415 (29%) in Argentina, 1215 (25%) in India, and 902 (18%) in South Africa. In all four countries, fewer girls were recruited than boys, and girls were even less well represented in the healthy sample of 4949 children. Girls accounted for 630 (44%) of 1417 included children in Turkey, 369 (41%) of 902 children in South Africa, 619 (44%) of 1415 children in Argentina, and 396 (33%) of 1215 children in India. Characteristics of the healthy sample are shown in table 1.

Of the 116 milestones investigated, the 50th percentile point estimates were more than age 36 months for ten milestones (panel) and were therefore excluded from further analysis. The 50th percentile point estimates with

95% CrIs for the remaining 106 milestones are shown in table 2. Milestones with non-equivalent differences across sexes and countries are shown also in table 2. For example, for milestone 68 in the fine motor domain (holds a pencil or stick skilfully at lower tip with fingertips and draws), non-equivalent differences were identified between the median age of attainment for boys and girls (30.3 months [95% CrI 29.1–31.5] vs 26.5 months [25.4–27.6]; table 2) and between most countries (25.6 months [95% CI 24.1–27.2] for Argentina; 28.3 months [27.0–29.9] for India; 33.1 months [30.2–37.1] for South Africa; and 29.5 months [28.0–31.2] for Turkey; table 2).

Across the sexes, most milestones were attained at a younger age by girls than boys, but the differences between sexes were small (102 [96%] of 106 milestones were equivalent). Most milestones (81 [76%] of 106) were equivalent across all four countries. When examined by domain, most milestones were equivalent across countries in the play (18 [100%] of 18), fine motor (nine [82%] of 11), gross motor (14 [88%] of 16), relating (eight [73%] of 11), expressive language (20 [77%] of 26), and receptive language (ten [67%] of 15) domains. In the self-help domain, only two (22%) of the nine milestones were equivalent. 11 (44%) of the 25 milestones that were not equivalent across countries involved exposure to tasks such as children taking care of themselves, climbing up and down stairs, and drawing; seven of these were in the

	Total (N=4949)	Argentina (n=1415)	India (n=1215)	South Africa (n=902)	Turkey (n=1417)
Sex					
Female	2014 (41%)	619 (44%)	396 (33%)	369 (41%)	630 (44%)
Male	2935 (59%)	796 (56%)	819 (67%)	533 (59%)	787 (56%)
Child's age					
0–6 months	1976 (40%)	575 (41%)	502 (41%)	446 (49%)	453 (32%)
7–12 months	888 (18%)	216 (15%)	217 (18%)	172 (19%)	283 (20%)
13–18 months	584 (12%)	164 (12%)	140 (12%)	89 (10%)	191 (13%)
19–24 months	529 (11%)	168 (12%)	119 (10%)	64 (7%)	178 (13%)
25–30 months	355 (7%)	102 (7%)	96 (8%)	44 (5%)	113 (8%)
31–36 months	355 (7%)	101 (7%)	83 (7%)	42 (5%)	129 (9%)
37–42 months	262 (5%)	89 (6%)	58 (5%)	45 (5%)	70 (5%)
Mother's education*					
<12 years	2422/4942 (49%)	1031/1414 (73%)	340/1210 (28%)	464/902 (51%)	587/1416 (41%)
≥12 years	2520/4942 (51%)	383/1414 (27%)	870/1210 (72%)	438/902 (49%)	829/1416 (59%)
Mother's age†					
≤19 years	313/4897 (6%)	218/1392 (16%)	7/1205 (1%)	59/888 (7%)	29/1412 (2%)
20–24 years	1222/4897 (25%)	464/1392 (33%)	202/1205 (17%)	255/888 (28%)	301/1412 (21%)
25–34 years	2709/4897 (55%)	556/1392 (40%)	854/1205 (71%)	451/888 (51%)	848/1412 (60%)
≥35 years	653/4897 (13%)	154/1392 (11%)	142/1205 (12%)	123/888 (14%)	234/1412 (17%)
Partner's education‡					
<12 years	1915/4563 (42%)	868/1179 (74%)	284/1208 (24%)	263/763 (34%)	500/1413 (35%)
≥12 years	2648/4563 (58%)	311/1179 (26%)	924/1208 (76%)	500/763 (66%)	913/1413 (65%)

Data are n (%), or n/N (%) when N differs from the total N given at the top of the column. The sum of percentages for some columns does not equal 100 because all percentages are presented to the nearest whole number. *Data for seven children were missing. †Data for 52 children were missing. ‡Data for 386 children were missing.

Table 1: Sociodemographic characteristics of participants

	Total	Girls	Boys	Argentina	India	South Africa	Turkey
Expressive language							
1. Relaxes when held	0.0 (0.0-0.1)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
2. Makes different sounds for happy, irritable, hungry states	0.0 (0.0-0.4)	0.1 (0.0-0.5)	0.0 (0.0-0.4)	0.0 (0.0-0.5)	0.1 (0.0-0.4)	0.4 (0.0-1.0)	0.8 (0.0-1.1)
3. Vocalises vowels	1.1 (1.0-1.3)	1.3 (1.1-1.4)	1.1 (0.9-1.2)	1.6 (1.4-1.8)	0.8 (0.7-1.0)	1.0 (0.6-1.3)	1.3 (1.1-1.6)
4. Laughs aloud	2.8 (2.7-2.9)	2.9 (2.7-3.1)	2.7 (2.6-2.9)	3.0 (2.8-3.2)	3.0 (2.8-3.2)	3.0 (2.7-3.2)	2.3 (2.0-2.4)
5. Vocalises combined vowel and consonant sounds	4.6 (4.5-4.8)	4.5 (4.3-4.8)	4.7 (4.5-4.9)	5.3 (5.0-5.6)	4.7 (4.3-5.0)	4.6 (4.3-4.9)	4.0 (3.7-4.2)
6. Uses gestures (shakes head in protest, lifts arms to be picked up)	5.4 (5.2-5.5)	5.3 (5.0-5.5)	5.4 (5.2-5.6)	5.5 (5.2-5.8)	6.2 (5.9-6.6)	5.1 (4.8-5.4)	4.7 (4.4-5.0)
7. Repeats syllables	6.3 (6.1-6.4)	6.1 (5.9-6.4)	6.3 (6.1-6.6)	6.2 (5.9-6.5)	6.7 (6.4-7.1)	5.4 (5.1-5.7)	6.8 (6.5-7.2)
8. Has one meaningful word	9.3 (9.1-9.6)	9.2 (8.9-9.5)	9.4 (9.1-9.7)	8.4 (8.0-8.8)	10.1 (9.6-10.5)	9.0 (8.5-9.5)	10.0 (9.6-10.4)
9. Uses arm or hand to point to people or objects	8.5 (8.3-8.8)	8.3 (8.0-8.6)	8.7 (8.4-9.0)	8.0 (7.7-8.5)	9.8 (9.5-10.4)	8.8 (8.3-9.4)	7.8 (7.4-8.1)
10. Uses index finger to point	12.0 (11.7-12.2)	11.8 (11.4-12.1)	12.1 (11.8-12.5)	12.5 (11.9-13.0)	11.9 (11.4-12.4)	11.4 (10.8-12.0)	12.0 (11.6-12.4)
11. Uses two meaningful words	12.5 (12.2-12.9)	12.2 (11.7-12.7)	12.8 (12.4-13.2)	11.2 (10.7-11.8)	12.2 (11.6-12.8)	14.1 (13.2-15.1)	13.0 (12.5-13.6)
12. Caregivers understand some of child's communication	13.6 (13.3-13.9)	13.2 (12.7-13.6)	13.9 (13.4-14.3)	13.1 (12.5-13.6)	12.1 (11.5-12.7)	15.7 (14.7-16.7)	14.1 (13.5-14.7)
13. Uses four meaningful words*	15.3 (14.9-15.7)	14.8 (14.3-15.4)	15.7 (15.2-16.2)	14.4 (13.9-14.9)	14.0 (13.5-14.5)	17.7 (16.2-19.5)	15.7 (15.3-16.2)
14. Uses six meaningful words	16.7 (16.3-17.1)	15.8 (15.3-16.4)	17.3 (16.8-17.8)	15.7 (14.9-16.4)	16.1 (15.3-16.8)	19.2 (18.3-20.1)	16.8 (16.1-17.5)
15. Uses combination of words and gestures to communicate desires†	16.2 (15.8-16.5)	15.5 (15.0-16.1)	16.7 (16.2-17.2)	14.8 (14.1-15.5)	15.6 (15.0-16.4)	18.8 (17.7-19.9)	16.5 (15.8-17.1)
16. Strangers understand some of child's communication*	16.5 (16.1-16.9)	15.7 (15.1-16.3)	17.1 (16.5-17.7)	15.7 (14.9-16.5)	14.3 (13.5-15.0)	19.8 (18.7-21.1)	17.4 (16.7-18.2)
17. Uses two-word sentences (eg, "give water")‡	21.1 (20.6-21.5)	20.3 (19.7-20.9)	21.7 (21.1-22.4)	23.4 (22.4-24.4)	19.1 (18.3-19.9)	20.6 (19.5-21.7)	20.8 (20.1-21.5)
18. Caregivers understand most of child's speech*‡§	21.5 (21.0-22.0)	20.7 (20.0-21.5)	22.1 (21.4-22.8)	24.3 (23.3-25.3)	17.0 (16.1-17.9)	22.4 (21.3-23.6)	22.4 (21.6-23.2)
19. Uses sentences with at least three words to communicate	24.9 (24.4-25.4)	23.9 (23.3-24.6)	25.8 (25.1-26.5)	25.4 (24.5-26.4)	23.2 (22.3-24.2)	22.0 (20.7-23.4)	26.5 (25.6-27.4)
20. Caregivers understand all of child's speech	25.2 (24.6-25.9)	23.9 (22.9-24.7)	26.4 (25.5-27.4)	26.7 (25.5-28.1)	22.8 (21.5-24.2)	24.1 (22.0-26.6)	25.8 (24.8-26.8)
21. Uses three word sentences to communicate desires (eg, "mama want food")	25.3 (24.8-25.8)	24.3 (23.6-25.0)	26.2 (25.5-26.8)	27.2 (26.3-28.2)	23.6 (22.7-24.5)	23.7 (22.5-25.0)	25.7 (24.9-26.5)
22. Uses pronouns	25.6 (25.1-26.1)	24.3 (23.7-25.1)	26.7 (25.9-27.5)	25.4 (24.4-26.4)	24.4 (23.5-25.4)	24.4 (23.1-25.8)	27.2 (26.3-28.2)
23. Uses past tense	28.0 (27.5-28.6)	26.8 (26.0-27.6)	29.1 (28.2-29.9)	28.2 (27.0-29.3)	27.8 (26.6-29.1)	28.5 (26.9-30.3)	27.8 (26.9-28.7)
24. Uses sentences with four words to communicate†¶	28.1 (27.6-28.7)	27.0 (26.2-27.8)	29.1 (28.3-29.9)	28.9 (27.9-29.9)	26.9 (25.9-27.9)	24.9 (23.5-26.2)	30.0 (29.0-31.1)
25. Strangers understand most of child's speech	28.7 (27.9-29.6)	27.0 (25.9-28.2)	30.1 (29.0-31.2)	30.1 (28.6-31.9)	26.7 (25.2-28.4)	25.8 (23.6-28.4)	30.1 (28.6-31.8)
26. Recounts a story or an event	30.4 (29.8-31.1)	29.1 (28.3-30.0)	31.5 (30.6-32.4)	32.0 (30.7-33.2)	29.8 (28.6-31.2)	30.3 (28.6-32.2)	29.6 (28.6-30.6)
Receptive language							
27. Alerts when talked to, slows down movements	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.1)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
28. Shows listening by watching face when caregiver speaks	0.4 (0.3-0.5)	0.3 (0.2-0.5)	0.4 (0.3-0.6)	0.3 (0.1-0.5)	0.4 (0.3-0.6)	0.3 (0.0-0.8)	0.9 (0.3-1.2)
29. Responds by making sounds when caregiver talks	1.6 (1.5-1.7)	1.6 (1.5-1.8)	1.5 (1.4-1.7)	1.4 (1.2-1.6)	1.5 (1.3-1.7)	1.9 (1.7-2.2)	1.6 (1.3-1.8)
30. Shows understanding of common words (eg, "no" and "mummy")	6.1 (5.9-6.3)	6.0 (5.8-6.4)	6.2 (5.9-6.4)	5.0 (4.7-5.3)	7.0 (6.6-7.4)	6.5 (6.1-7.0)	6.2 (5.8-6.5)
31. Understands names of familiar people	7.3 (7.0-7.5)	7.2 (6.9-7.6)	7.3 (7.0-7.5)	6.1 (5.7-6.4)	8.1 (7.8-8.6)	7.4 (7.0-7.9)	7.6 (7.2-7.9)
32. Understands verbs or action words‡	8.1 (7.9-8.3)	8.0 (7.7-8.3)	8.2 (7.9-8.5)	6.6 (6.2-6.9)	10.1 (9.6-10.5)	8.6 (8.1-9.1)	7.7 (7.3-8.1)
33. Understands names of objects	10.3 (10.1-10.6)	10.2 (9.8-10.6)	10.4 (10.1-10.7)	9.7 (9.3-10.2)	9.6 (9.2-10.0)	11.6 (10.9-12.3)	10.7 (10.3-11.1)

(Table 2 continues on next page)

	Total	Girls	Boys	Argentina	India	South Africa	Turkey
(Continued from previous page)							
34. Waves "bye" or gestures in response to command	10.8 (10.6–11.0)	10.6 (10.2–10.9)	11.0 (10.6–11.3)	10.4 (10.0–10.9)	10.2 (9.8–10.6)	11.7 (11.1–12.4)	11.2 (10.8–11.5)
35. Understands one simple command	12.5 (12.3–12.8)	12.4 (12.0–12.8)	12.7 (12.3–13.0)	13.5 (12.9–14.1)	12.1 (11.7–12.6)	14.4 (13.7–15.2)	11.4 (11.0–11.9)
36. Understands more than one simple command*†¶	14.4 (14.0–14.7)	14.3 (13.8–14.9)	14.4 (14.0–14.9)	14.3 (13.7–14.9)	13.2 (12.7–13.8)	19.1 (18.1–20.4)	13.4 (12.8–13.9)
37. Listens to brief stories or when caregivers narrate an event¶	15.5 (15.2–15.9)	15.2 (14.6–15.8)	15.8 (15.3–16.3)	15.9 (15.3–16.6)	15.6 (14.9–16.5)	19.9 (18.7–21.1)	13.7 (13.1–14.3)
38. Understands names of at least three objects (eg, ball, dog, spoon)*‡§	19.2 (18.8–19.7)	18.8 (18.2–19.5)	19.6 (19.0–20.2)	19.7 (18.9–20.5)	15.5 (14.8–16.2)	22.9 (21.7–24.1)	20.5 (19.8–21.3)
39. Answers simple questions ("Is mummy home?")	20.3 (19.9–20.7)	19.6 (19.0–20.3)	20.8 (20.2–21.4)	19.7 (18.9–20.4)	19.3 (18.5–20.2)	22.4 (21.3–23.7)	20.6 (19.9–21.4)
40. Understands two-level commands*	21.6 (21.1–22.0)	21.1 (20.4–21.9)	21.9 (21.2–22.6)	21.0 (20.2–21.9)	19.7 (18.9–20.6)	25.2 (23.7–26.9)	22.0 (21.2–22.8)
41. Understands prepositions (eg, "under" or "on top")	21.8 (21.3–22.3)	21.2 (20.5–22.0)	22.2 (21.6–22.9)	21.5 (20.6–22.5)	20.2 (19.2–21.1)	22.8 (21.2–24.6)	22.1 (21.3–22.9)
Gross motor							
42. Moves arms and legs equally on both sides	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–0.0)
43. Raises face when lying on tummy (prone)	0.1 (0.0–0.2)	0.2 (0.0–0.4)	0.1 (0.0–0.2)	0.2 (0.0–0.5)	0.1 (0.0–0.2)	0.4 (0.0–0.8)	0.7 (0.0–1.1)
44. Turns head (prone)	0.4 (0.3–0.5)	0.4 (0.2–0.6)	0.4 (0.2–0.5)	0.4 (0.1–0.6)	0.4 (0.3–0.6)	0.0 (0.0–0.0)	0.8 (0.2–1.2)
45. Holds head steady and erect	2.1 (2.0–2.3)	2.1 (1.9–2.3)	2.2 (2.0–2.3)	2.2 (2.0–2.4)	2.8 (2.5–3.0)	2.5 (2.3–2.7)	1.2 (0.6–2.0)
46. Lifts head 90° (prone)	2.5 (2.4–2.6)	2.5 (2.3–2.7)	2.5 (2.3–2.6)	2.7 (2.5–2.9)	3.2 (3.0–3.4)	2.4 (2.2–2.6)	1.7 (1.4–2.0)
47. Held erect, straightens, pushes legs rather than bending	3.8 (3.7–3.9)	3.9 (3.7–4.0)	3.7 (3.6–3.9)	3.4 (3.2–3.6)	3.9 (3.7–4.2)	3.7 (3.5–4.0)	4.1 (3.9–4.2)
48. Sits with support	4.3 (4.1–4.4)	4.3 (4.2–4.5)	4.2 (4.1–4.3)	3.8 (3.6–4.1)	4.6 (4.3–4.8)	4.2 (4.0–4.4)	4.5 (4.3–4.7)
49. Rolls front to back to front	5.7 (5.6–5.9)	5.8 (5.5–6.0)	5.7 (5.5–5.9)	6.2 (5.9–6.5)	5.6 (5.4–5.9)	5.1 (4.8–5.3)	6.1 (5.8–6.4)
50. Sits without support	6.5 (6.4–6.7)	6.3 (6.1–6.6)	6.7 (6.5–6.9)	6.6 (6.3–6.9)	7.1 (6.8–7.5)	5.3 (5.1–5.6)	7.3 (7.1–7.6)
51. Pulls to stand holding on to objects	8.5 (8.3–8.7)	8.6 (8.3–8.9)	8.5 (8.2–8.7)	8.3 (8.0–8.7)	8.2 (7.9–8.6)	8.2 (7.8–8.5)	9.4 (9.0–9.8)
52. Walks holding on to objects	9.7 (9.6–9.9)	9.9 (9.6–10.2)	9.6 (9.4–9.9)	10.2 (9.8–10.6)	9.7 (9.4–10.1)	9.1 (8.7–9.5)	10.0 (9.6–10.3)
53. Stands alone momentarily	10.0 (9.8–10.2)	9.9 (9.6–10.3)	10.0 (9.7–10.3)	10.1 (9.7–10.5)	9.9 (9.5–10.3)	9.7 (9.3–10.2)	10.2 (9.9–10.5)
54. Walks alone	12.9 (12.7–13.1)	13.0 (12.7–13.4)	12.8 (12.5–13.1)	13.3 (12.8–13.8)	12.6 (12.1–13.0)	12.9 (12.4–13.5)	12.8 (12.5–13.2)
55. Kicks ball or another object	13.9 (13.6–14.2)	14.3 (13.8–14.8)	13.7 (13.3–14.0)	14.0 (13.5–14.6)	13.9 (13.3–14.4)	14.7 (14.0–15.5)	13.5 (13.1–14.0)
56. Walks up stairs holding caregivers' hand or rail*†‡¶	17.6 (17.1–18.1)	17.8 (17.0–18.6)	17.4 (16.8–18.1)	19.3 (18.2–20.3)	15.3 (14.7–15.9)	26.4 (24.2–29.0)	15.3 (14.8–15.9)
57. Walks down stairs holding caregiver's hand or rail*†‡¶	20.0 (19.5–20.6)	20.0 (19.2–20.9)	20.1 (19.3–20.9)	21.9 (20.8–23.1)	17.7 (16.9–18.5)	30.8 (28.2–34.2)	17.4 (16.8–18.1)
Fine motor							
58. Keeps hands open (not fist) some of the time	2.1 (2.0–2.2)	2.1 (2.0–2.1)	2.1 (2.0–2.2)	2.1 (1.8–2.4)	1.7 (1.2–2.1)	2.3 (2.0–2.6)	2.6 (2.3–2.9)
59. Brings both hands to midline	2.2 (2.1–2.3)	2.2 (2.0–2.4)	2.2 (2.0–2.4)	1.9 (1.6–2.1)	2.4 (2.1–2.7)	2.5 (2.1–2.7)	2.2 (1.9–2.5)
60. Keeps hands open (not fist) most of the time	2.2 (2.0–2.3)	2.1 (1.8–2.4)	2.2 (1.9–2.4)	2.1 (1.8–2.4)	1.7 (1.2–2.1)	2.3 (2.0–2.6)	2.6 (2.3–2.9)
61. Reaches towards objects or people with hands	4.1 (4.0–4.2)	4.1 (3.9–4.2)	4.2 (4.0–4.3)	3.6 (3.4–3.8)	4.7 (4.5–4.9)	3.9 (3.7–4.1)	4.4 (4.2–4.6)
62. Holds and handles toys or objects (not grasp reflex)	4.1 (4.0–4.2)	4.1 (4.0–4.3)	4.1 (4.0–4.3)	3.8 (3.6–4.0)	4.6 (4.4–4.8)	4.2 (4.0–4.4)	4.0 (3.8–4.2)
63. Transfers objects hand to hand using fingers and palm	5.6 (5.5–5.8)	5.5 (5.3–5.7)	5.7 (5.5–5.9)	5.4 (5.1–5.7)	6.3 (6.1–6.6)	5.2 (5.0–5.5)	5.6 (5.4–5.9)
64. Picks up small objects using pincer (thumb and index) aided by other fingers	6.4 (6.3–6.6)	6.2 (6.0–6.5)	6.6 (6.4–6.8)	6.0 (5.7–6.2)	7.3 (6.9–7.6)	6.3 (6.0–6.7)	6.4 (6.1–6.7)
65. Picks up small objects using pincer (thumb and index) only	9.4 (9.2–9.6)	9.4 (9.1–9.8)	9.4 (9.1–9.7)	9.5 (9.1–10.0)	9.3 (8.8–9.7)	9.4 (8.9–9.9)	9.7 (9.4–10.1)
66. Holds pencil or stick in any way and scribbles	13.5 (13.3–13.8)	13.4 (13.0–13.8)	13.6 (13.3–14.0)	13.7 (13.2–14.3)	13.4 (12.9–13.9)	14.2 (13.5–15.0)	13.2 (12.9–13.6)

(Table 2 continues on next page)

	Total	Girls	Boys	Argentina	India	South Africa	Turkey
(Continued from previous page)							
67. Holds with fingers pencil or stick and scribbles†‡¶	18.3 (17.8-18.8)	17.9 (17.1-18.6)	18.7 (17.9-19.4)	23.8 (22.5-25.2)	17.5 (16.8-18.2)	19.2 (17.5-21.0)	15.4 (14.8-16.0)
68. Holds pencil or stick skilfully at lower tip with fingertips, draws*†¶ **	28.5 (27.8-29.4)	26.5 (25.4-27.6)	30.3 (29.1-31.5)	25.6 (24.1-27.2)	28.3 (27.0-29.9)	33.1 (30.2-37.1)	29.5 (28.0-31.2)
Relating							
69. Looks at caregiver's face and follows with eyes	0.3 (0.2-0.4)	0.3 (0.2-0.5)	0.3 (0.2-0.5)	0.2 (0.2-0.4)	0.4 (0.3-0.6)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
70. Smiles back to caregiver's playful approaches	0.6 (0.4-0.7)	0.8 (0.5-0.9)	0.4 (0.1-0.7)	0.6 (0.3-0.8)	0.6 (0.3-0.8)	0.9 (0.0-1.2)	1.0 (0.3-1.3)
71. Has prolonged, meaningful eye contact	0.9 (0.8-1.0)	1.0 (0.8-1.2)	0.9 (0.7-1.0)	0.8 (0.6-1.0)	1.0 (0.8-1.2)	1.2 (0.9-1.4)	1.0 (0.4-1.3)
72. Shows desire to engage with people (eg, looks, smiles, reaches, vocalises)	2.0 (1.9-2.2)	2.0 (1.8-2.2)	2.1 (1.9-2.2)	2.0 (1.8-2.1)	2.6 (2.4-2.8)	2.7 (2.1-3.2)	1.7 (1.4-1.9)
73. Shows preference to and recognition of caregivers (eg, reaches, smiles, inspects faces)	3.7 (3.5-3.8)	3.5 (3.3-3.7)	3.7 (3.6-3.9)	3.7 (3.5-3.9)	4.5 (4.3-4.8)	3.2 (2.8-3.5)	3.1 (2.9-3.4)
74. Reacts when caregiver leaves, relaxes when they are reunited	5.7 (5.5-5.9)	5.5 (5.2-5.8)	5.8 (5.6-6.1)	5.9 (5.7-6.2)	5.8 (5.5-6.0)	4.5 (3.6-5.2)	5.4 (5.2-5.9)
75. Shows recognition of strangers (eg, turns away, shows caution, shyness, fear)	6.0 (5.8-6.2)	5.7 (5.4-6.0)	6.1 (5.9-6.4)	7.1 (6.7-7.6)	6.6 (6.2-6.9)	4.3 (3.4-5.1)	6.0 (5.6-6.4)
76. Spontaneously seeks to share enjoyment with others (eg, cuddles or kisses caregiver)	8.6 (8.4-8.8)	8.7 (8.4-9.1)	8.5 (8.2-8.8)	8.2 (7.8-8.6)	7.9 (7.5-8.3)	9.9 (9.2-10.6)	8.9 (8.5-9.3)
77. Imitates others' behaviours (eg, waving back)‡	10.8 (10.6-11.1)	10.6 (10.2-11.0)	11.0 (10.6-11.3)	9.5 (9.0-9.9)	12.2 (11.7-12.8)	10.9 (10.3-11.7)	11.0 (10.6-11.4)
78. Initiates specific interactions with people*‡§	12.7 (12.4-13.1)	12.6 (12.0-13.1)	12.8 (12.3-13.2)	10.6 (10.1-11.1)	15.8 (15.0-16.8)	11.4 (10.5-12.3)	12.5 (12.0-13.0)
79. Talks about favourite people when they are not with them (eg, "where is grandpa?")†‡	26.2 (25.6-26.7)	25.2 (24.5-26.0)	27.0 (26.3-27.8)	30.0 (28.9-31.2)	23.8 (22.8-24.7)	25.5 (23.4-27.6)	25.5 (24.6-26.3)
Play							
80. Engages when approached playfully (moves limbs)	0.1 (0.0-0.4)	0.3 (0.0-0.6)	0.0 (0.0-0.4)	0.3 (0.0-0.5)	0.2 (0.0-0.4)	0.6 (0.0-1.4)	1.0 (0.0-1.2)
81. Makes sounds in response to play	1.3 (1.2-1.4)	1.3 (1.1-1.5)	1.3 (1.2-1.5)	1.3 (1.1-1.4)	1.3 (1.1-1.5)	1.5 (1.2-1.7)	1.5 (1.2-1.7)
82. Grasps toys or objects with interest (not reflex)	3.5 (3.4-3.6)	3.5 (3.3-3.7)	3.4 (3.3-3.6)	3.4 (3.2-3.6)	4.0 (3.8-4.3)	3.3 (2.7-3.9)	2.7 (2.4-2.9)
83. Brings toy or objects to mouth	3.6 (3.5-3.7)	3.5 (3.4-3.7)	3.6 (3.5-3.7)	3.4 (3.3-3.6)	3.7 (3.5-3.9)	3.9 (3.7-4.1)	3.3 (3.1-3.5)
84. Looks at own hands	3.9 (3.8-4.0)	3.9 (3.7-4.1)	3.9 (3.8-4.1)	3.8 (3.6-4.0)	4.3 (4.0-4.5)	4.1 (3.9-4.4)	3.6 (3.4-3.8)
85. Responds to interactive play such as "peek-a-boo"	4.6 (4.4-4.7)	4.5 (4.3-4.8)	4.6 (4.4-4.8)	4.4 (4.2-4.7)	4.9 (4.6-5.1)	4.3 (3.2-5.3)	4.0 (3.8-4.2)
86. Shakes toys or objects in play	4.7 (4.6-4.8)	4.6 (4.4-4.8)	4.8 (4.6-4.9)	4.6 (4.4-4.9)	5.1 (4.9-5.4)	4.5 (4.2-4.7)	4.6 (4.4-4.8)
87. Throws and bangs toys or objects	5.8 (5.6-5.9)	5.6 (5.4-5.9)	5.8 (5.6-6.0)	5.6 (5.3-5.8)	6.4 (6.2-6.7)	5.4 (5.1-5.7)	5.6 (5.4-5.9)
88. Inspects toys or objects with curiosity, looks at some detail	6.3 (6.1-6.5)	6.1 (5.9-6.4)	6.4 (6.2-6.6)	6.1 (5.7-6.4)	6.7 (6.4-7.1)	6.3 (5.9-6.7)	6.1 (5.8-6.4)
89. Looks for toys or objects that disappear	6.3 (6.2-6.5)	6.2 (6.0-6.5)	6.4 (6.2-6.6)	7.0 (6.6-7.4)	6.5 (6.3-6.8)	5.9 (5.5-6.2)	5.9 (5.7-6.2)
90. Imitates gestures during play (eg, clapping hands, making a face)	7.8 (7.6-8.0)	7.6 (7.3-7.9)	7.9 (7.6-8.2)	7.7 (7.4-8.2)	8.3 (7.9-8.6)	7.2 (6.8-7.6)	7.9 (7.6-8.3)
91. Initiates interactive game like "peek-a-boo"	8.4 (8.2-8.7)	8.4 (8.0-8.7)	8.5 (8.2-8.8)	7.7 (7.3-8.1)	8.6 (8.2-9.0)	9.2 (8.6-9.8)	8.7 (8.3-9.0)
92. Inspects how toys or objects work (eg, how doll moves, lights turn on)	10.8 (10.5-11.1)	10.7 (10.3-11.1)	10.9 (10.5-11.2)	11.0 (10.4-11.6)	10.7 (10.2-11.2)	11.4 (10.7-12.2)	10.6 (10.3-11.0)
93. Has simple imaginary play (eg, feeding doll, driving cars)	13.6 (13.2-13.9)	13.5 (13.0-14.0)	13.6 (13.2-14.1)	14.1 (13.5-14.7)	13.6 (13.0-14.3)	13.7 (12.9-14.6)	13.1 (12.4-13.7)
94. Involves others in play	13.7 (13.3-14.0)	13.5 (13.0-14.1)	13.7 (13.3-14.2)	12.8 (12.2-13.4)	13.8 (13.1-14.5)	13.7 (12.9-14.7)	14.2 (13.5-14.9)

(Table 2 continues on next page)

	Total	Girls	Boys	Argentina	India	South Africa	Turkey
(Continued from previous page)							
95. Has complex pretend play (eg, cooking a meal, feeding a doll, driving, filling a car up with gas)**	24·4 (23·7–25·0)	21·5 (20·6–22·3)	26·8 (26·0–27·6)	23·0 (21·7–24·4)	24·4 (23·3–25·5)	24·9 (23·2–26·7)	25·1 (24·1–26·2)
96. Sustains complex pretend play with many themes (house, soldiers) alone**	31·6 (30·7–32·6)	27·9 (26·7–29·1)	34·4 (33·3–35·6)	28·8 (27·1–30·7)	32·7 (31·4–34·2)	30·6 (27·6–35·2)	32·3 (31·0–33·7)
97. Sustains complex play with many themes (house, soldiers) with others**	34·0 (33·0–35·0)	31·1 (29·8–32·6)	35·8 (34·6–37·1)	33·4 (31·4–35·8)	35·6 (34·0–37·6)	35·3 (32·8–38·8)	32·3 (31·0–33·8)
Self help							
98. Uses fingers to feed self (knows it is food, eats)	8·6 (8·4–8·8)	8·5 (8·2–8·8)	8·8 (8·5–9·0)	8·2 (8·0–8·4)	10·4 (9·9–11·0)	8·1 (7·9–8·4)	8·3 (8·0–8·6)
99. Drinks from cup*†¶	13·0 (12·5–13·4)	12·8 (12·2–13·5)	13·1 (12·5–13·6)	16·6 (15·6–17·6)	14·4 (13·8–15·1)	8·7 (8·2–9·1)	13·0 (12·4–13·5)
100. Takes a piece of clothing off*†‡§	14·9 (14·2–15·4)	14·5 (13·6–15·3)	15·2 (14·4–16·0)	24·5 (23·3–25·9)	19·4 (18·4–20·3)	9·1 (8·0–10·1)	10·4 (9·5–11·2)
101. Uses one feeding utensil	15·1 (14·7–15·5)	14·5 (13·9–15·1)	15·6 (15·0–16·1)	15·1 (14·3–15·8)	15·9 (15·3–16·6)	14·5 (13·5–15·6)	15·0 (14·4–15·6)
102. Washes hands with assistance†‡	20·7 (20·1–21·2)	20·2 (19·4–21·0)	21·0 (20·3–21·8)	26·3 (25·1–27·6)	17·9 (17·0–18·8)	18·0 (16·8–19·2)	20·0 (19·2–20·7)
103. Brushes teeth with assistance†‡§¶	24·2 (23·6–24·8)	23·9 (22·9–24·8)	24·4 (23·6–25·4)	27·6 (26·3–29·0)	20·9 (19·9–22·0)	20·9 (19·5–22·5)	25·7 (24·5–26·9)
104. Toilet trained during the day†‡§¶	29·0 (28·3–29·6)	28·5 (27·6–29·5)	29·4 (28·4–30·3)	33·5 (32·4–34·7)	24·4 (23·4–25·7)	24·4 (23·0–25·9)	30·2 (29·2–31·2)
105. Puts some clothing on (eg, jacket or skirt)†‡	29·2 (28·5–30·0)	27·4 (26·4–28·4)	30·7 (29·7–31·8)	32·7 (31·0–34·8)	28·9 (27·5–30·5)	25·6 (24·1–27·2)	28·5 (27·3–29·7)
106. Toilet trained during the night (dry most nights)†‡¶	33·6 (32·8–34·4)	33·3 (32·3–34·4)	33·8 (32·8–34·8)	36·3 (35·1–37·8)	30·8 (29·4–32·5)	27·2 (24·8–29·9)	34·6 (33·5–36·0)
Data are median months (95% CrI). The region of practical equivalence test was used to assess whether differences in the 50th percentile ages of attainment of milestones were clinically equivalent between countries and sexes. CrI=credible intervals. *Differences between India and South Africa were not clinically equivalent. †Differences between Argentina and South Africa were not clinically equivalent. ‡Differences between Argentina and India were not clinically equivalent. §Differences between India and Turkey were not clinically equivalent. ¶Differences between South Africa and Turkey were not clinically equivalent. Differences between Argentina and Turkey were not clinically equivalent. **Differences between boys and girls were not clinically equivalent.							

Table 2: 50th percentile age of attainment of 106 milestones across seven developmental domains for the total sample and by sex and country

self-help domain, two in gross motor domain, and two in the fine motor domain. Differences in two expressive language and all five receptive language milestones were associated with caregivers' understanding of children's speech or interpretation of what children understand such as verbs, commands, objects, prepositions, or stories. Additionally, four milestones associated with the production of words and sentences, and three associated with relating to people did not meet criteria for equivalence across the four countries.

The distribution of ages of attainment for selected milestones are shown in figures 1 and 2, illustrating some of the similarities and differences across sexes and countries.

Discussion

We studied a large sample of healthy children in four countries with different cultural and linguistic characteristics to examine the development of children in the first 3 years of life. Our study provides information on developmental milestones that might be used across populations to assess development and also on those that require further investigation or elimination from international instruments.

The aim of most research comparing early childhood development across populations has been to describe cultural and ethnic variations and their association with contextual differences.^{20,24} Most studies have included children from high-income countries, ethnic minorities,

and small samples from LMICs. By contrast, our objective was to describe the variability in the ages of attainment of milestones and to establish whether enough similarities exist to guide the development of universal instruments, to avoid the costly restandardisation and revalidation of instruments. We therefore used definitions of equivalence to interpret our data rather than statistical significance alone.

In a cross-sectional study⁹ with a similar goal led by WHO in the 1990s, approximately 28 000 children aged 0–6 years were tested in China, India, and Thailand. The prevalence of health risks in the samples was not described and different developmental instruments were applied across sites. Both factors might have accounted for differences in the median age of attainment of milestones across countries and within country urban and rural sites. Nevertheless, when comparing the study led by WHO⁹ and our study, the median ages of attainment for the milestone of saying one meaningful word in our sample and the samples from urban China and India in the WHO study are similar (9·3 months in our study vs 9·7 months in China and 9·3 months in India) and for the milestone of saying two meaningful words (21·5 months in our study vs 20·1 months in China and 18·7 months India). The WHO Motor Development Study¹³ assessed the ages of attainment of six gross motor milestones in healthy children in five countries. This study used both caregiver report and direct observations to establish when children attained

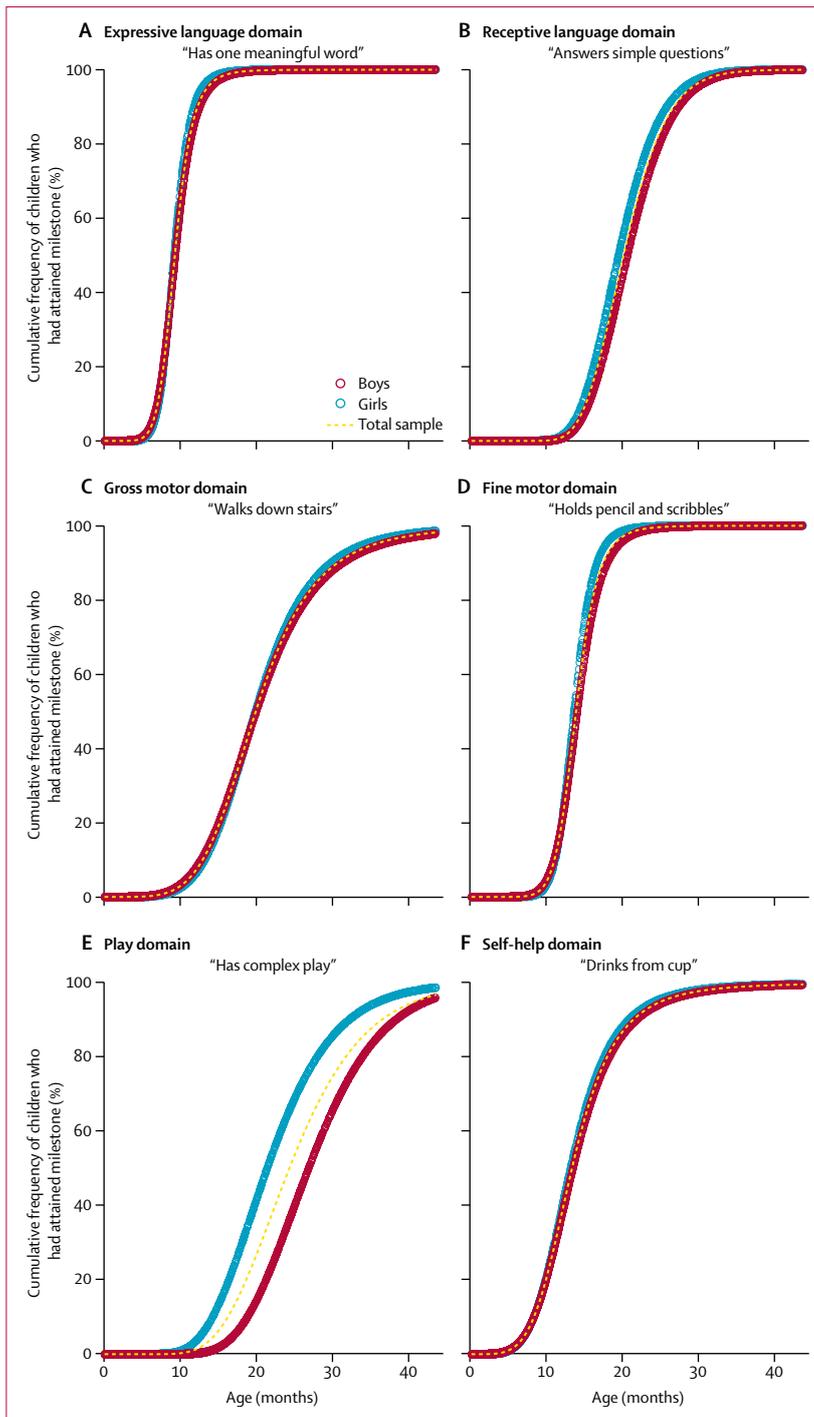


Figure 1: Distribution of ages of attainment for selected developmental milestones across sexes and the total sample

milestones. Again, the median age of attainment for the milestones common to both studies (ie, sits without support, stands alone, and walks alone) in our study compared with the Motor Development Study are similar (6.5 months vs 5.9 months for the sitting alone milestone, 10.0 months vs 10.8 months for standing

alone, and 12.9 months vs 12.0 months for walking alone). Furthermore, to compare our data with data obtained in high-income countries, we examined the Denver II developmental screening test,²⁵ an instrument developed in the USA. The median ages of attainment of our total sample were almost identical for milestones such as “uses six meaningful words”, “walks alone”, “kicks ball”, “reaches to objects”, and “holds pencil and scribbles”. These striking similarities provide further support for the universality of development across countries for some milestones, and also for the validity of the open-ended question technique used in our study.

Our study advances the understanding of early childhood development by showing that many milestones in numerous domains are similarly attained across sexes and countries. We found that the attainment of almost all milestones is similar in the first year when environmental and cultural influences might have the smallest effect. The similarity of play across our country samples parallels earlier studies.²⁶ The difference in ages of attainment for pretend play between girls and boys emerging in the third year of life might reflect cultural influences with regard to how boys and girls are expected to play. The ages of attainment of play milestones in healthy children across countries is of utmost importance to integrated interventions that include play and are being highly promoted in LMICs.^{3,27}

A large proportion of the differences in ages of attainment of milestones was associated with timing of children’s exposure to experiences. For example, South African children could drink from a cup at a median age of 8 months compared with Argentinian children who reached this milestone at a median age of 16 months. In South Africa, where early independence is encouraged,²⁸ children attained most self-help milestones at an earlier age than children in the other three countries, whereas in Argentina a more protective parenting style is generally adopted,²⁹ which might explain later attainment of these milestones. Culture is not the only factor that determines experiences. South African and Argentinian children attained the milestone of climbing up and down stairs at an older age than Indian and Turkish children, which is probably because most children included in these samples were more likely to live in single-storey houses, whereas Indian and Turkish children were more likely to live in apartment buildings with stairs.

The differences between countries in language milestones must be interpreted with caution. Receptive language is known to be difficult to assess because it is dependent on what caregivers expect and think children understand.³⁰ Consistent with these recognised difficulties in assessing the attainment of receptive language is the finding that most language milestones attained at different ages were associated with caregivers’ understanding of children’s speech and their interpretation of what children understand. More objectively, interpretable expressive

language milestones such as the use of pronouns, the use of past tense, or the ability to recount a story or event were attained at nearly identical ages across countries, suggesting that overall language acquisition was similar. Milestones on acquisition of sentences might reflect differences in syntax. Furthermore, considerable differences were found across countries in maternal and paternal education. Whether differences in language milestones reflect true differences in children, cultural and ethnic differences in caregivers' interpretations of what children convey or understand, caregivers' use of language with young children, or the effect of psychosocial factors (eg, caregivers' education) requires further study.

Our study has important strengths. First, the cross-sectional design avoids potential biases of repeated questioning and retention of compliant families. Second, the countries included are from diverse geographical areas of the world with ethnic, cultural, and language differences. Third, the sample of almost 5000 children is one of the largest to date, providing information on multiple domains of development of healthy children younger than 3 years. Fourth, our criteria for a healthy sample were more stringent than criteria used in previous research.^{31–33} We excluded children with health conditions associated with potential adverse developmental outcomes.³⁴ The fact that half of the recruited sample was excluded supports the high prevalence of health problems in LMICs that has been reported previously,² which has been shown to adversely affect children's development. More girls than boys were excluded from our study because of health problems, which might support evidence for sex-associated health disparities. Further research using such milestones that are attained similarly in healthy children will enable the development of common methods to examine the effect of health-associated risk factors on child development, and comparisons of child development between populations with differences in the prevalence of such risk factors.

Our study has important limitations. We did not include a large number of LMICs, particularly those with lower incomes. We chose four countries that were culturally distinct and had collaborating teams with the capacity to do rigorous research and to provide services for children identified with risk factors. Another limitation is that the sample did not include rural sites. Thus, the applicability of our results to rural populations needs to be established. The small sample size—particularly the small number of older children (aged 25–42 months) enrolled in South Africa—is a limitation that is reflected in the larger confidence intervals in South Africa for some of the milestones attained at an older age, and might require repetition in larger samples. The number of children who were excluded because of health problems was more than we expected in all countries, but particularly in South Africa, where we could not change our recruitment strategy as we did in India, because the sociodemographic characteristics of children attending private paediatric

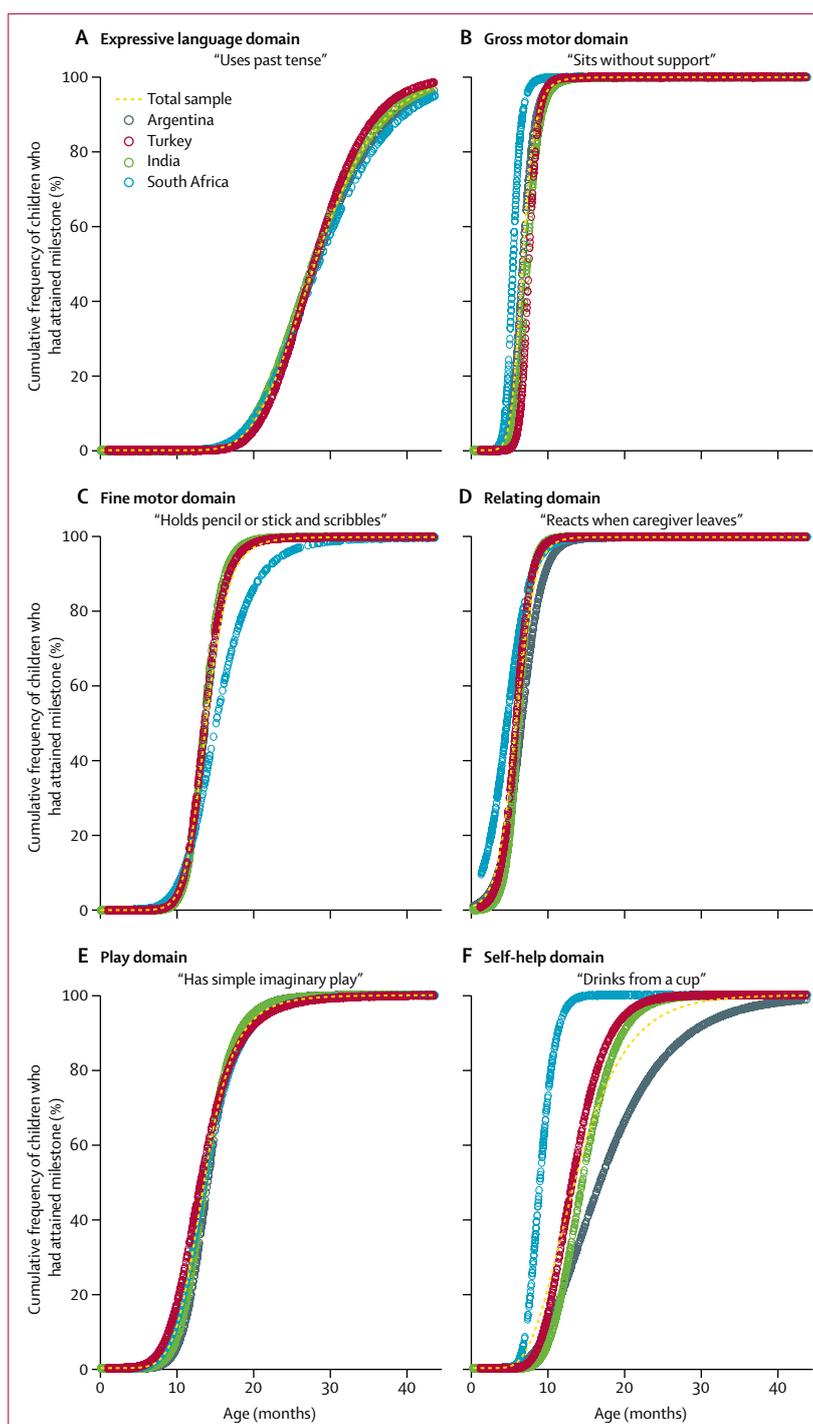


Figure 2: Distribution of ages of attainment for selected developmental milestones across Argentina, Turkey, India, and South Africa, and the total sample

clinics would have been substantially different. We recruited children from health clinics and not from homes to enable application of health criteria. This approach might decrease generalisability because our sample might have included more children with health

problems using the clinics than children with health problems in the general population, or an increased number of healthy children that access primary care. Bias in either direction should not affect the results of the healthy sample. Direct measurements of undernutrition and anaemia, detailed questioning of caregivers about birthweight, perinatal and chronic illness, and a health checklist provided by clinicians were the most rigorous health criteria we could apply. Nevertheless, we might have erroneously included some children with unknown health conditions. We did not exclude children with psychosocial risk factors such as poverty, a low level of caregiver education, or depression.³⁴ Further research is required to define the effects of psychosocial risk factors on the ages of attainment of developmental milestones.

Our study has identified the median age at which healthy children of both sexes and from four countries attain milestones in multiple developmental domains. These findings might contribute to the construction of internationally applicable tools to assess children's development to guide policy, service delivery, and intervention research that might help narrow the gap between high-income countries and LMICs in addressing early childhood development.

Contributors

IOE and BWCF conceptualised and designed the study, guided data analysis and interpreted the data, drafted the manuscript, and approved the final manuscript as submitted. VK, MCM, YS, RS, HB, OG, and BB contributed to the conduct of the study, the design of the data collection instruments, interpretation of the data, conceptualisation, and writing of the manuscript. GG, LC, VS, and BJ analysed the data, contributed to interpretation of the results, and edited the manuscript. All authors critically reviewed drafts and approved the final manuscript as submitted.

Declaration of interests

We declare no competing interests.

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