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Use of the ages and stages questionnaire adapted for South Africa and Zambia

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Abstract

Background There are few readily available, relatively easy to use and culturally adaptable developmental assessment tools for young children in southern Africa.The overarching aim of this study is to test the psychometric properties, contextual appropriateness and cut-off scores across 21 age groups of the Ages and Stages Questionnaire Third Edition (Squires & Bricker, 2009) among a group of typically developing children in South Africa and Zambia through a combination of both caregiver-report and direct observations, and to compare children's performance across sociodemographic variables.

Methods The sample consisted of 853 children (50.5% Zambia, with 50.1% girls for Zambia and 50% girls for South Africa) aged 2 months to 60 months. Information on caregiver employment, education and household assets were also obtained.

Results The psychometric properties of the ASQ-3 in southern Africa are consistent with those found in the extant literature. Analysis of item difficulty at each age reveals adequate levels of difficulty for majority of the items, with exception of the problem solving domain where half of the items at 54 and 60 months have poor pass rates. Sociodemographic variables were significantly associated with children's performance: higher caregiver levels of education are associated with higher toddler scores on the personal–social domain and higher preschooler scores on the problem solving domain; children whose caregivers earn a salary have higher fine motor scores during toddlerhood and higher problem solving scores during preschool and children who attend preschools have higher gross motor scores during toddlerhood and higher fine motor scores during the preschool years.

Conclusions Findings provide evidence to support the psychometric properties and feasibility of using the ASQ-3 in both South Africa and Zambia through a combination of caregiver-report and direct observations.

Keywords
ages and stages questionnaire, child development assessment, early childhood development, southern Africa

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Introduction

In the first years of life, critical developments occur in all domains, building the foundation for children's competencies and later outcomes. In high-income countries, early cognitive and socio-emotional development are strong determinants of educational progress (Pianta and McCoy 1997), and early language and communication contribute to later socioemotional competence (Prizant and Wetherby 1990). In middle and low income countries, there is a paucity of data on

children's early development, contributing to the invisibility and lack of attention to the problems of poor early development (Grantham-McGregor *et al.* 2007). A major contributor to lack of empirical evidence about early child development and relationships to later outcomes in southern Africa is limited access to standardized developmental assessment and screening tools, with most instruments designed and normed in Western countries. This has far-reaching consequences for identifying and supporting children with developmental difficulties and their families, for monitoring the effects of interventions and for estimating the national prevalence of developmental delays.

Where developmental instruments are available and standardized, they tend to be time consuming, costly and require specialized training (e.g. the Bayley Scales of Infant Development; BSID, Bayley 1969). Furthermore, given the broad range of individual differences in early development, with some children developing faster in some areas than others, it is important to differentiate between normal variations within a healthy range and developmental delays (Shonkoff and Phillips 2000).

With the exception of the BSID (Richter and Griesel 1988), the Draw-a-Person test and the McCarthy's Scales of Children's Development in South Africa (Richter *et al.* 1994), the Peabody Picture Vocabulary Test (Sigman *et al.* 1989) and the Developmental Neuropsychological Assessment (Mulenga *et al.* 2001) in Zambia, no other instruments to screen development have been normed among South African or Zambian children. The Ages and Stages Questionnaire Third Edition (ASQ-3) is an easy to use, reliable and valid parent-completed screening instrument to identify potential developmental delays among children 2 months to 5 years who need further assessment (Squires and Bricker 2009). It is a culturally and linguistically adaptable tool tapping into five developmental domains: communication, gross motor, fine motor, problem solving and personal–social. The ASQ-3 assesses development across 21 time points from 2 to 60 months through six items in each of the five domains. Referral for follow-up is suggested when scores on one or more of the domains fall below the established cutoff, set at 2 standard deviations below the mean of the normed group (Squires and Bricker 2009).

The ASQ-3 has been used to identify developmental delay with high sensitivity (82%) and specificity (78%) in high income countries (e.g. Limbos & Joyce, 2011) and in low and middle income countries (e.g. Juneja *et al.* 2012; 83.3%, 75.4%). It is translated into many languages and has been adapted, validated and shown to have good psychometric properties with respect to test–retest reliability, inter-rater-reliability, internal consistency, criterion and content validity in many countries (e.g. Kerstjens *et al.* 2009; Kapci *et al.* 2010; Schonhaut *et al.* 2013).

The goal of this study was to test the psychometric properties and appropriateness of the ASQ-3 in South Africa and Zambia through a combination of caregiver-completed questions and direct observations. The aim was to determine how the instrument may need to be adapted to render age-appropriate assessment in the region. Addressing this gap conveys benefits for both research and health, social and educational services working with young children in this region.

Methodology

Participants

In South Africa, participants were recruited randomly from well-baby clinics and daycare centres in Vulindlela, KwaZulu-Natal, an urban–rural mix. In Zambia, participants were recruited randomly from well-baby clinics, daycare centres and home visits in Lusaka, a peri-urban environment. The sample consisted of 853 children (50.5% Zambia, with 50.1% girls for Zambia and 50% girls for South Africa) aged 2–60 months with approximately 10 boys and 10 girls in each of the ASQ-3 age groups across the two countries. Children's caregiver was mostly the child's biological mother (85.6%). Given the absence of routine screening of children's development, and lack of validated instruments, caregivers completed a short screening survey to establish eligibility of the child for inclusion in the sample. Criteria for inclusion were that the child was born full-term with normal birth weight, had no known disabilities and the caregiver expressed no specific concerns about their child's development

Measures

The ASQ-3 was translated and back-translated from English into Zulu in South African sample, and into Nyanja in Zambia. Individuals with knowledge and experience in child development assessments in these regions evaluated the translated items across all 21 ages for cultural appropriateness. Wherever necessary, adaptations were discussed and consensus reached on conceptual equivalence, (e.g. 'Last name' changed to 'Surname'). Because of low caregiver literacy levels, self-assessment was combined with tester administration, and trained research assistants administered the questionnaires.

Caregivers were invited to try each activity with their child to facilitate accurate item assessment. Testing packs included all materials and toys necessary to administer each item. An item was scored 'yes' if the child was able to perform the activity, 'sometimes' if the child tried and failed but the caregiver reported that sometimes s/he could perform the item and 'no' if the child was unable to perform the item. Caregivers were also asked about their employment, education and household assets.

Procedure

Female research assistants experienced in conducting child assessments were trained at each site. Training involved: group review, discussion and demonstration of all items; a pilot for practice of study procedures, and a field pilot to gain experience with recruitment and study setup (e.g. in South Africa, a gazebo was set up outside preschools as centres often had insufficient space). At each training phase, the team discussed challenges faced and lessons learnt. Research assistants were video recorded during the pilot phase, and video clips were played back so the group could identify issues and discuss solutions; in Zambia, mothers from villages who were invited to participate in the study, many of whom had never been exposed to research studies in the past, turned to traditional leaders in the community for guidance. Ongoing supervision and group discussions were held throughout to ensure data quality and address issues arising in the field. This study was approved by the Research Ethics Committee of the Human Sciences Research Council (HSRC) in South Africa, and the University of Zambia (UNZA) Humanities and Social Sciences Research Ethics Committee in Zambia.

Results

There were no gender differences in performance across any age interval and developmental domain, with the exception that girls ($M = 58.25$, $SD = 4.06$) scored higher than boys ($M = 51.75$, $SD = 9.90$) in both the gross motor at 8 months ($P < .05$), and in problem solving at 9 months ($M = 52.39$, $SD = 9.64$ for girls; $M = 45$, $SD = 12.36$ for girls, $P < .05$). All subsequent analyses were based on samples combined across gender. As there were also no substantial country differences, scores were combined to maximize sample size.

Descriptive and reliability analysis

Table 1 provides the demographic characteristics of the sample. Chi-square tests reveal that the majority of caregivers had completed up to secondary level education (70.5%), were not employed (80.3%) and most children were not attending a preschool (77.3%). A *t*-test revealed no differences between the two countries in household socioeconomic status (SES). The two countries differed significantly in caregiver education, employment, and child preschool attendance. We therefore controlled for country when comparing children's performance across these sociodemographic variables. The mean, standard deviation and range for each age interval across each domain and cut-off scores are presented in Table 2. Cut-off values are the mean scores minus 2 standard deviations, as used in the extant literature (e.g. Heo *et al.*, 2008; Squires and Bricker 2009). In general, the mean scores tend to decrease from the younger to the older age range for the fine motor and the problem solving domains.

Table 1. Demographic characteristics of study sample *N* (%)

	South Africa	*Zambia*	*Combined*	*P-value*
Caregiver level of education				
Completed primary school	32 (7.6)	124 (28.8)	156 (18.3)	.000
Completed secondary school	357 (84.6)	244 (56.6)	601 (70.5)	.000
Completed tertiary education	33 (7.8)	63 (14.6)	96 (11.3)	.000
Caregiver employment				
Yes	59 (14)	107 (24.8)	166 (19.5)	.000
No	363 (86)	322 (74.7)	685 (80.3)	.000
Child attending preschool/daycare				
Yes	140 (33.2)	54 (12.5)	194 (22.7)	.000
No	282 (66.8)	377 (87.5)	659 (77.3)	.000
Household SES (mean, SD)[a]	10.58 (3.75)	10.39 (3.76)	10.48 (3.76)	.464

[a] Assessed based on sum of assets owned from a list of 22 items.

Cronbach's alpha, item-total correlations and domain-total correlations were calculated to examine internal consistency. Cronbach's alpha ranged from .20 (8 months) to .73 (22 months) for communication, from .16 (60 months) to .79 (14 months) for gross motor, from .20 (10 months) to .79 (60 months) for fine motor, from .23 (42 months) to .75 (8 months) for problem solving and from .09 (16 months) to .65 (12 months) for the personal–social domain. For the total score, Cronbach's alpha ranged from .60 (42 months) to .88 (24 months).

The following number of items per domain had poor item-total correlations, defined as being lower than 0.30: 10 of the 126 items (7.9%) in communication, 15 of 126 items (11.9%) in fine motor, 12 of 126 items (9.5%) in gross motor, 13 of 126 items (10.3%) in problem solving and 18 of the 126 items (14.3%) in the personal–social domain. The domain-total score correlations for communication were all significant ($P < .01$) and ranged from .45 (60 months) to .85 (24 months), from .55 (2 months) to .85 (60 months) for fine motor

Table 2. Number of participants, means, standard deviations, range and cut-off scores for each domain, M(SD, Min–Max)

Age	*n*	*Communication*	*Cutoff*	*Gross motor*	*Cutoff*	*Fine motor*	*Cutoff*	*Problem solving*	*Cutoff*	*Personal social*	*Cutoff*
2	42	52.9 (9.9, 30–60)	33.0	55.4 (6.9, 40–60)	41.5	56.1 (5.7, 45–60)	44.5	45.7(12.0, 10–60)	21.5	51.1 (8.1, 20–60)	34.9
4	38	57.2 (5.6, 35–60)	45.9	58.5 (4.1, 40–60)	50.3	52.6 (9.4, 15–60)	33.6	52.0 (11.3, 20–60)	29.2	52.8 (8.4, 30–60)	36.0
6	41	54.3 (7.5, 30–60)	39.3	58.5 (4.1, 20–60)	50.3	53.1 (9.6, 20–60)	33.9	50.0 (10.7, 20–60)	28.4	42.0 (12.0, 10–60)	17.9
8	40	56.1 (5.8, 40–60)	44.4	55.0 (8.1, 30–60)	38.6	57.5 (6.2, 30–60)	45.1	52.0 (12.7, 20–60)	26.5	53.2 (9.2, 30–60)	34.7
9	42	51.3 (11.4, 5–60)	28.3	41.6 (13.2, 20–60)	15.1	53.2 (6.7, 40–60)	39.8	49.0 (11.4, 20–60)	26.1	40.8 (13.0, 20–60)	14.8
10	40	55.2 (8.9, 20–60)	37.2	50.5 (10.6, 25–60)	29.2	55.1 (5.9, 40–60)	43.3	52.7 (8.6, 30–60)	35.3	48.3 (12.3, 20–60)	23.7
12	40	55.5 (6.6, 40–60)	42.1	51.3 (13.2, 10–60)	24.9	44.6 (10.5, 20–60)	23.4	49.5 (11.6, 10–60)	26.2	43.8 (14.7, 0–60)	14.4
14	40	48.1 (9.8, 30–60)	28. 4	49.5 (14.9, 10–60)	19.6	41.5 (14.0, 10–60)	13.3	48.7 (10.7, 15–60)	27.1	44.2 (11.0, 20–60)	22.1
16	40	47.6 (12.3, 20–60)	23.0	53.0 (10.4, 20–60)	32.0	50.5 (11.3, 20–60)	27.7	51.5 (10.5, 20–60)	30.4	52.7 (7.6, 30–60)	37.4
18	42	44.7 (12.7, 20–60)	19.1	52.8 (12.1, 0–60)	28.6	49.0 (12.6, 20–60)	23.8	46.3 (10.8, 20–60)	24.7	53.3 (7.3, 40–60)	38.5
20	41	46.1 (15.3, 10–60)	15.3	54.1 (9.3, 25–60)	35.4	44.1 (12.1, 20–60)	19.8	40.7 (11.1, 20–60)	18.4	53.6 (9.1, 25–60)	35.3
22	41	41.4 (16.4, 5–60)	8.6	54.2 (10.1, 20–60)	33.9	40.7 (11.5, 15–60)	17.5	48.4 (12.1, 10–60)	24.0	49.3 (11.6, 10–60)	26.0
24	39	50.3 (12.4, 0–60)	25.5	54.0 (11.3, 0–60)	31.2	44.1 (13.5, 0–60)	16.9	45.7 (13.0, 0–60)	19.6	49.3 (10.8, 0–60)	27.6
27	41	51.7 (10.1, 25–60)	31.3	53.7 (9.2, 20–60)	35.2	43.4 (13.8, 10–60)	15.6	45.5 (11.0, 20–60)	23.4	42.8 (12.0, 20–60)	18.7
30	40	49.1 (11.1, 20–60)	26.8	55.8 (9.4, 20–60)	37.0	45.1 (15.5, 20–60)	13.9	41.7 (13.2, 10–60)	15.3	46.8 (9.3, 30–60)	28.2
33	39	53.7 (8.9, 20–60)	35.9	57.7 (5.7, 40–60)	46.2	44.1 (13.6, 10–60)	16.7	43.8 (14.9, 0–60)	17.8	47.8 (11.1, 15–60)	25.4
36	41	55.1 (7.7, 25–60)	39.7	56.5 (7.3, 30–60)	41.8	50.3 (11.6, 20–60)	26.9	48.4 (12.7, 10–60)	22.8	50.1 (9.3, 15–60)	31.3
42	40	51.8 (9.3, 30–60)	33.1	56.5 (4.9, 45–60)	46.6	36.9 (12.8, 10–50)	11.3	51.5 (8.8, 30–60)	33.8	51.0 (9.4, 30–60)	32.0
48	40	50.5 (12.3, 0–60)	25.7	57.2 (7.1, 30–60)	42.9	29.6 (14.9, 0–50)	—	40.3 (12.3, 0–60)	15.6	47.7 (13.0, 0–60)	21.6
54	40	53.9 (9.7, 10–60)	34.4	58.2 (4.2, 40–60)	49.7	32.1 (17.5, 0–60)	—	29.2 (13.4, 0–60)	2.2	48.8 (11.0, 15–60)	26.8
60	40	48.5 (9.9, 15–60)	28.6	59.2 (2.6, 50–60)	53.9	32.6 (18.6, 0–60)	—	31.1 (12.0, 15–60)	7.0	55.0 (5.8, 40–60)	43.7

($P < .001$), from .35 (2 months) to .86 (24 months) for gross motor ($P < .05$) with the exception of the 4, 54 and 60-month questionnaires, from .44 (16 months) to .87 (2 months) for problem solving ($P < .01$) and from .42 (18 months) to .85 (33 months) for personal–social ($P < .01$) with the exception of the 60-month questionnaire.

Exploratory factor analysis

An exploratory factor analysis was performed with factors extracted using the principal axis method with an oblique Promax rotation ($K = 4$) to examine the underlying factor structure of each domain. Eigenvalues ≥ 1.0 and items with loadings of at least 0.40 after rotation were considered significant. A single factor was extracted for the communication and fine motor domains, whereas the gross motor, problem solving and personal–social domains had two-factor solutions. Item loadings for the communication and fine motor domains could not be rotated; therefore, a two-factor solution was chosen as the best fit (Table 3). Gross motor was best explained by the first factor accounting for 35.55% of the total variance (eigenvalue = 2.13). The second factor explained 18.05% of the variance (eigenvalue = 1.08). The first factor of the problem solving domain explained 30.36% of the variance (eigenvalue = 1.82). The second factor was responsible for 16.91% of the variance (eigenvalue = 1.02). The first factor of the personal–social domain explained 25.49% of the variance (eigenvalue = 1.53). The second factor was responsible for 17.38% of the variance (eigenvalue = 1.04).

The percentage pass rate for each item at each age was calculated to identify difficult items, calculated as a proportion of the total number of correct responses to the test item using the formula $P = R / T \times 100$, where P is the item difficulty index, R is the number of correct responses and T is the total number of responses (Johnstone 2003). An item was considered difficult when was passed by fewer than 40% of children.

Of the total 630 items, 11 items (1.7%) had a an item difficulty index < 40%: 0 items in communication, 4 items in fine motor, 1 in gross motor, 1 in personal–social and 5 in problem solving (see Table 4). The two items pertaining to the puzzle were the most difficult. Similarly, items requiring children to name colours and to recognize numbers also had a low item difficulty index (were more difficult). In the personal–social domain, item #4 at 30 months ('Does your child put on a coat, jacket, or shirt by himself') had a low item difficulty index ($P = 34\%$), with $P = 59\%$ in the next age interval (33 months), but an acceptable item difficulty index of $P = 49\%$ in the previous age interval (27 months), suggesting that this item may have been inconsistently interpreted during administration. At both 54 and 60 months, three out of the six items in the problem solving domain had a low item difficulty index, indicating that items in this domain are very difficult for children in this context.

Table 3. Promax rotated factor pattern matrix from the exploratory factor analysis for the communication, fine motor, gross motor, problem solving and personal social domains

Domains	Domains eigenvalues	% of variance	Items	Factor weights
Communication				
Factor 1	1.94	32.41		
Fine motor				
Factor 1	2.14	35.73		
Gross motor				
Factor 1	2.13	35.55	Gross motor 1	−0.05
			Gross motor 2	−0.12
			Gross motor 3	0.10
			Gross motor 4	0.76*
			Gross motor 5	0.60*
			Gross motor 6	0.16
Factor 2	1.08	18.05	Gross motor 1	0.39
			Gross motor 2	0.53*
			Gross motor 3	0.43*
			Gross motor 4	−0.13
			Gross motor 5	0.09
			Gross motor 6	0.50*
Problem solving				
Factor 1	1.82	30.35	Problem solving 1	−0.15
			Problem solving 2	0.57*
			Problem solving 3	0.44*
			Problem solving 4	0.07
			Problem solving 5	0.36
			Problem solving 6	0.18
Factor 2	1.01	16.91	Problem solving 1	0.53*
			Problem solving 2	−0.15
			Problem solving 3	0.04
			Problem solving 4	0.14
			Problem solving 5	0.20
			Problem solving 6	0.43*
Personal social				
Factor 1	1.52	25.48	Personal social 1	0.34
			Personal social 2	−0.03
			Personal social 3	0.20
			Personal social 4	0.40*
			Personal social 5	0.32
			Personal social 6	0.40*
Factor 2	1.04	17.37	Personal social 1	0.10
			Personal social 1	0.59*
			Personal social 1	0.15
			Personal social 1	−0.02

*Items with greater weights (significant factor loadings ≥ 0.40) *Item difficulty*.

Table 4. ASQ-3 difficult items

Domain
Item # (Month, Item difficulty index [*P*])
Item difficulty index in adjacent age intervals (if identical item exists in adjacent age intervals)
Fine motor
#6 (22 months, *P* = 29%): Can your child string small items such as beads, macaroni or pasta onto a string or shoelace?
24 months: *P* = 60%
#6 (33 months, *P* = 36%): Does your child try to cut a paper with child-safe scissors? He does not need to cut the paper but must get the blades to open and close while holding the paper with the other hand.
36 months, *P* = 56%
#5 (42 months, *P* = 5%): Does your child put together a five to seven-piece interlocking puzzle?
48 months, *P* = 10%
#4 (54 months, *P* = 37%): Ask your child to trace on the line below with a pencil. Does your child trace on the line without going off the line more than two times?
60 months, *P* = 53%
Gross motor
#4 (9 months, 36%): While holding onto furniture, does our baby bend down and pick up a toy from the floor and then return to a standing position?
10 months: 55%
Personal–Social
#4 (30 months, *P* = 34%): Does your child put on a coat, jacket or shirt by himself?
27 months, *P* = 49%
33 months, *P* = 59%
Problem solving
#5 (18 months, *P* = 34%): After watching you draw a line from the top of the paper to the bottom with a crayon (or pencil or pen), does your child copy you by drawing a single line on the paper in *any direction*?
20 months, *P* = 34%
22 months, *P* = 54%
#4 (48 months, *P* = 25%): When shown objects and asked, 'What colour is this?' does your child name five different colours, like red, blue, yellow, orange, black, white or pink?
54 months, *P* = 29%
60 months, *P* = 38%
#5 (54 months, *P* = 27%): Does your child count up to 15 without making mistakes?
60 months, *P* = 58%
#6 (54 months, *P* = 17%): Does your child know the names of numbers? 3 2 1
60 months, *P* = 30%
#6 (60 months, *P* = 15%): Does your child name at least four letters in her name? Point to the letter and ask 'what is this'?

Comparison across sociodemographic variables

An analysis of variance (ANCOVA) was performed to examine whether children's performance in the five domains varied across sociodemographic variables, controlling for country. As applied to the ASQ by Filgueiras, Pires, Maissonette, and Landeira-Fernandez (2013), the 21 age intervals were divided into three age categories that define the first 5 years of life: 2, 4, 6, 8 months (Infancy); 9, 10, 12, 14, 16, 18, 20, 22, 24, 27, 30, 33 months (Toddlerhood); and 36, 42, 48, 54, and 60 months (Preschool). Children whose caregiver completed secondary education scored significantly higher on the personal social domain during toddlerhood than children whose caregiver completed primary school only ($M = 48.53$, $SD = 10.73$; $M = 44.50$, $SD = 13.82$, respectively, $P < .05$), and children whose caregiver completed tertiary education scored significantly higher on the problem solving domain during preschool than children whose caregiver completed primary education only ($M = 44.53$, $SD = 3.34$; $M = 34.26$, $SD = 2.67$, respectively,

$P < .05$). Children with employed caregivers scored significantly higher in the fine motor domain during toddlerhood than children with unemployed caregivers ($M = 48.41$, $SD = 11.23$; $M = 45.80$, $SD = 13.09$, respectively, $P < .05$), and in the problem solving domain during preschool ($M = 46.52$, $SD = 11.73$; $M = 38.04$, $SD = 15.23$, respectively, $P < .01$). Children who attended preschool scored higher in the gross motor domain during toddlerhood ($M = 55.59$, $SD = 9.61$; $M = 51.92$, $SD = 11.82$, respectively, $P < .05$) and in the fine motor domain during preschool, ($M = 38.70$, $SD = 15.94$; $M = 32.46$, $SD = 18.05$, respectively, $P < .01$) than children who did not attend preschool.

Discussion

To our knowledge this study is the first to adapt, translate, and examine the psychometric properties and utility of the ASQ-3 in an African setting. Findings suggest that the internal reliability of most of the 21 ASQ-3 questionnaires is similar to what has been found in other contexts (Heo *et al.* 2008; Kapci *et al.* 2010; Filgueiras *et al.* 2013). There were some age intervals with poor internal consistency which could be because of items within some domains tapping into different underlying constructs. Results from the EFA indicate two factors were extracted for the gross motor, problem solving and personal–social domains. In their adaptation of the 36 months ASQ-3 questionnaire in Taiwan, Tsai *et al.* (2006) reported some items in the problem solving and personal–social domains not fitting with others in the same subscale. Specifically, some items in the problem solving domain assess auditory sequential memory rather than problem solving skills (e.g. repeating two numbers in the same order), and compared with other items which involve social interaction, some items in the personal–social domain pertain more to adaptive motor skills (e.g. feed self with spoon) than to personal–social development (e.g. whether the child imitates the caregiver in certain gestures such as blinking eyes). Similarly, some of the items in the gross motor domain may also differ slightly. For instance, some items require hand–eye coordination (e.g. catching a ball), which involves the visual system to coordinate information to control the hands to perform the task, known as visual–motor integration (Carey 2000), whereas other gross motor items do not require this process (e.g. standing on one foot for at least 5 s). Consistent with the existing literature is the finding that the personal–social subscale has the poorest internal consistency among the five domains, with the lowest level of Cronbach's alpha and the most number of item-total correlations falling below .30, suggesting that this domain may be most susceptible to interpretation based on differences in cultural understanding and expectations. Recommendations on the use of the ASQ-3 in southern Africa are in Appendix A.

Our results conform to the consistent finding that parental education, employment and preschool experience are generally associated with higher scores on developmental tests of children's abilities (Hertzman and Boyce 2010). Our study reveals that children of caregivers with higher levels of education have higher scores on the personal–social domain during toddlerhood and higher scores on the problem solving domain during preschool; children whose caregivers earn a salary have higher fine motor scores during toddlerhood and higher problem solving scores during preschool and children who attend preschools have higher gross motor scores during toddlerhood and higher fine motor scores during preschool. These findings provide strong evidence for the impact of sociodemographic factors in shaping children's development from toddlerhood to preschool in southern Africa.

It is important to note several study limitations. Although we used both parent report and child performance to assess children on each of the applicable items, test–retest assessments would provide useful information on the reliability of the ASQ-3 scores over time. Second, there is a need to compare the ASQ-3 domains with other developmental assessment instruments, such as the BSID or the McCarthy's Scales of Children's Development, in order to establish convergent validity of the ASQ-3 in this context. The current study only included children at low risk of developmental delay; future studies should apply the ASQ-3 to a clinical sample of children with developmental disabilities in order to investigate its sensitivity and specificity in detecting early impairments. Another limitation is the small cell size with an average of 40 children at each age group. Given that this was the first time the ASQ-3 was applied in southern Africa, we adopted a rigorous approach by focusing our attention on adapting the tool to the local culture and in training research assistants to administer the questionnaires so that children's performance could be observed and accurately assessed. The approach to combine caregiver-reports with direct observations was also warranted because of low levels of caregiver literacy and caregivers' unfamiliarity with the tasks set out in the ASQ-3 and developmental assessment in general. This adaptation deviates from the original intention of the ASQ-3 as a parent-completed screening measure. However, given the specific contextual factors in which the ASQ-3 was administered in the present study, these adaptations were necessary to achieve an accurate and consistent screen of the development of young children. Accuracy and consistency are achieved by avoiding the possibility of variations because of differences in parent observations and understanding of the level of child competence

expected with respect to a particular question. This limitation might have implications for interpretation of cut-off scores for this sample.

In conclusion, we provide evidence for psychometric properties and feasibility of use of an adapted version of the ASQ-3 in both South Africa and Zambia which includes both caregiver-report and direct observations and therefore have some confidence in its applicability in other similar southern African contexts, given appropriate translation and adaptation. By demonstrating that early on in life, children from disadvantaged families are at risk of falling behind in some domains compared with their peers, the ASQ-3 can be valuable in garnering evidence to inform local policy makers and government in their decisions on investments in early child development.

Key Messages

- There are few readily available, relatively easy to use, and culturally adaptable developmental assessment tools for young children in Southern Africa.
- This is the first study to examine the usefulness of the Ages and Stages Questionnaire (ASQ-3) adapted for the southern African context, and our findings demonstrate that the psychometric properties of the adapted version of the ASQ-3 in South Africa and Zambia are consistent with those found in other countries.
- Items across all domains up to 48 months can be used to screen early development in South Africa and Zambia.
- Sociodemographic variables including caregiver level of education and income, and preschool attendance are significantly associated with children's ASQ-3 scores.
- An important area for future studies is to compare the adaptations made in the current study with a gold standard developmental assessment, such as the Bayley Scales of Infant Development, to test the sensitivity and specificity of this modified version of the ASQ-3 in Southern Africa.

Conflicts of interest

The authors declare that they have no conflict of interest.

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References

Bayley, N. (1969) *Bayley Scales of Infant Development*. Psychological Corporation, New York.

Carey, D. P. (2000) Eye–hand coordination: eye to hand or hand to eye? *Current Biology*, **10**, 416–19.

Filgueiras, A., Pires, P., Maissonette, S. & Landeira-Fernandez, J. (2013) Psychometric properties of the Brazilian-adapted version of the Ages and Stages Questionnaire in public child daycare centre. *Early Human Development*, **89**, 561–576.

Grantham-McGregor, S., Cheug, Y. B., Cueto, S., Glewwe, P. & Richter, L. (2007) Developmental potential in the first 5 years for children in developing countries. *Lancet*, **369**, 60–70.

Heo, K. H., Squires, J. & Yovanoff, P. (2008) Cross-cultural adaptation of a pre-school screening instrument: comparison of Korean and US populations. *Journal of Intellectual Disability Research*, **52**, 195–206.

Hertzman, C. & Boyce, T. (2010) How experience gets under the skin to create gradients in developmental health. *Annual Review of Public Health*, **31**, 329–347.

Johnstone, A. (2003). LTSN physical sciences practice guide: effective practice in objective assessment the skills of fixed response testing. https://www.heacademy.ac.uk/sites/default/files/ps0072_effective_practice_in_objective_assessment_mar_2004.pdf. Accessed 21 August 2015.

Juneja, M., Mohanty, M., Jain, R. & Ramji, S. (2012) Ages and Stages Questionnaire as a screening tool for developmental delay in Indian children. *Indian Pediatrics*, **49**, 457–461.

Kapci, E. G., Kucuker, S. & Uslu, R. I. (2010) How applicable are Ages and Stages Questionnaires for use with Turkish children? *Topics in Early Childhood Special Education*, **30**, 176–188.

Kerstjens, J. M., Bos, A. F., ten Vergert, E. M. J., de Meer, G., Butcher, P. R. & Reijneveld, S. A. (2009) Support for the global feasibility of the Ages and Stages Questionnaire as developmental screener. *Early Human Development*, **85**, 443–447.

Limbos, M. M. & Joyce, D. P. (2011) Comparison of the ASQ and PEDS in screening for developmental delay in children presenting for primary care. *Journal of Developmental and Behavioral Pediatrics*, **32**, 499–511.

Mulenga, K., Ahonen, T. & Aro, M. (2001) Performance of Zambian children on NEPSY: a pilot study. *Developmental Neuropsycholy*, **20**, 375–384.

Pianta, R. C. & McCoy, S. J. (1997) The first day of school: the predictive validity of early school screening. *Journal of Applied Developmental Psychology*, **18**, 1–22.

Prizant, B. M. & Wetherby, A. M. (1990) Toward an integrated view of early language and communication development and socioemotional development. *Topics in Language Disorders*, **10**, 1–16.

Richter, L. M. & Griesel, R. D. (1988) *Bayley Scales of Infant Development – Norms for Interpreting the Performance of Black South African Infants*. University of South Africa, Pretoria.

Richter, L., Griesel, R. & Rose, C. (1994) The McCarthy Scales of Children's Abilities: adaptation and norms for use among Black South African children. *South African Journal of Occupational Therapy*, **24**, 17–30.

Shonkoff, J. P. & Phillips, D. (2000) *From Neurons to Neighborhoods: The Science of Early Child Development*. National Academy Press, Washington, DC.

Sigman, M., Neumann, C., Janen, A. J. & Bwibo, N. (1989) Cognitive abilities of Kenyan children in relation to nutrition, family characteristics and Education. *Child Development*, **60**, 1463–1474.

Squires, J. & Bricker, D. (2009) *Ages & Stages Questionnaires: A Parent-Completed Child Monitoring System, Third Edition* edn. Paul H. Brookes Publishing, Baltimore.

Schonhaut, L., Armijo, I., Schonstedt, M., Alvarez, J. & Cordero, M. (2013) Validity of the Ages and Stages Questionnaires in term and preterm infants. *Pediatrics*, **131**, 1468–1474.

Tsai, H. L. A., McClelland, M. M., Pratt, C. & Squires, J. (2006) Adaptation of the 36-Month Ages and Stages Questionnaire in Taiwan: results from a preliminary study. *Journal of Early Intervention*, **28**, 213–225.

Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site.

Appendix A: Recommendations of the use of the ASQ-3 Adapted for southern Africa