ORIGINAL RESEARCH

STUNTED GROWTH IN A COHORT OF TWO-YEAR OLDS IN THE KHANH HOA PROVINCE IN VIETNAM – A FOLLOW-UP STUDY

ARILD VAKTSKJOLD[1], ĐOÀN VĂN TRÍ [2], DƯƠNG TRỌNG PHÏ[2] and TORKJEL SANDANGER[3]

[1]Nordic School of Public Health, Gothenburg, Sweden, a subsidiary of the Nordic Council of Ministers, Denmark; [2]Pasteur Institute, Nha Trang, Viet Nam; and [3]Norsk Institutt for Luftforskning, Tromsø, Norway.

Corresponding author: Arild Vaktskjold (arild.vaktskjold@nhv.se)

ABSTRACT

Objectives: Vietnam is undergoing rapid socio-economic changes. The Vietnamese government has introduced programmes to combat malnutrition and stunted child-growth twice during the past decade. However, in a recent study of a cohort in the Khanh Hoa province the proportion of children in late infancy with short stature was three fold that expected under the new WHO growth standards. The findings warranted a follow-up study of this cohort. In the present study, stature growth of the cohort was assessed at age two years using the same growth standards as reference, and potential risk factors for short stature were analysed. **Methods**: A cohort of 237 singleton infants born at term in the period May to July 2005 in three main delivery clinics in the Khanh Hoa province were followed prospectively. Their height-for-age two years later was analysed using the new WHO sex-specific growth standards and compared with short stature at age one. Associations between short-stature-for-age and parity, rurally born, maternal age, duration of breastfeeding, and disease in the second year of life were investigated. **Results**: Twenty-six percent (95% confidence interval: 20.4-32.4%) of the children were within the 5th percentile of the standards for height-for-age. Of these, 38% had been within the same percentile at age one. Neither incidence nor prevalence of short-stature-for-age were associated statistically with any of the analysed maternal and child factors. **Conclusions**: Based on the new WHO growth standards, the proportion of children in this cohort with stunted growth at age two was markedly higher than expected, and the majority of them did not have short stature-for-age a year earlier. These findings confirm the need for policies and early interventions to prevent stunting in Vietnam – in particular in the Khanh Hoa province. In this cohort, stunted growth at age two was not independently associated with parity, being rurally born, maternal age, duration of breastfeeding, and disease occurrences in the second year of life.

KEY WORDS: Child health; Growth standard; Stunting; Vietnam.

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INTRODUCTON

The majority of the world's children under age five with stunted growth live in Asia (de Onis et al, 2000). In Vietnam, where anaemia, malnutrition and hookworm infestation have been widespread (Aikawa et al., 2006; Khan et al., 2007; Trinh and Dibley, 2007), the World Health Organisation (WHO) (2008) estimated that about one third of children under five were stunted and/or underweight for age. In 2006, the government announced an anti-malnutrition programme to reach the national goal of less than 25% stunted growth and less than 20% underweight in the child population by 2010 (Viet Nam News, 2006). A plan to reduce child malnutrition had been launched also in 2001 (Khan et al., 2007). Hence, studies using the new WHO standards to assess the situation and developments concerning the growth of children in Vietnam were warranted and province and district specific data are required.

A child may be inhibited from reaching its genetic growth potential if nutritional, socio-economic, health, or environmental factors are unfavourable (Dewey, 1998; Ulijaszek, 2006). The WHO Working Group on Infant Growth (1995) views anthropometric assessments of infants useful to judge nutritional adequacy and the impact of illness, and for that purpose the WHO published new international growth standards in 2006. The standards include sex-specific weight, length (height) and body mass index for age; and weight-for-length. The standards are intended to depict how healthy, breastfed children living under favourable conditions should grow in all populations, regardless of time and place. Hence, deviations from the standard pattern can be considered evidence of abnormal growth (WHO, 2006), and can be used to diagnose wasting, stunting, as well as over- and underweight (Fenn and Penny, 2008). Growth deficiency is considered present in a population when more than five percent fall below the 5th percentile of the standard (WHO, 2006). The previously applied growth references had low validity for international use as they were based on the growth of North American infants who were pre-dominantly formula-fed (WHO, 1995, 2006; Schwarz et al., 2007; Fenn and Penny, 2008).

Retarded stature growth in early life is associated with poor functional outcomes in later life and these children do usually not catch up in growth (Martorell et al., 1994; Kar et al., 2008). In a sample of singleton infants born at term in three main delivery hospitals in the Khanh Hoa province in Vietnam, we found that 18% were within the standard 5th percentiles for length-for-age at age one year. The findings indicated that stunted growth was prevalent which warranted an additional follow-up study. The study also revealed that infants born in a rural area had a lower length-for-age then their urban counterparts, independent of diarrhoea (Vaktskjold et al., 2010a).

The aim of this study was to assess the stature growth of this sample of children one year later (age two) based on the new

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WHO growth standards. Our specific study questions were as follows: (1) Was the proportion of children who were within the WHO standard 5th percentiles for height-for-age higher than 5 percent? (2) What was the proportion of children who were within the low 5th percentile of the standards at age two years of the children who were not in that same tail of the standard distributions a year earlier? and (3) Were any of the following factors associated with being within the low 5th percentile of the standards at age two: rural or urban district of delivery, duration of lactation, disease occurrences in the second year of life, and maternal age and parity?

METHODS

Enrolment and Data Collection

The study took place in the coastal city of Nha Trang (363 000 inhabitants), the capital of the province Khanh Hoa, and in the nearby inland rural district of Dien Khanh (126 000 inhabitants) (Hansen et al., 2009). The Pasteur Institute in Nha Trang initiated the investigation in co-operation with the University in Tromsø and Norsk Institutt for Luftforskning, Norway.

Women attending routine third trimester pre-natal care within a two-month period in the three main delivery units were invited to participate in a follow-up study of their newborns. The participating delivery units were the obstetric department at the provincial hospital and the public delivery clinic in Nha Trang and the obstetric clinic at the district hospital in Dien Khanh. Of the 245 women attending care during the study period, 240 (98%) gave consent to participate. The enrolled women delivered 242 newborns in the period from May to July 2005, whereof 237 were live born and singleton; 128 in Nha Trang and 109 in Dien Khanh. All babies were delivered at term (≥37 weeks of gestation). Details about the enrolment and baseline data collection were previously published (Hansen et al., 2009; Vaktskjold et al., 2010b).

After one year (between May and July 2006), 221 (93.2%) of the singleton born were observed again. Mothers who did not visit the local health centre were visited at home. Weight and length of all but four babies were measured and mothers were interviewed about disease occurrences and lactation while visiting the local health centre. In addition, medical records were consulted for notes referring to diarrhoea and other disease occurrences during the previous year. The length of the child was measured to the nearest centimetre in recumbent position using the measuring tool made and used by the National Nutrition Programme for Children in Vietnam.

A second follow-up was carried out about two years after birth (between May and June 2007). The procedures conducted during this second follow-up were the same as at the one-year follow-up, except that the children's length was now measured in standing position. The data collection took place at the local health centres, supervised by the Pasteur Institute in Nha Trang.

Information about the study sample from birth and the one-year follow-up

The mean birth weight at baseline of the singleton babies was 3201 grams and 51% of the babies were boys. Four (1.7%) of the infants weighed less than 2500 grams, but all had at least 37 weeks of gestation, and three were born with an anomaly (cleft lip and palate, polydactyly, and hands and feet defects, respectively). The mean maternal age was 27.8 (95% confidence interval: ±0.7) years and 44 percent of the enrolled women delivered for the first time (Vaktskjold et al., 2010b).

At the one-year follow-up, the length of the 221 babies varied from 65 to 96 cm and weight from 5.8 to 14.0 kg. The mean length had increased by 26.8 cm (range: 15-53) and the weight by 5.9 kg (range: 3.3-10.1). Boys had a higher weight, length, weight-for-length and BMI than girls. The length of infants born in Dien Khanh (rural) was 2.2 cm shorter and the weight 550 grams less for age compared to those born in the city – adjusted for sex, age at follow-up, birth weight and length, Apgar score, diarrhoea, maternal age, height and parity in multiple linear regression analyses. Twelve (5.4%) of the infants had been clinically observed with diarrhoea and one with dysentery, pneumonia and dengue fever, respectively. Of these, five were diagnosed before the age of 6 months. Twenty-nine women (15%) had terminated breast-feeding before the first follow-up. A blood sample was collected from 189 of the infants; of these 21 (11.1%) had anaemia (Vaktskjold et al., 2010a).

Statistical Analyses

The height-for-age at the second follow-up was determined by comparing the height of each infant with the WHO sex-specific growth standards (2006) for age in months, and the proportion within the low 5th standard percentiles estimated. Two multiple logistic regression analyses were conducted: one with being within the low 5th standard percentiles (yes/no) as the outcome (prevalent cases), and a similar model with incident cases as the outcome where the children stunted at age one were excluded. In both models the independent study factors investigated were rural or urban district of delivery, duration of lactation (in months), disease in second year of life (yes/no), and maternal age and parity – adjusted for sex. The estimated odds ratios and proportions were reported with 95% Wald confidence intervals (CI). The tolerance level for every factor in the regression model was used for assessing multi-collinearity.

Ethical considerations

The study was approved by the Ministry of Health in Viet Nam and the University of Tromsø in Norway, while the Ethical Council of the Ministry of Health in Viet Nam approved the method of data collection. Each participating woman gave her informed consent for participation for herself and her child before delivery and at follow-up.

RESULTS

Of the original 237 babies, 209 (88.2%) were located again for the two-year follow up. Overall, 47% had been born in the rural area and the mean age was 23.4 months (range 21.7-25.0). The unadjusted height varied from 73 to 100 cm and weight from 8.2 to 18.0 kg, and the mean weight for height was 13.4 kg per meter. One child could not be weighed and measured. This child was stunted at age one. Two (1.0%) of the infants had been clinically observed with diarrhoea and 15 (7.2%) with an upper respiratory tract infection since the previous follow-up, but none had been diagnosed with dysentery, pneumonia or dengue fever. The mean duration of breastfeeding was 15.0 months. Of the children with small stature, 60% were born rurally, compared to 42% of the other children in the cohort (Table 1) .

Thirty-four children (62%) within the 5th percentile of the standards for height-for-age had not been in that percentile a year earlier, and the proportion changed from 18.0% (95%-CI:

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13.0, 23.0) to 26.4% (95%-CI: 20.4, 32.4) between ages one and two. Forty percent of the children within the 5th percentile at age one were not within that percentile at age two. Four (10.3%) of the children within the 5th percentile at age one were lost to follow-up at age two (Table 2).

None of the assessed risk factors were associated with the number of incident or prevalent children within the 5th percentile of the standards at age two, adjusted for the other factors and sex (Table 3). To improve the precision of the OR estimates, duration of breastfeeding was removed from the models since information was missing for 16 children and the factor was not associated with the outcomes. The adjusted OR per month increase in duration of breastfeeding was 1.04 [95%-CI: 0.94, 1.15].

Table 1: Characteristics of the children within the 5th percentile of the growth standards for height and the children above the 5th percentile at the two year follow-up.*

	At or below 5th percentile (n=55)	Above 5th percentile (n=154)
Mean age at follow-up (SD), months	23.1 (0.8)	23.6 (0.8)
Mean height (SD), metres	0.79 (0.02)	0.86 (0.04) **
Mean weight (SD), kg	10.3 (0.9)	11.6 (1.7) **
Mean weight/height (SD), kg/m	13.1 (1.2)	13.5 (1.7) **
Proportion girls (%)	47.3	50.0
Proportion born rurally (%)	60.0	42.2
Median duration of breastfeeding (range), months	16.0 (6-21)	16.0 (0.5-26)
Mean number of previous deliveries (SD)	0.7 (0.7)	0.6 (0.7)
Mean maternal age at delivery (SD), years	27.5 (5.6)	28.3 (5.3)

*11.8 % of the children enrolled at baseline were lost to follow-up. **n=153.

Table 2: Stunting distribution at age 2 years based on stunting status at age 1

	At or below 5th percentile at age 2 years	Above 5th percentile at age 2 years	Lost to follow-up age 2 years*
At or below 5th percentile at age one	21 (38%)	14 (9%)	4
Above 5th percentile at age one	34 (62%)	139 (91%)	4
Total number of children	55	153	8

*Of the children examined at age one.

Table 3. Results of multivariate logistic regression analysis: adjusted odds ratios (OR) for being within the low 5th percentile of the WHO sex-specific growth standards for height-for-age for children at age two years.*

	Prevalence of stunting at age 2 years		Incidence of stunting at age 2 years	
	Odds ratio**	95%-CI***	Odds ratio	95%-CI
Disease in second year of life	1.4	0.5, 4.4	1.0	0.3, 3.9
Parity	1.3	0.7, 2.4	1.3	0.6, 2.6
Mother's age	1.0	0.9, 1.0	0.9	0.9, 1.0
Rurally born	1.8	0.9, 3.5	1.3	0.6, 3.0

*The independent factors were included in the same model and adjusted for the sex of the child using multivariate logistic regression analyses; **A sub-analysis also including short stature at age 1 as a factor in the model (OR=5.9 [2.6, 13.2]), did not change the parameter estimates and ORs of the above factors; ***95%-CI = 95% confidence interval.

DISCUSSION

Based on the WHO standard distributions, the proportion with low height-for-age in the study cohort was substantially larger than expected. On an individual basis, a low height-for-age ratio is either due to normal variation in growth or a deficit in growth. However, the WHO growth standards, which are based on the growth of healthy infants and children from several countries, including developing countries, take in the normal variation (WHO, 2006). Thus, a proportion larger than 5% within the 5th percentile of the standards can be assumed due to a growth deficit, and not due to normal variation or an ethnic growth difference. Height provides a good measure of growth-for-age since it is uncorrelated with weight, and reflects protein malnutrition well.

Of the children within the low 5th percentile of the standards at the end of infancy, 60 percent were also in that same part of the distributions a year later. Considering that children with retarded stature growth in early life tend not to catch up later in life (Martorell et al., 1994; Kar et al., 2008), this proportion was lower than expected. None of the studied children were treated for malnutrition by the second follow-up. The National Nutrition Programme does not provide any food or supplements beyond one capsule of vitamin-A/child/year, and the World Food Programme was not active in this part of Vietnam. The nutritional recommendations given by the nurses at the health stations may have led to a catch-up in growth for some of the children, but the proportion with short stature was likely also influenced by the accuracy of measurements for children borderline to the 5th percentile, and perhaps by the validity of the standards themselves.

On the other hand, 62% of the children within the standard 5th percentiles at age two were not in that percentile a year earlier. Thus, our findings indicate that the prevalence of stunting increased between age one and two. However, when considering that stunting tends to reflect long-term malnutrition, an increase in prevalence with age was not surprising in a

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population where malnutrition is present. Hop et al. (1997) used another growth standard, but found that the largest deficit in height of Vietnamese children (in Hanoi) was towards the end of their second year of life. Our finding of an increasing prevalence was also in accordance with findings in other studies from Vietnam and Asia (de Onis and Blössner, 2003; Fenn and Penny, 2008). In our study cohort, insufficient nutrition appears to have begun in infancy, most likely before breastfeeding was terminated, maybe through the introduction of inadequate complementary foods.

Although nation-wide Vietnamese surveys of the age group 0 to 5 years found a substantial reduction in the prevalence of malnutrition between 1990 and 2004, the estimated prevalence of stunting in 2004 was 31% using a previously applied standard (Khan et al., 2007). A survey of Vietnamese children in the age group of 6 to 17.9 months using the new WHO growth standards found that 19% were stunted in 2000 (Fenn and Penny, 2008). Thus, the prevalence of stunting in our study group was on a similar level, even though our observations occurred a few years later. Policies and intervention programmes to improve nutrition and to reduce the prevalence of stunted growth still appear to be required in Viet Nam, while the effectiveness of the governmental programme should be evaluated.

In our cohort, stunted growth at age two was not associated with any of the potential risk factors, independently of whether the children were stunted at age one or not. Thus, malnutrition appeared to manifest independently of the studied maternal and child factors. Surveys in Vietnam in the period between 1990 and 2004 found a higher prevalence of both wasting and stunting in rural than urban areas (Khan et al., 2007), and at the first follow-up (age one) we found that the children born in the rural area were more prevalent within the 5th percentile of the standards and had a shorter mean stature than the urban born (Vaktskjold et al., 2010a). The difference in mean stature remained at age two years (adjusted for sex and age), but being born rurally did then not increase the odds of being within the low 5th percentile of the standard, when adjusted for the other covariates. However, some of the children born in the rural area had moved to Nha Trang before the follow-up. Thus, the over-representation of rurally born children in the study sample may have slightly elevated the proportion in the low percentile compared to the true proportion in the population. However, if this argument is valid, the prevalence of stunting in the rural area is even higher than in the studied cohort.

The effect of terminating breastfeeding after the first six months on growth is dependent on the nutritional quality of the weaning food, but exclusive breastfeeding beyond 6 months tend to be negatively associated with infant growth (WHO, 1995, 2006; Ong et al., 2002). We had information about the duration of breastfeeding, but not about exclusive breastfeeding. A study conducted in Hanoi found that the average duration of exclusive breastfeeding was short (1.6 months), however this information is from the 1980s (Hop et al., 1997). Continued breastfeeding beyond six months as a supplement to food tends to be positive for growth if the quality of the food is poor. Earlier studies from Vietnam found that the growth of Vietnamese infants began to lag behind reference populations from the West from age four to six months. The authors suggested that the introduction of inadequate complementary foods from that age was a possible explanation (Nga and Weissner, 1986; Hop et al., 1997; Hien and Ushijima, 2007). In our study, duration of being breastfed was not associated with stunting, which was also the case for the data from the one-year follow-up. One possible explanation could be that the average duration was relatively long (15 months), and only 15% of babies were not breastfed beyond the first year, while 5% of babies were breastfed for less than 6 months. The mean duration among the low height-for-age children at the second follow-up was 15.9 months, and for the children short at both follow-ups 16.6 months.

There have been reports of a positive correlation between maternal height and infant length which increased with the children's age (Bryan and Hindmarsh, 2006). Maternal height can serve as a marker for genetic factors influencing stature growth, and has been associated with stunting (Adair and Guilkey, 1997). As an *a posteriori* control, we included maternal height in the multiple regression models, but it was not associated with the outcome and did not change the estimates of the included covariates. Birth defects were not adjusted for as only two of the children available at follow-up were affected.

Our study sample met well the baseline inclusion criteria that formed the basis of the WHO growth standards (WHO, 2006). Namely, only singleton births delivered at term were included in the study sample; smoking in pregnancy was more or less absent (Hansen et al., 2009); and our data showed that breastfeeding was common. The data facilitated well the assessment of growth compared with the WHO standards by using the actual age at the time when the follow-up anthropometric measurements were carried out. On the other hand, the spread in infant age at follow-up, given the sample size, did not allow us to estimate the variance or z-score at each age-point in months. The relatively small sample size was the main limitation of the study, which was reflected in the precision of the estimates.

Measurement of length or height is often difficult to obtain in a primary care setting (WHO, 1995), but no information bias was apparent. However, the few cases of diarrhoea in the second year of life might indicate under-reporting of this disease. As seasonal variation in growth is common in developing countries (Adair and Guilkey, 1997; Liu et al., 1998), it was a strength of our study that the children were born in within a few months of each other.

Some 28 children (11.8%) of the original study sample at birth were lost to the two year follow-up because the mothers did not live any longer at the addresses given to the birth clinic. It is common that women in Vietnam travel to their home district to stay with their mothers when pregnant and deliver there. However, even with an assumption that all the missing children did not have stunted growth the proportion within the 5th percentile of the standards would have been 23%.

Since the studied cohort was recruited from the three main delivery clinics, the sample represented well infants delivered in the main birth clinics in the province, but was thereby less representative of children born in the numerous small delivery wards. Thus, the external validity of the study was limited in terms of the magnitude of the estimates.

CONCLUSION

The proportion of children with short stature-for-age at age two was higher than expected based on the WHO growth standards, which confirms the need for policies and early interventions to prevent stunting in Vietnam and in particular in the Khanh Hoa province. The majority of the children within the low 5th percentile of the standard distributions at age two were not within that percentile a year earlier. Duration of breastfeeding and diseases in the second year of life were

found unrelated to stunting, and parity, maternal age or being born rurally were not independent markers of stunting at age two in this relatively small cohort of children born in three of the main delivery clinics in the Khanh Hoa province.

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