



Creating a Cambodia-specific developmental milestone screening tool – A pilot study

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ABSTRACT

Background: Approximately 600 million people are living with various types of disabilities throughout the world and over 200 million children under age of 5 years old not reach their developmental potential. These adverse outcomes can be prevented through early detection and treatment. To accurately assess the development of children, a culturally appropriate screening tool must be used. Cambodia lacks such tool and other studies have shown that western tools are not valid in other cultures.

Aims: This study aimed at creating a culturally appropriate screening tool – called the Angkor Hospital for Children Developmental Milestone Assessment Tool (AHC DMAT) – for screening neurodevelopmental disability in Cambodian children.

Study design, subject, outcome measures: Western milestones from the DDST II were used with cultural modifications. Children of both genders and aged from 1 month to 6 years assumed to have normal development were included in two pilot screenings (N = 100 and N = 63) with further modifications to the AHC DMAT made as necessary after each screening.

Results: The final AHC DMAT consists of 140 milestones (49% directly from DDST II, 17% modified DDST II, 34% added through expert opinion).

Conclusion: Extensive revision of the DDST II was needed in order to create a more valid Cambodian screening tool. This study was the first step to create a Cambodian-specific screening tool but further large-scale testing of the AHC DMAT is needed to strengthen the tool's validity and to identify the age-range percentiles of each milestone before it can be used for neurodevelopment screening.

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1. Background

Approximately 600 million people are living with various types of disabilities throughout the world and it is estimated that 80% of people with disabilities live in low income countries [1]. One type of disability that is often neglected in the developing world is neurodevelopmental disability. According to Grantham-McGregor and colleagues [2], as a result of poverty, poor health and nutrition, and inadequate care, more than “200 million children under the age of five years fail to reach their developmental potential”. Failure to detect developmental abnormalities in children can have severe negative life-long consequences for them. Disability in children can also adversely affect society as a whole by reducing the productivity and economic potential of the population and by leading to increased poverty and costs of healthcare and other social welfare programs. Children in developing countries are particularly vulnerable to many biological and environmental factors [3]. Cambodia is among the poorer countries [4] and ranks low on

child health indicators such as infant mortality and under-five mortality, thus it is likely that Cambodian children suffer from high rates of childhood disability.

Early identification and treatment of neurodevelopmental disability can help improve the lives of disabled children and reduce the severity of the deficit. The Cambodian government has already shown willingness to protect the rights and interest of disabled people by passing several relevant pieces of legislation such as the United Nation Convention on the Rights of the Child [5] and the UN Convention to protect disabled persons' rights [6]. Unfortunately, in Cambodia today, disability services are not available to many people who need them; however there are a number of national and international non-government organizations that are working towards protecting the rights of disabled persons through advocacy campaigns, public health initiatives and provision of services. Nonetheless, there is still limited data on childhood neurodevelopmental disability in Cambodia. Several screening tools, such as the Denver Developmental Screening Test II (DDST II) [7], are available to aid health care workers in assessing development, but most of these tools were created based on western norms. Studies conducted in different populations [8–15] have shown that direct application of western tools can be inappropriate and invalid due to

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differences in culture, language, and environmental exposure. Currently, there is no Cambodia-specific developmental screening tool.

The aim is to create a culturally appropriate neurodevelopmental screening tool for assessing Cambodian children, called the Angkor Hospital for Children Developmental Milestone Assessment Tool (AHC DMAT). The AHC DMAT would assist Cambodian doctors to assess for developmental milestones and thereby help to improve identification and management of Cambodian children with developmental delays and disabilities.

2. Methods

A prospective approach using two pilot screenings was used to create the AHC DMAT. The flowchart in Fig. 1 describes the study process. The AHC DMAT was initially created using the DDST II as reference with additional consultation with Cambodian pediatricians. Necessary revisions were made to the western milestones listed in the DDST II in order to fit the Cambodian culture (e.g. changing “wave bye-bye” to “play chab chab”, a gesture more commonly taught to Cambodian infants). All revisions were agreed by the four investigators consisting of three pediatricians (a Cambodian pediatrician, a German pediatrician who has been working and living in Cambodia for over 7 years, and an American pediatrician who has been working and living in Cambodia for 5 years) and one Cambodian nurse. When needed, the investigators sought consultancy from Cambodians pediatricians and healthcare workers before suggesting any revision.

The milestones were divided into 4 domains similar to the DDST II: Gross Motor (GM), Fine Motor (FM), Language (LA), and Personal/Social (SO). In this first version, the milestones were grouped into different age-ranges corresponding to the 75th percentile of DDST II and by consensus of the screeners. Information on gender, date of birth, weight, height, child and parents’ education status were also collected.

The AHC DMAT was tested by interviewing (screening) outpatient children assumed to be developmentally normal. The data was collected between January and June 2007. Inclusion criteria included: Cambodian nationality, age 1 month to 6 years, and outpatient. Exclusion criteria included: admission to hospital or referral to emergency room, history of premature birth, moderate to severe malnutrition as defined by the WHO (\leq minus 2 Standard Deviation of weight to height) [16], known chronic diseases (including but not limited to congenital heart disease, diabetes mellitus, hemophilia, thalassemia,

thyroid problems, cerebral palsy, epilepsy, HIV/AIDS), and known developmental or physical disability.

Three investigators served as the screeners. They made their best effort to test by child demonstration, but parent’s/caretaker’s report was allowed. The screeners marked which milestones were “passed” by demonstration and which by report.

The focus of the first pilot screening was the feasibility and face validity of the AHC DMAT, including ease of use and cultural applicability of the milestones. After revisions, a second version of the AHC DMAT was created. A second pilot screening was then done with the same inclusion and exclusion criteria. The main differences of this second screening were the inclusion of a standardized kit containing various props for the children to demonstrate some of the milestones, standardized instructions for the screeners, and the use of a ceiling and flooring method. This method was added in order to eliminate the difficulties of assigning ages to each milestone in a somewhat arbitrary or subjective manner. In the ceiling and flooring method, the screeners started at a milestone which roughly corresponded to the child’s age. If the child failed/passed the milestone, the interviewer would test the milestone below/above the one failed/passed. This process would continue until the interviewer reached 4 consecutive passes or fails, thus determining the upper limit of each child’s development. This method assumed that once the child fails/passes 4 times, s/he will fail/pass any milestone that is more/less advanced. A comparable ceiling and flooring method has been previously described in another study [17].

The screeners met again after the second pilot screening to further revise and improve upon the face validity of the AHC DMAT. Milestones which were added, deleted, or changed due to culture-specific considerations were discussed with other Cambodian health workers and physicians before formally being added to the AHC DMAT.

3. Results

3.1. Sample size and demographics

The first pilot screening enrolled a total of 100 children, of which 46 were male, 45 female, and 5 surveys with missing gender information. The median age was 16 months (IQR 7–30 months). The second pilot screening enrolled a total of 63 children, of which 32 were male,

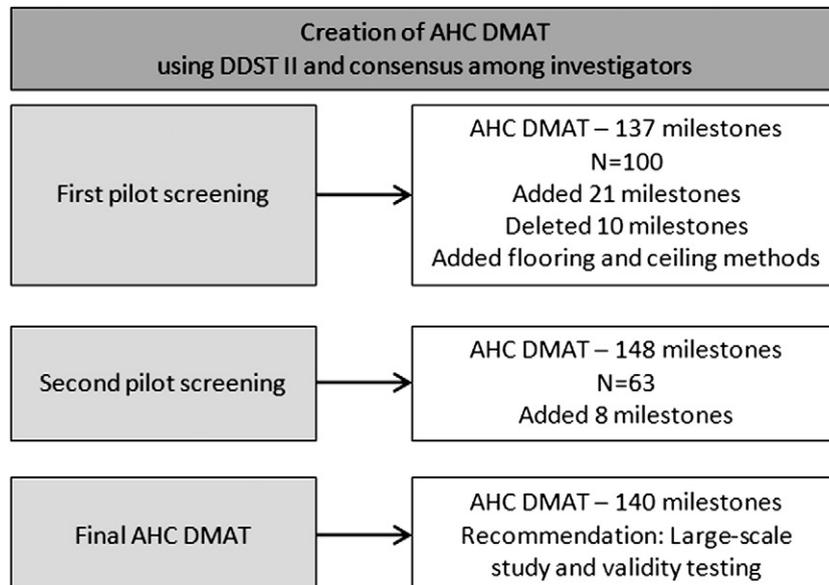


Fig. 1. AHC DMAT study flowchart.

27 female, and 4 surveys with missing gender information. The median age was 24 months (IQR 8–48 months) (Table 1).

3.2. Final AHC DMAT

Twice as many passed milestones in both pilot screenings were passed by demonstration compared to by report. The AHC DMAT started with 137 milestones (75% from DDST II, 25% from expert opinion) and was used to screen 100 children during the first pilot. During the first revision, 21 milestones were added and 10 milestones were deleted. The second version of the AHC DMAT had 148 milestones (48% from DDST II, 16% modified DDST II, and 36% from expert opinion) and was used to screen 63 children during the second pilot. During the second revision, eight more items were deleted: Item “say 2 words” was deleted because it was considered as not different from item one word beside mama and item say 3 words. Item “match shapes” was deleted because most Cambodian children do not have many different-shaped toys, especially those from rural areas. In fact, most of those from the village do not own a toy. During the interview, interviewers had difficulty explaining how to match shapes even to parents. Item “put on shirt” was too similar to item dress without help, and thus were not included in the Final Tool. The interviewers experienced that it was difficult to assess Cambodian children for Items “define 5 words” and item “define 7 words” and the items were deleted. They were more responsive to questions where they can see or play with like the ball and blocks. Finally, Cambodian children start preschool at age 6. Item “add and subtract” was considered inappropriate for Cambodian children at 6 years old as this is not usually taught by this age.

The final AHC DMAT has 140 milestones (49% from DDST II, 17% modified from DDST II and 34% by expert opinion). Of these milestones, 32 (23%) are GM items, 33 (24%) are LA, 37 (26%) are FM, and 38 (27%) are SO items (Fig. 2). The GM milestones had the

Table 1
Screening demographics (Age) and distribution.

Age	1st screening	2nd screening
Month	N=100	N=63
1	1	3
2	3	0
3	6	3
4	3	0
5	7	1
6	1	4
7	3	4
8	4	4
9	6	1
10	3	0
11	3	1
12	0	1
13	2	1
14	2	0
15	4	0
16	0	0
17	3	2
18	7	1
20	1	1
22	2	3
24	9	2
30	4	4
36	3	5
42	3	2
48	4	6
54	4	1
60	3	3
66	2	1
72	3	9
Missing	4	0
Mean	22.0 months	31.2 months
Median	16 months	24 months
IQR	7–30 months	8–48 months
SD	19.4	24.4

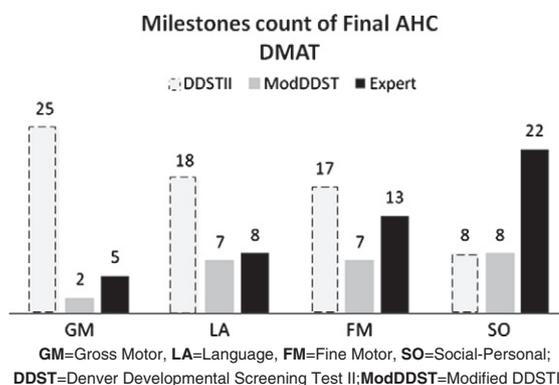


Fig. 2. Milestones Count.

highest percentage taken from the DDST II (directly and modified) with 84% of the total items included in the final version of the AHC DMAT while the SO domain had the highest percentage of milestones added by the investigators with 52%. The percentages of milestones directly from DDST II for the other domains were 50% for FM and 60% for LA (Fig. 2).

All three screeners agreed that ease of administration of the AHC DMAT was better in the second pilot due to the standardized instructions and props. The time of administration averaged 15–20 minutes for each survey. The final version of the AHC DMAT is shown in Fig. 3.

4. Discussion/conclusion

It is often assumed that neurodevelopment is a purely biological process and thus all children can be evaluated for neurodevelopment problems using the same methods. However, culture has a significant effect on how children develop, including what particular milestones they attain and when they attain them. For example, Cambodian children are generally not allowed to play with their food and usually eat by themselves later than their western counterparts. Alternatively, Cambodian children are often expected to help their parents and can perform some tasks earlier (e.g. chopping onions). Culture can also clearly play a role in personal and social interactions.

This pilot study supports the evidence that western tools, specifically the DDST II, may not be appropriate to screen non-western children for developmental delay, particularly in developing countries like Cambodia [8–15,17]. This study attempted to take a first step by creating a tool which can be used in a future large-scale study with normally developing Cambodian children.

The first pilot determined how feasible the AHC DMAT is in practice and identified milestones that were confusing or not culturally relevant. Lessons learned after the first pilot screening included the need for instructions for certain milestones and for standardized props to minimize the risk of subjective interpretation by the screeners. Additionally, several milestones that were confusing and were being failed repeatedly were inferred to be inadequate or irrelevant tests and were thus removed. Milestones were then added to replace the removed milestones. This was the case particularly in the FM and SO domains where many of the DDST II milestones were found to be inadequate tests. For example, “add and subtract” and “define 7 words” had high fail rates because Cambodian children learn these concepts late in school, or may have no formal education. Similarly, many Cambodian children do not use a pencil and paper until at least age of 5 or 6, but many of the DDST II fine motor tests for ages 3–5 years depend on drawing. Thus, additional fine motor tests for these ages had to be added to replace some of the drawing tests. It was also found that having specific age-range groups for

AHC DMAT

Angkor Hospital for Children Developmental Milestone Assessment Tool (AHC DMAT)

Exam Date:	Height / Weight:	Participant ID:
Mother finished primary school:	Yes No	Sex: Male Female
Child attends schools:	Yes No	DOB: day/mo/year Age:

Age	D	R	F	Gross motor (GM)	D	R	F	Language (LA)	D	R	F	Fine motor-adaptive (FM)	D	R	F	Personal/Social (SO)
1 mo				1 Equal movement				2 Response to noise				3 Follow to midline				4 Recognize face
2mo				6 Lift head				8 Make sounds								5 Cry when appropriate
				7 Turn head side when on stomach												9 Smile spontaneously
3mo				11 Head up 45 degree				12 Laugh				13 Follow pass midline				10 Smile responsively
4mo				15 Sit-head steady				17 Squeal				18 Grasp big objects				14 Recognize own hands
				16 Bear weight on legs								19 Play with own body				
5mo				21 Chest up arm support				23 Turn to sounds				20 Hand together				
				22 Roll over								24 Follow 180 degree				26 Brief interest in toy/sound
6mo				27 Pull to sit, no head lag				28 Turn to voice				25 Regard rice/small object				
7mo				31 Sit no support				32 Babble (mumm)				29 Reach for object				30 Recognize stranger
								33 Mama (unspec)				34 Take lotus seeds				36 Observe object in each hand
8mo				37 Stand holding on				39 Response to name				35 Put finger/object in mouth				37 Anxiety separation
												40 Take two objects				42 Seek object after fallen on floor
9mo				43 Crawl								41 Transfer object				
																44 React/respond to play
10mo				46 Getting to sitting				48 Say play sound				49 Thumb-finger grasp				45 Start to explore environment
				47 Pull to stand												50 play chab chab
11mo				51 Stand 2 seconds												
12mo				52 Take steps w/ mother holding								53 Bang 2 objects together				
				54 Turn head all direction												
13mo								55 Mama/dada/Bong (spec)								56 Indicate needs/wants by pointing/saying
																57 Greeting with hands clasp
14mo				58 Stand alone				59 Say 1 word beside "mama"				60 Put block in cup				
15mo				61 Stoop and recover												62 Play vak...mmm
				63 Walk well												
17mo				64 Walk backwards								65 Scribble with stick				66 Drink from cup
																67 One-step command
18mo				68 Run				69 Say 3 words				70 Drop very small object into container (pincer grasp)				71 Use spoon
20mo								72 Say 6-10 words								73 Imitate activities

D=demonstration R=report F=Failed

Fig. 3. Final AHC DMAT.

AHC DMAT

Age	Gross motor (GM)			Language (LA)			Fine motor-adaptive (FM)			Personal/Social (SO)		
	D	R	F	D	R	F	D	R	F	D	R	F
22mo												
24mo												
30mo												
36mo												
42mo												
48mo												
54mo												
60mo												
66mo												
72mo												

D=demonstration R=report F=Failed

Fig. 3. Final AHC DMAT (continued).

this first version of the AHC DMAT made it less useful. Many children were passing or failing all the milestones in their specific age-range group but there was no procedure to screen them with other milestones. This led to the introduction of a ceiling and flooring method for the revised AHC DMAT and second screening.

The second screening helped to create a final AHC DMAT version that was more practically feasible and had fewer obviously invalid milestones than both the first version and the DDST II. Moreover, the ceiling and flooring method helped to estimate the upper limit of each child's development, which would be very useful in a large-

scale study to identify age-range percentiles. Thus, the second pilot method can serve as a model for any future large-scale study to determine the normal milestones of Cambodian children and to validate the tool.

The main limitation of this study was the small sample size, which prevented reliability and validity testing of the specific AHC DMAT milestones and limited how representative the study population was to the population of the country as a whole. Non-statistical face and content validity were, however, achieved through discussion and consensus obtained among the investigators who, when necessary, consulted

AHC DMAT - Instructions

- 1 Hold child in middle and observe for equal movement.
- 3 Pass if baby turns head or moves eyes.
- 4 Pass if baby looks at mom's face.
- 6 Put baby on stomach and observe baby lift head
- 12 Pass if laugh with sound.
- 13 Pass if eye and head move.
- 14 Baby use hands and stare at them for 2 seconds.
- 17 Make loud happy sound (not crying sound).
- 18 Give a block, pass if baby takes the block.
- 21 Put baby on stomach, pass if support with arm.
- 22 Pass if roll over at least one way.
- 25 Pass if baby looks at small object. Small object can be beads.
- 29 Baby must work for the object placed in front.
- 30 Pass if baby starts crying when given to stranger, stop when given back to mom.
- 34 Place lotus seed (small object). Pass if baby picks it up.
- 37 Mother leave and baby still cries.
- 38 Baby able to stand while being held by the arms.
- 41 Transfer from own hand to own hand.
- 42 Drop object. Pass if child look for then fallen object. Try at least 2 times
- 44 Child plays with parents.
- 45 Pass if starts to crawl. Khmer would say a child is "laphuk".
- 47 Pass if stand when mother pull by the hands.
- 48 Play with voice with lips
- 49 Give small object. Pass if pick it up using thumb.
- 51 Pass if mother let go for 2 seconds.
- 59 Pass if can say "rice" "porridge", "water", "eat",or others.
- 61 Fall and get up.
- 67 Pass if can follow command - "sit", "scribble", "get me that", "go to room".
- 73 Is child following older sibling at play or doing task?
- 75 Show photo of elephant, cow or cat and ask—where is elephant...cow?
- 79 Pass if can say phrases, ex. "I eat rice", "want to pee", "want to play".
- 82 Child plays by self and not sharing.
- 86 Show photo of elephant and ask: What is this? Pass if points to photo correctly.
- 90 Can follow 2-step command: "Go to kitchen and bring me that spoon".
- 93 Show photos and ask: What is this? Pass if child point to photo correctly.
- 95 Fold a paper once. Pass if child can do the same.
- 101 Pass if can balance each foot (both feet).
- 102 Ask: Which one flies (bird), say meow (cat), say moo (cow), is eating?
- 103 Can child use "I or khoum" appropriately?
- 104 Know what to do with a cup (drinking), spoon (eating), pencil (writing).
- 106 Pass if can do at least one thumb.
- 108 Show child how to put bead into string. Pass if child can copy you.
- 112 Know what to do with a cup (drinking), spoon (eating).
- 114 Ask: Put something on a table...in a box...outside the box...in front of you.
- 116 Pass if circle is closed.
- 117 Can follow: "go to room, get me the spoon, and put it on the table".
- 118 Pass if can hop 5 times in place.
- 123 Show two lines, short and long. Ask: Which is longest line?
- 125 Pass if can do on both feet.
- 126 Without pictures, ask: If elephant is tall and big, a mouse is? If your mother is tall, you are? fat vs.thin? closed vs opened, fast vs slow. Pass if gets 2/ 3.
- 127 Start conversation with child by showing picture, or recalling a story. Pass if child can carry a conversation.
- 129 Pass if can serve "bor bor" self.
- 131 Pass if can play the marble game, hide-and-seek, shoe game, etc...
- 134 Pass if drawing has at least a head, arm and body in right place.
- 140 Must know Monday to Sunday.

Fig. 3. Final AHC DMAT (continued).

other experts such as Cambodian pediatricians, nurses, and other health professional working at the hospital where the study setting took place. Face validity was further determined through the process of removing specific milestones which were clearly confusing to the children/caretakers during the two pilot screenings.

The hospital setting also presented a further limitation as most patients seen at outpatient clinic were sick. Though severely sick and chronically sick children were excluded, even mild illness can limit how cooperative a child may be with developmental screening. It is recommended that any future study seeking to find normal developmental milestones will need to include healthy children from community-based settings, such as schools and homes across Cambodia.

As with any developmental screening tool, reporter bias is an inherent limitation. This study attempted to minimize this bias by relying as much as possible on demonstration of the milestones rather than parent report, although it was not possible to test each milestone on each child solely by demonstration due to time constraints, shyness in the child, uncooperative child, etc. However, of the all the milestones that were passed in this study, twice as many were passed by demonstration than by parent report. Language barrier was another limitation.

Although the pilot screenings were conducted in Khmer and all the screeners were fluent in both Khmer and English, the language of the tool itself is in English. Thus, there was a possibility of mistranslation or misunderstanding. This was minimized by providing clear instructions. For any future study, it will be beneficial for the AHC DMAT to be translated into Khmer.

Cambodia needs its own population-specific developmental screening tool since western tools are not appropriate for use here. This notion is well recognized by a study conducted by Scherzer [18] who included outpatient children at AHC using a simple one-page check-off developmental milestone chart consisting of western milestones. In this particular study, it was observed that 25% and 31.5% of children failed to achieve one or more age-appropriate developmental milestones. One should be cautious when interpreting such findings since it is difficult to conclude whether the problem lay with the children tested or with the tool itself.

Our study was the first step towards creating such a tool. We recommend that a larger scale study be conducted to validate the milestones of the AHC DMAT and to establish the age-range percentiles of normally developing Cambodian children.

Conflict of interest

The authors declare no conflict of interest. Two of four authors are employees of Angkor Hospital for Children, the setting of the study, and the other two were volunteers at the hospital. No funding was received for this pilot study.

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The first author declares having the role of the study investigator (e.g. in the study design, in the collection, analysis and interpretation of data). All authors read and approved the writing of this manuscript and decided to submit the manuscript for publication. All authors listed met the criteria for authorship as defined by EHD. In preparing for this manuscript, the authors did not receive any technical help or writing assistance.

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