

Short Communication

Greater length-for-age increases the odds of attaining motor milestones in Vietnamese children aged 5-18 months

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Early childhood malnutrition has been associated with delayed development. Limited data exist however about the timing of developmental delay early in life. We assessed motor milestone (MM) achievement using the World Health Organization's windows of achievement for gross motor milestones. We performed secondary analysis of baseline data of 158 Vietnamese children aged 5-18 months from a randomized community intervention trial. Median age of motor milestone achievement was compared to WHO reported medians. Multivariate logistic regression was used to identify socioeconomic, anthropometric and dietary factors associated with motor milestone achievement during the windows of achievement. Thirty four per cent of the children were stunted. Median age of MM achievement of Vietnamese children lagged by 2.4-3.7 months, compared to the WHO median for all MMs. Greater length-for-age increased the odds for walking with assistance, standing alone and walking alone by more than 3 times. Greater weight-for-age increased the odds by 3.6 for hand-and-knees crawling. Likewise, frequency of daily complementary feeding raised the odds by 3.6 for standing with assistance. In this first application of WHO windows of achievement in Viet Nam, pre-schoolers achieved motor milestones later than WHO reported median age. High prevalence of stunting and association of length-for-age with motor milestone achievement underscore the importance of addressing chronic malnutrition to optimize children's growth and development.

Key Words: development, growth, Viet Nam, preschool children, motor milestones

INTRODUCTION

Child undernutrition is a critical issue in Asia and elsewhere.^{1,2} Among preschool Vietnamese children, 2 million (20% of all children) are underweight,³ and 36% are stunted.⁴ Research has shown an association between undernutrition, motor development and cognitive development.^{5,6,7} It is important to assess motor development in a population, as undernutrition and poor intellectual development have been associated with adverse economic impact due to decreased human productivity and low wages.⁸

In 2006, new methods for assessing child growth and development were released by the World Health Organization (WHO) through its Multicentre Growth Reference Study (MGRS).^{9,10} These include six gross motor development milestones (sitting without support, standing with assistance, hands-and-knees crawling, walking with assistance, standing alone and walking alone). MGRS developed windows of achievement for each motor milestone, during which 95% of study children achieved the milestone.¹⁰

We analysed baseline data of children aged 5-18

months from a community intervention trial (Viet Nam Study to Improve Outcomes in Nutrition, ViSION) to compute the prevalence of motor milestone achievement and median age of achievement using the WHO Motor Development Study, and to identify factors associated with motor milestone achievement.

MATERIALS AND METHODS

We conducted a randomized community intervention trial (ViSION) in rural north central Viet Nam with 240 children (120 children in the intervention group and 120 children in the comparison group) aged 5-24 months. Data were collected at baseline, every month for the first 6 months and at 12 months. For the current analysis, we used only the base line data (collected in December 1999

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and January 2000). The study is described in greater detail elsewhere.¹¹ All procedures and protocols of the VISION study were approved by Emory University's Institutional Review Board. Informed consent was obtained from the children's parents. This secondary data analysis was exempted from further review by the same Board.

Trained field workers obtained anthropometric measurements in triplicate. Digital reading tare SECA scales (UNICEF, electronic scale 890, SECA Ltd, Birmingham, UK) precise to 100 g and Shorr infant/child/adult measuring boards (Shorr Productions, Olney, MD, USA) precise to 1 mm recumbent height were used.¹¹ Data collection on anthropometric measurements was standardized for the field workers to reduce measurement error. Standardization was based on a set protocol that assessed each field worker's ability to maintain consistency and duplicity of measurements. The average of the triplicate anthropometric measurements was used for the current analyses.

For motor milestones (MM), field workers collected 23 graded measurements of gross motor milestone function ranging from baby sits up with help to child can jump.¹¹ Field workers were provided with a guide depicting pictures of motor milestones. The highest milestone achieved was obtained by observing the child and interviewing the caregiver, showing pictures and verbally confirming that the child could complete a particular activity.¹¹ For the current analysis, the 23 motor milestones from the baseline data were regrouped¹² into the 6 WHO gross motor milestones as described in the WHO Motor Development Study.¹⁰ Any of the 23 motor milestones that preceded a particular WHO gross motor milestone were grouped in the previous WHO motor milestone category. For example, all of the motor milestones that a child achieved before being able to crawl were placed in the sitting without support category since sitting without support generally occurs before learning to crawl.

Statistical analysis

For this analysis, only children 5 to 18 months were considered (n=158) as children beyond 18 months had already started walking. WHO Anthro Software (Version 3, April 2009) was used to compute children's weight-for-age (WAZ), weight-for-length (WLZ), and length-for-age (LAZ) Z scores per WHO standards. Further analysis of the data was completed using SAS 9.2 (Cary, NC, USA). Median age of the highest observed milestone was calculated (and hereafter is referred to as age of MM achievement) and compared with the WHO reported median for each of the 6 milestones.

Sample size for the logistic regression models for each of the motor milestones was determined by the number of children who were within the "windows of achievement" (i.e., age groups) for every motor milestone, per the WHO Motor Development Study.¹⁰ Binary responses for the outcome variable were based on whether or not a specific motor milestone or a more advanced one was attained during the window of achievement. Using this variable, the prevalence of achieving each of the motor milestones was calculated. Potential explanatory variables included household income, child age, LAZ and WAZ scores, infant and young child feeding practices, number of hours in childcare, and household consumption of iodized

salt.¹³⁻¹⁸ Stepwise selection was followed to obtain variables for these to be entered into final models for logistic regression for the six motor milestones that were significant at $p < 0.2$. Household income and mother's education were controlled for in all models irrespective of the variables selected in the stepwise selection procedure. Sex of the child was not included in the model: MGRS data indicate no significant difference between sexes in motor milestone attainment.¹⁹ Household income, child's age, WAZ, LAZ, frequency of feeding non-breast milk foods and liquids, and hours spent in childcare were added as continuous variables, while children who were bottle fed in the first 6 months of life, households consuming iodized salt, and mothers' education level were categorised as yes or no. Diarrhoea in the 2 weeks prior to the survey was not considered as a potential explanatory variable due to low prevalence. All assumptions of logistic regression were met.

RESULTS

Children's mean age was 12.7 month, and 89% of children were breastfeeding at the time of the survey. Mean WAZ score was -1.2, mean LAZ score was -1.5 and mean WLZ score was -0.5 (Table 1).

The median age of motor development showed a 2.4-3.7 month delay for Vietnamese children compared to the median age reported by WHO (Table 2). The prevalence of MM achievement for each of the 6 MM ranged from 30-66% (Table 3).

An increase in child age by one month increased the odds of achieving all of the milestones by 2.5-9.4 times (Table 4). A unit increase in LAZ more than tripled the

Table 1. Characteristics of Vietnamese children aged 5-18 month, their mothers and families (n=158)

Characteristics	Value
Child age in mo, mean (SD)	12.7 (3.5)
Girls, n (%)	75 (47.7)
Mean WAZ score (SD)	-1.2 (0.9)
Mean LAZ score (SD)	-1.5 (1.1)
Mean WLZ score (SD)	-0.5 (0.9)
WAZ < -2, n (%)	25 (15.8)
LAZ < -2, n (%)	54 (34.2)
WLZ < -2, n (%)	9 (5.7)
Child diarrhoea in the past 14 d, n (%)	12 (7.6)
Child currently breastfeeding, n (%)	139 (88.5)
Maternal height in cm, mean (SD)	151 (4.7)
Maternal Body Mass Index in kg/m ² , mean (SD)	19.5 (1.5)
Mothers educational status [†]	
-Primary education not completed, n (%)	8 (5.1)
-Primary education completed, n (%)	75 (47.8)
-Junior high school completed, n (%)	54 (34.4)
-High school and above, n (%)	20 (12.7)
Households consuming iodized salt, n (%)	107 (68.6)
Households income in past 12 mo in USD, mean (SD) [‡]	479 (500)

WAZ: Weight-for-Height Z score; LAZ: Length-for-Age Z score; WLZ: Weight-for-Length Z score; calculated using WHO Anthro Software (Version 3, April 2009)

[†] 1 missing value

[‡] 1USD=14,025 Vietnamese Dong

Table 2. Comparison of age (months) of motor milestone achievement: WHO median, ViSION study and published literature

Motor Milestone	WHO median ¹⁰	Viet Nam median (ViSION study)	Indonesia, median ^{† 20}	Nepal, Median ^{† 14}	Zanzibar median ^{† 15}	Honduras, ²³	Italy, median ²¹	Spain, median ²²
Study type	Longitudinal	Cross-sectional	Cross-Sectional	Cross-sectional	Cross-sectional	Longitudinal	Longitudinal	Longitudinal
Sitting without support	5.9	8.3	7	6	7	Did not assess	6.0-6.3	7 [‡]
Hands-and-knees crawling	8.3	10.9	9 [§]	7	9	7.0-7.2 (mean)	8.9-9.1	Did not assess
Standing with assistance	7.4	9.9	10	8	10	7.5-8.5 (median)	Did not assess	Did not assess
Walking with assistance	9.0	12.2	12	11	12	9.0-9.5 (mean)	Did not assess	Did not assess
Standing alone	10.8	13.2	14	13	12	10.5-11.0 (mean)	11.2-11.4	Did not assess
Walking alone	12.0	15.7	14	14	15	Did not assess	12.7-12.9	13 [‡]

[†]: Ages in Indonesia, Nepal and Zanzibar studies were estimated from graphs.

[‡]: Age corrected for very low birth weight infants

[§]: Pollitt et al.²⁰ assessed creeping (child's body weight rests on hands and knees without tummy touching the support surface) which equivalent to hands-and-knees crawling per the WHO definition.¹⁰

Table 3. Proportion of Vietnamese children achieving age-appropriate motor milestones per the WHO windows of achievement[†] (n=158)

Motor milestone	WHO window of achievement, months [†]	Vietnamese children	
		Age is in window of achievement, n	Achieved the specific milestone or higher during the window of achievement, n [‡] (%)
Sitting without support	3.7- 9.4	37	21 (56.8)
Hands-and-knees crawling	5.0-13.9	88	58 (65.9)
Standing with assistance	4.7-11.7	60	18 (30.0)
Walking with assistance	5.8-14.1	86	38 (44.2)
Standing alone	6.7-17.4	140	78 (55.7)
Walking alone	8.0-18.0	134	77 (57.5)

[†] Please refer to reference number 10

[‡]Total number of children is more than 158 since there is an overlap in the age range for windows of achievement for the motor milestones.

odds (3.0-3.7) of walking with assistance, standing alone and walking alone; and a unit increase in WAZ increased the odds of hands-and-knees crawling by 3.6. Frequency of feeding non-breast milk liquids and foods increased the odds of standing with assistance by 3.6 times. Household yearly income, maternal education, bottle feeding in the first 6 months and households consuming iodized salt variables were not significant for any motor milestones. The proportion of children breastfeeding and number of hours spent in child care were not retained in the stepwise selection procedure for any motor milestone model.

DISCUSSION

This is the first study to use the WHO windows of achievement to assess motor development in Viet Nam and to evaluate the factors affecting all of the WHO gross motor milestones. The Vietnamese sample showed a delay in all six MM.¹⁰ Cross-sectional studies in Indonesia,²⁰ Nepal,¹⁴ and Zanzibar,¹⁵ as well as longitudinal intervention trials in Italy,²¹ Spain,²² and Honduras,²³ also

found delays in the age of MM achievement (Table 1). For most milestones, the Vietnamese sample demonstrated a median age of MM achievement that was delayed as much or more than these studies.

The WHO windows of achievement are based on a longitudinal study as opposed to the cross sectional nature of the Viet Nam, Indonesia, Nepal and Zanzibar studies. A second limitation of our study is small sample size.

In our study, the odds of walking with assistance, standing alone and walking alone were greater in children with higher LAZ and the odds of hands-and-knees crawling were higher for children with higher WAZ. A study in Zanzibar found WAZ, LAZ and anaemia as predictors for walking alone¹⁵. Similarly, other studies in Nepal, Indonesia and Kenya have also reported significant associations between higher LAZ, WAZ, WLZ scores and MM achievement^{14,20,24}.

We found that feeding non-breast milk foods as a part of complementary feeding increased the odds of standing with assistance. Increased frequency of non-breast milk

Table 4. Odds ratios (95% CI) from multivariable logistic regression for factors[†] associated with Vietnamese children achieving motor milestones during the WHO windows of achievement

	Sitting without Support [‡] (n=37)	Hand-and-knees crawling (n=88)	Standing with assistance (n=60)	Walking with assistance (n=86)	Standing alone (n=140)	Walking alone (n=134)
Household yearly income	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (1.0-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (1.0-1.0)
Maternal education (junior high school completed=1, not completed=0)	1.2 (0.2-6.5)	0.4 (0.1-2.2)	0.6 (0.1-2.8)	1.6 (0.4-6.2)	2.2 (0.7-6.7)	0.5 (0.2-1.4)
Child age (month)	4.5 (1.6-12.5)	9.4 (2.6-34.3)	2.8 (1.6-4.9)	3.3 (2.0-5.5)	2.5 (1.9-3.3)	2.6 (1.9-3.6)
Child LAZ	§	-	-	3.7 (1.3-10.2)	3.0 (1.3-6.8)	3.1 (1.7-5.7)
Child WAZ	-	3.6 (1.0-12.7)	-	0.5 (0.2-1.3)	0.5 (0.2-1.3)	-
Daily frequency of feeding non-breast milk liquids and foods	-	3.7 (0.9-15.7)	3.6 (1.1-11.4)	-	-	-
Ever bottlefed in first 6 months (yes=1, no=0)	-	-	-	2.6 (0.6-10.8)	-	-
Household consuming iodized salt (yes=1, no=0)	-	-	-	-	-	2.8 (0.9-9.1)

LAZ: Length-for-age z score; WAZ: Weight-for-age z score

[†]The variables "children breastfed at the time of survey" and "daily hours spent for child care" were not selected for any of the models in the stepwise selection procedure and hence not included in the table

[‡]The small sample size for sitting without support precluded adding more variables to the model in order to meet the assumptions of logistic regression

[§]Cells with a hyphen indicate that the particular variable was not selected in the stepwise selection procedure and hence not included in the final model

food may lead to increased energy intake²⁵ which can contribute to motor development. One study in Indonesia found that energy and iron supplementation was associated with an earlier age for walking.²⁶ Numerous studies document the positive impact of micronutrient supplementation on motor development;^{13,14} however, there are no studies that investigate frequency of feeding and its relationship to motor development.

This study reports for the first time the use of the WHO windows of achievement to evaluate Vietnamese children's gross motor development. It provides a development snapshot of a sample of children in Viet Nam and reinforces the importance of addressing chronic malnutrition to reduce the detrimental effects of delayed growth and development.

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AUTHOR DISCLOSURES

None of the authors has competing interests to report.

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越南 5-18 個月的幼兒較高的年齡別身長有利於達到動作發展里程碑

幼兒早期的營養不良與延緩成長具有相關性。然而關於幼年期成長遲緩的時間點之資料有限。使用世界衛生組織(WHO)的粗大動作發展時程來評估動作里程碑(MM)的達到性。針對 158 名來自隨機社區介入試驗的 5-18 個月的越南幼兒執行第二次基線資料分析。比較達到動作里程碑的年齡中位數與 WHO 報告的中位數。使用多變項邏輯斯迴歸分析以確認社經地位、體位及飲食因素與達到動作里程碑之相關性。計有 34% 的兒童為發育遲緩。越南兒童達到 MM 的年齡中位數比起 WHO 的所有 MM 中位數慢了 2.4-3.7 個月。較高的年齡別身長增加在協助行走、自行站立及獨立行走的動作達到機率 3 倍以上。較重的年齡別體重提高用手腳爬行動作的機率 3.6 倍。同樣的，每日副食品餵食提高了 3.6 倍協助站立的動作達到機率。這是第一次將 WHO 動作發展時程應用在越南，顯示學齡前兒童達到動作里程碑的年齡中位數晚於 WHO 的報告。發育遲緩的高盛行率和年齡別身長與達到動作里程碑的相關性，突顯出解決慢性營養不良對理想的生長及發育的重要性。

關鍵字：發育、生長、越南、學齡前兒童、動作里程碑