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Evaluating Parental Screening Tool for Developmental Milestone in Children Under Five Years in Rural Western Kenya

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***Abstract*- Background**: An estimated 200 million children suffer from developmental delays, most in developing countries. Early diagnosis through screening is key to timely intervention. However, screening tools have not been assessed in developing countries.

Objective: This study thereforeassessesparental screening tool for evaluating developmental delays (PEDS; DM) in children under 5 years.

Method: Across-sectional survey of randomly selected 870 caregivers to test sensitivity and specificity of developmental domains of children under 5 years was used.

Results: Specificity above 89 % was observed in all the developmental domains and Sensitivityabove 57% was observed inall the domains except forgross motor that had 35.8%.
Negative predictive value was above 90% in all the domains while the positive predictive value was between 18% and 40%. In addition, an average scale reliability coefficient of 8.6 was observed and moderate likelihood ratio LR [5-10] in all the domains except for gross motor which had LR [2 – 5].

Conclusions: The PEDS;DM has high sensitivity and good reliability for all the developmental domains in children under 5 years and therefore it is adequate and can be used by primary health providers for initial testing to detect risk of developmental problems. However, thesensitivity should be improved for all the domains andspecificity for gross motor domain.

***Index Terms*-** developmental Delay, accuracy, PEDS:DM, Kenya

I. INTRODUCTION

The mortality of children under five years has significantly reduced in developing countries (1).Certain risk factors that precipitate mortality in children also have a negative impact on their development outcomes. Improvement in child health care does not eliminate these risk factors, these children therefore are faced with a new huddle to overcome. Consequently,among the surviving, more than 200 million children under five years are suffering from developmental delay (1). The common developmental problems affect the fine motor, gross motor, socio-emotional, self-help, receptive e and expressive language(2).

In developed countries, early intervention programs that are cost effective have demonstrated lifelong benefits and increased chance of reversal(3). However, there is need forearly identification (before two years of age) of affected children(4). There are a number of standardized developmental screening tools but most of them have not been assessed in developing countries. The few for developing countries have not been assessed in multiple population. Most of the time, these tools when adapted or developed in developing countries, their use are confided to the research population. Some of these tools require supplies, training and takes a lot of time hence they are rarely used outside research settings(5). A systematic review of 14 developmental screening tools used in low and middle income countries (LMICs)recommended further research and development to optimize the tools(6).

Parental Evaluation for Developmental status: Developmental Milestones (PEDS: DM) is used for screeningdevelopmental delay for children from birth to 8 years of age. It consists of 6 to 8 questions per age range(7). It is quick and easy to administer because it is based on caregiver's report. Each item measures one of the eight domains of developmentincluding fine motor, gross motor, socio-emotional, self-help, expressive language, receptive language and for older children, reading and math. Each item measures a different developmental domain giving a pass or a fail. The age level are grouped into 1 – 3 months for ages up to 2 years, then 4 to 6 months intervals up to 5.5 years of age(8). It can be administered at ages 9, 18, 24 and 30 months, thereafter it is administered annually up to 8 years. This study therefore sought to assess sensitivity, specificity and reliability of PEDS: DM in comparison to PEDS: DM norming scores in rural western Kenya.

II. METHODS

Design: The design of the study was cross-sectional surveytargeted caregivers of at least one child under five years from a given household. PEDS: DM was used as adevelopmental delay screening toolbased on caregiver report.

Study Site: The study was conducted in Ugunja sub-location which is located in Western Kenya. It has a population of 12,000; 3466 households and 1708 children under 5 years according to census survey of June 2014 by Ugunja Community and Resource center (UCRC). The site was chosen because the organization (UCRC) has made marked progress in trying to address issues of child development. They have a dedicated database of children under five years and their caregivers and run a community health center and early childhood development center

Subjects: The study population was of caregivers of at least one child under age five years from a given household. The details of all households, caregivers, children under 5 years were obtained from UCRC a database updated regularly by Community Health Volunteers (CHVs). The children born preterm or children with birth defects or known developmental disabilities were excluded from the study.Free and informed consent of subjects were obtained and Ethical approval was sought from Moi University/Moi Teaching and Referral hospital Institutional Research Ethics Committee

Data collection and analyses: The response options of the domains were 3 scale likert; fine motor (no, sometimes, yes); receptive language and expressive language (none, 1, 2 or more); and socio-emotional (no, often, yes). These responses were ordered into scores 1, 2 and 3. Each child's performance was scored based on their caregivers' response on a question (item) in each developmental domain. A child would perform well in the item if they scored three (3) in expressive and receptive language and socio-emotional items, and two (2) or three(3) in fine and gross motor items.

Because there was no developmental assessment data using a different tool, the PEDS:DM data in each domain was again normalized by age group and sex to provide sample level estimation of grouping of risk of developmental delay. A child was grouped at risk of developmental delay in a domain if their quotient was equal to or below 16th percentile of the normalized data. The age group was 3 months grouping between 0 – 59 months.

Data analysis for sensitivity, specificity, positive and negative predictive values was based on the tools scoring ability to predict the sample level norm grouping. Scale reliability of the tool was measured using Cronbach's Alpha.

III. Results

A total of 870 children were screened of which 460 (52.9%) were female. Median age was 32 months, range (1 – 59 months). Median age of the caregiver was 28 years range (18- 81 years). This information is summarized in table 1.

Table 1: Demographic characteristics of the study population

Characteristics	**Measurement (N=870)**
Child Age (Months)	Median = 32, range(1-59)
Caregiver Age (Years)	Median = 28, range (18 – 81)
Child Sex Male Female	 410(47.13%) 460(52.87%)
Number of children in household	Median = 3, range(1-9)
Caregiver years in school	Median = 8, range (0 – 17)

Specificity and Sensitivity: Specificity of the tool was high in all the domains; expressive language 89.72%, receptive language 92.15%, fine motor 93.34%, gross motor 89.69% and socio-emotional 89.84%. Sensitivity of the tool was low; expressive language 54.90%, receptive language 75.44%, fine motor 57.81%, gross motor 35.80% and socio- emotional 52.50%. Positive predictive value of the tool was lowwith wide confidence intervals in all the domains, exhibiting 23% in expressive language, 39% in receptive language, 38% in fine motor, 25% in gross motor and 18% in Socio-emotional.Positive predictive value of the tool was low in all the domains, while Negative predictive value was high exhibiting 98% in expressive language, 98% in receptive language, 96% in fine motor, 93% in gross motor and 98% in Socio-emotional (See table 2).The low sensitivity of the tool in measuring gross motor was attributed to three questions. The questions regarding use of stairs and ladders and walking forward heal to toe. Averagely 22% of the caregivers either refused to answer or were not sure. The distribution of caregiver score to these questions did not match the pattern of the rest of the questions

Table 2: Specificity, Sensitivity, and predictive values of the PEDS: DM tool

Domain	Rate (%)	95% CI
Expressive language		
Sensitivity	64.47	(44.41, 75.02)
Specificity	89.72	(87.45, 91.71)
Positive predictive value	23.42	(15.91, 32.41)
Negative predictive value	97.76	(96.44, 98.69)
Receptive language		
Sensitivity	74.55	(61.00, 85.33)
Specificity	92.15	(90.08, 93.90)
Positive predictive value	39.05	(29.67, 49.06)
Negative predictive value	98.17	(96.95, 99.00)
Fine motor		
Sensitivity	57.63	(44.07, 70.39)
Specificity	93.34	(91.40, 94.96)
Positive predictive value	38.64	(28.44, 49.62)
Negative predictive value	96.80	(95.32, 97.92)
Gross motor		
Sensitivity	37.33	(26.43, 49.27)
Specificity	89.69	(87.36, 91.71)
Positive predictive value	25.45	(17.63, 34.65)
Negative predictive value	93.82	(91.86, 95.42)
Socio-Emotional		
Sensitivity	57.58	(39.22, 74.52)
Specificity	89.84	(87.60, 91.81)
Positive predictive value	18.27	(11.37, 27.05)
Negative predictive value	98.17	(96.95, 99.00)

Reliability

Internal scale reliability of the tool when used in this population using Cronbach's Alpha, gave a scale reliability coefficient of averagely 0.86 for all domains of development (See table 3).

Table 3: Cronbach's alpha for internal scale reliability of PEDS:DM per developmental domains

Domain	Number of items	Cronbach's Alpha (Scale reliability coefficient)
Expressive language	17	0.87
Receptive language	18	0.86
Fine motor	16	0.86
Gross motor	13	0.82
Socio-emotional	17	0.88

Positive likelihood ratio

The probability of disease was increased by moderate units, Likelihood ratio (LR)of between 5 to 10 in all domains except in gross motor, where there was small increase likelihood of disease, LR of between 2-5.The LR in the various domains with 95%

confidence interval was Expressive language had 5.88[3.54,9.05], Receptive Language 9.49[3.34,4.50], Fine Motor 8.65[3.53,5.31], Gross Motor 3.62[2.09,5.95] and Socio-emotional 5.67[3.16,9.10 (figure 1).

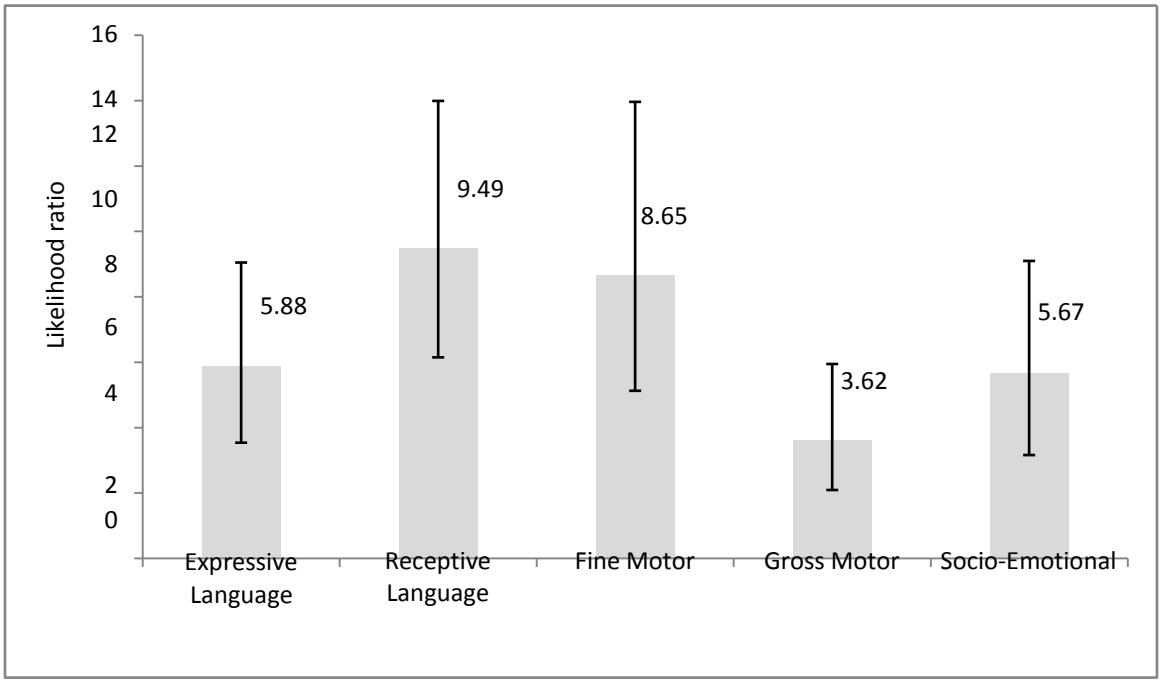

Figure 1: Positive likelihood ratio with 95% CI of PEDS:DM in measuring risk of development delay in the various developmental domains

IV. Discussions

The sensitivity of the tool was consistently 57% or higher in each developmental domain except in gross motor and specificity was consistently 89% or higher. The positive predictive value ranged from 18 – 39% while the negative predictive value ranged from 93-98%. Reliability was above 85% in all domains showing high level reliability of the tool. Although the sensitivity of the tool did not meet the recommended sensitivity of 70% in all domains except receptive language(9) the results shows that the tool is likely to identify higher proportion ofchildren with possible difficulties for further screening but it is not sensitive enough to pick out all children (10). The likelihood ratioconfirmed that using the tool increased the probability of identifying children at risk of delay by moderate unitswhich lies between 5 to 10 in all domains except in gross motor.

The pattern of the results seen in this study was also seen in a similar study conducted in Thailand using adapted PEDS:DM(11). These patterns of sensitivity and specificity had also been reported by a study in South Africa when comparing a nationally developed tool to PEDS(12) where sensitivity was lower than 70% but specificity was usually high at above 89% for all domains. Conversely, a study using norming data for developmental milestones from the United States found that PEDS have high sensitivity and specificity often above the recommended sensitivity 70% and Specificity 80%. The negative predictive value and positive predictive value patterns was also consistent with a study(7) that compared the tool with Baileys Scales of Infant Development Second edition which reported low positive predictive value (mean of 50%) and high negative predictive value (mean of 95%). The study also showed that positive likelihood ratio was averagely 4.5 which compares with the results of this study.

The low specificity due to the three questions asking about use of ladders, stairs and walking heal to toe may have included questions of construct validity of the tool (13). This means that the questions may not be interpreted correctly by the caregivers in this setting.

PEDS;DM has high Sensitivity and good reliability and sensitivity for all the developmental domains except gross motor in children under 5 years and therefore is adequateas a screening tool to be used by primary health practitioners. However, the specificity should be improved for all the domains and sensitivity for gross motor domain. This can be done by further research to modify the questions to the rural populations and setting.

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