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Effect of morbidity on change in mid-upper arm circumference in children under five years of age

A COHORT STUDY IN PURWOREJO, CENTRAL JAVA, INDONESIA

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ABSTRACT The objective of this study were to find out the effect of morbidity (diarrhoeal diseases /DD & acute respiratory infection/ARI) on mid-upper arm circumference (MUAC) in children uner five years of age and to evaluate the impact of potential confounding and effect modifying factors on association between morbidity and MUAC development i.e. socio-economic status, living area and breast feeding. A cohort study was carried out to follow morbidity and MUAC development from February 1996 to January 1997, including home visits and examinations every 3 months, totally four times. Data were collected through interviews and MUAC was measured using standard non-stretchable plastic tape. This analysis was performed on 2708 individuals (45.3% of the total sample), where complete morbidity and MUAC information was available, DD and ARI prevalence was highest in the second half of infancy. The overall period prevalence of DD and ARI was 1.4 and 9.9%, respectively. There was a small, but significant negative effect of diarrhoea on change in MUAC among infants below one year in the rural area, less so in the urban area. In older children there was no association between morbidity and MUAC velocity. There was a small positive association between maternal education and MUAC development in both age groups. Diarrhoeal diseases, showed a negative influence on MUAC development in infancy. However, in this study MUAC development from 12 months and onwards was not influenced by the load of illness. MUAC seems to be less sensitive in reflecting the morbidity history of the child, as compared to other anthropometric measurements. **[Paediatr Indones 2001; 41:225-230]**

Keywords: *diarrheal diseases, mid-upper arm circumference, morbidity, cohort study*

THE ASSOCIATION BETWEEN INFECTIOUS DISEASES AND POOR nutritional status has been recognized for a long time, and both commonly these health problems occur in the same unfortunate child. Together they play a major role in the high morbidity and mortality rates of children in developing countries [1-3]. Malnourished children are reportedly more severely affected by DD [4] and ARI [5] and have an increased risk of dying from a variety of infectious diseases, including DD [6] and ARI [5] . DD and ARI, especially lower respiratory tract infection (LRTI), have adverse effects on growth and are important causes of malnutrition [7].

However, in a longitudinal study from East Bhutan from 7 to 36 months of age, DD was associated to weight-for-age (W/A) or height-for-age (H/A) , but was not significantly associated to weight-for-height (W/H) or MUAC [8].

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On the other han, result from field studies, in which malnutrition has been examined as a risk factor for DD, are not conclusive. In Nigeria, Tomkins [9] concluded that nutritional status was related more to duration than to incidence of DD, but he also found wasted children to have significantly more episodes of diarrhea. Chen et al. [6] , in Bangladesh found no association between nutritional status measure as W/A, H/A, and W/H and subsequent risk of DD.

MUAC is known to be less age-dependent than either weight or height and is thus an attractive alternative when age determination is known to be a problem, which often is the case in developing countries [10]. MUAC measurements can be made by minimally trained health or field workers [10] , and are suitable for screening because of the simplicity of the method, especially in the developing countries [11, 12].

The objective of this study is to find out the impact of common childhood morbidity (diarrhoeal diseases and acute respiratory infection) on the development of mid-upper arm circumference (MUAC) in children 0-4 years of age.

Methods

The study presented is based on data from a large surveillance program of the Community Health and Nutrition Research Laboratory (CHN-RL). The program started in June 1994 in Purworejo District, Central Java Province. CHN-RL was built to support the Ministry of Health of Indonesia in developing and implementing community health and nutrition programs. In the CHN-RL surveillance system information about child and maternal health is continously collected every 3 months, including use of health services, morbidity, mortality an a number of possible associate factors.

An open cohort study was carried out to estimate the effect of morbidity (DD and ARI) on growth and nutritional status measured as MUAC. The background characteristics such as child's sex and age, mother's education and occupation, breast feeding and geographic area were used to measure the potential confounding and effect modifying factors, and the association between exposure (DD and ARI) and outcome.

The questionnaires were designed by the surveillance team and tried for acceptance before being implemented in the field. The period of recall for morbidity information was two weeks preceding the three-monthly interview.A case of DD was diagnosed if the child suffered from frequent or liquid stools at least three times in 24 hours in the two-week period preceding the interview. A case of ARI was recorded if a child suffered cough or symptoms of common cold/nasal discharge with or without fever any time in the same two-week period.

Data on child morbidity (diarrhoeal diseases and acute respiratory infection), age, sex, breast feeding, socio-economic status, area of residency, are used in this study for analyzing the possible factors associated with MUAC development, including measurements every 90 days for one year, from February 1996 to January 1997. Data analysis was performed with SPSS 7.5.1 software. Chi-square and linear regression were used, to analyze the association MUAC and age by sex, to assess the impact of morbidity on MUAC development and the effect of other factors on the association between morbidity and MUAC.Ethical approval was provided by Medical Faculty, Gadjah Mada University and the Research Ethics Committee of the Medical Faculty, Umea University.

Out of 5985 children, 2708 (45.3%) constituted a closed cohort over the year, having complete information of four cycles of follow up, including initial and final MUAC, morbidity and socio-economic background information. Data were collected in 4 cycles, i.e. in February-April 1996, May-July 1996, August-October 1996 and November 1996-January 1997 (cycles 5, 6, 7, and 8, respectively).

MUAC information was considered complete if measurements were taken at least on first and last visit. Morbidity information, on the other hand, was only complete if collected on all four occasions. Non-participation in one or several examinations was caused by various factors, such as entering the surveillance by birth, leaving the surveillance due to 5 years of age, disagreeing to measurements, that the child refused to be measured, temporary out-migration, death and other unknown causes.

Results

The distribution of background characteristics of participating and non-participating children under five years of age is shown in Table 1. Distributions differed to some extent for rural and urban residency, sex, mother's education and occupation ($p < 0.05$). However age distribution of children strongly differed ($p < 0.001$).

TABLE 1. BACKGROUND CHARACTERISTIC OF THE SAMPLES

Characteristic of the samples	Complete MUAC information (n = 2708)		Incomplete MUAC information (n = 3275)		p - value
	no.	%	no.	%	
Sex : boy	1350	49.9	1724	52.6	< 0.05
girl	1358	50.1	1551	47.4	
Age :					
0 - 5 months	337	12.4	713	25.6	
6 - 11 months	369	13.6	163	5.9	
12 - 35 months	1153	42.6	677	24.3	< 0.001
36 - 59 months	849	31.4	1231	44.2	
Residency :					
urban	246	9.1	359	11.0	< 0.05
rural	2462	90.9	2916	89.0	
Mother's education :					
No formal education	306	11.3	426	13.0	
Primary school	1639	60.5	1858	56.7	
Secondary school	381	14.1	483	14.7	< 0.05
High school or more	382	14.1	508	15.5	
Mother's occupation					
Housewife	1085	40.1	1389	42.4	
Farmer	1187	43.8	1313	40.1	< 0.05
Other occupation	436	16.1	573	17.5	

TABLE 2 . PREVALENCE OF DIARRHEAL DISEASES AND ACUTE RESPIRATORY INFECTION BY AGE GROUP AND SEASON

Period	Age groups	Diarrhoeal diseases (%)	ARI (%)	Total (n)
Feb-Apr	0 - 5 mo	0.9	6.5	337
	6 - 11 mo	3.5	15.7	369
	12 - 35 mo	1.8	13.3	1153
	36 - 59 mo	1.5	10.0	849
	Total	**1.8**	**11.7**	**2708**
May-Jul	0 - 5 mo	1.5	7.1	336
	6 - 11 mo	4.1	9.2	369
	12 - 35 mo	2.7	8.2	1152
	36 - 59 mo	0.4	6.2	849
	Total	**2.0**	**7.6**	**2706**
Aug-Oct	0 - 5 mo	1.8	12.5	337
	6 - 11 mo	3.3	13.4	367
	12 - 35 mo	1.7	11.5	1147
	36 - 59 mo	0.7	7.6	847
	Total	**1.6**	**10.6**	**2698**
Nov-Jan	0 - 5 mo	2.4	15.1	337
	6 - 11 mo	3.5	13.3	369
	12 - 35 mo	1.0	9.5	1153
	36 - 59 mo	0.5	6.9	849
	Total	**1.4**	**9.9**	**2708**

Morbidity

The average period prevalence of diarrhoea over the year was 1.7%, while the corresponding figure for ARI was 9.9% (Table 2). The prevalence of diarrhoea as well as ARI was consistently higher in the 6 - 11 months. DD was more common in the wet season, while ARI prevalence was higher in the dry season. No consistent sex difference in the prevalence of diarrhoea or ARI was observed (Table 3).

The relation between morbidity and MUAC development

Reported diarrhoea during the year of observation negatively influenced the change in MUAC over time in infants, i.e. MUAC velocity in the age interval 0-11 months of age, in the rural but not in the urban area (Table 4). In the older age group, 12-59 months at start of study, only 10% of the variation was explained by the final regression model. There was no significant association to morbidity or breast feeding during the observation period, while there was a small positive association to mother's education level, apart from age at start and MUAC at start. There was no sex different in MUAC velocity.

TABLE 3 : PREVALENCE OF DIARRHOEAL DISEASES AND ACUTE RESPIRATORY INFECTION BY GENDER

Period	Age groups	Acute Respiratory Infection		p-value	Diarrhoeal diseases		p-value	Total
		boys	girls		boys	girls		
		(%)	(%)		(%)	(%)		(n)
Feb-Apr	0 - 5 months	7.4	5.6		1.1	0.6		337
	6 - 11 months	14.7	16.9		3.7	3.4		369
	12 - 35 months	11.7	14.8		2.3	1.4		1153
	36 - 59 months	9.6	10.4		1.9	1.2		849
	Total	10.9	12.6	**>0.5**	2.2	1.5	**>0.9**	**2708**
May-Jul	0 - 5 months	6.3	8.1		.0	3.1		336
	6 - 11 months	10.5	7.9		2.6	5.6		369
	12 - 35 months	7.8	8.7		3.4	2.0		1152
	36 - 59 months	4.3	8.1		0.2	0.5		849
	Total	6.9	8.3	**>0.15**	1.9	2.1	**<0.05**	**2706**
Aug-Oct	0 - 5 months	13.6	11.2		0.6	3.1		337
	6 - 11 months	13.2	13.6		4.2	2.3		367
	12 - 35 months	11.4	11.6		2.1	1.2		1147
	36 - 59 months	7.9	7.2		0.5	0.9		847
	Total	10.9	10.4	**>0.5**	1.7	1.5	**>0.12**	**2698**
Nov-Jan	0 - 5 months	15.3	14.9		2.3	2.5		337
	6 - 11 months	15.7	10.7		3.1	3.9		369
	12 - 35 months	11.0	8.2		1.6	0.5		1153
	36 - 59 months	6.2	7.7		0.5	0.5		849
	Total	10.7	9.1	**>0.3**	1.6	1.2	**>0.5**	**2708**

The relation between morbidity and MUAC development

Reported diarrhoea during the year of observation negatively influenced the change in MUAC over time in infants, i.e. MUAC velocity in the age interval 0-11 months of age, in the rural but not in the urban area (Table 4). In the older age group, 12-59 months at start of study, only 10% of the variation was explained by the final regression model. There was no significant association to morbidity or breast feeding during the observation period, while there was a small positive association to mother's education level, apart from age at start and MUAC at start. There was no sex different in MUAC velocity.

Discussion

In this study of Javanese children under five years of age, we have shown that the speed by which MUAC develops only to limited extent was influenced by morbidity; diarrhoea decreased the velocity for infants, in the rural area, while no effect of diarrhoea was seen among children above 1 year of age. No association was observed between ARI and MUAC velocity. Morbidity of the individual during a 90-day period was represented by the final 14 days. This morbidity measurement maybe characterizes the group in a better way than the individual, since 5/6 of the period for the individual is not reported. On the other hand, four 14-day periods were added for the individual during the observation year, increasing the chances of at least catching morbidity of an individual, who is prone to get repeated episodes of diarrhoea or respiratory infection. Thus, there are methodological limitations of the collected information, i.e. a limited sample of observation periods from the individual's illness history, and a relatively long time period for the calculation of change in MUAC. The age-specific absolute levels of morbidity and MUAC measurements are probably well representing the situation in Purworejo, although there were some minor differences in socio-economic characteristics of the participating and non-participating parts of the original sample. The found association, between morbidity and MUAC development are probably, given the mentioned

TABLE 4 . DETERMINANTS OF MUAC VELOCITY (CM/YEAR) IN CHILDREN 0-11 AND 12-59 MONTHS AT START OF STUDY. DATA FROM PURWOREJO SURVEILLANCE SYSTEM, CENTRAL JAVA, INDONESIA. LINEAR REGRESSION ANALYSIS

Independent variable	Unit, levels	Age 0-11 months		Age 12-59 months	
		β-coefficient	p-value	β-coefficient	p-value
Sex	1=boy, 2=girl	-0.12	<0.001	0.01	0.777
Age at start	months	-0.15	<0.001	0.08	<0.001
MUAC at start	cm	-0.67	<0.001	-0.34	<0.001
Diarrhoea	number of days/56 days	0.40	0.023	-0.03	0.865
Mother's education	Levels 0-3	0.03	0.003	0.08	<0.001
Area of residency	1=urban, 2=rural	0.07	0.049	0.02	0.345
Interaction area of residency-diarrhoea		-0.39	0.027	0.08	0.676
r^2		0.58	<0.001	0.10	<0.001
n		702		2002	

methodological limitations, relevant also in other similar settings in Indonesia and elsewhere.

The found diarrhoea period prevalence of 1,7% is lower than the officially reported prevalence in Indonesia of 12% [12], and figures usually reported from low income countries [2, 7.] Also, the ARI prevalence was lower than the reported country average (10 versus 29%) but within the range usually reported from similar countries [13]. The difference may be caused by several factors, e.g. design of studies, definition of DD and ARI as well as performance of field workers. However, the difference is probably mainly a reflection of a better child health situation in Central Java, as compared to the rest of Indonesia [13] . The diarrhoea peak prevalence in the 6-11 age groups confirms other reports from Indonesia and elsewhere [13,14].

The MUAC level of boys and girls in this study was lower than NCHS/WHO reference, but similar to results from studies in Madura [15], and other low income countries, such as Botswana [16] and Kasongo, Zaire [15]. The varying results between the NCHS/WHO reference on the other hand and the different studies in low income countries, may be due to different types of samples, differences in food intake and other factors, such infectious diseases, environment, etc. Results and interpretations of comparisons between MUAC assessments and other anthropometric measurements (W/A, W/H, H/A) show conflicting results. Some researchers stress that MUAC is simple, quick and less expensive to use, although being less accurate as an expression of nutritional status [10, 12].

Others state that MUAC is good enough, of a reasonable validity and easy to learn, and recommend it as an alternative to standard anthropometric measurement [17]. Moreover, MUAC has a relatively poorer correlation with H/A, which represents the by far most common expression of malnutrition in low income countries; the linear growth retardation [10, 12]. Based on that experience MUAC may be a less appropriate measurement, in a community, such as that in Purworejo, when stunting is a major problem. In this study we have only investigated one aspect of the usefullness of MUAC measurements; to what extent morbidity is reflected in MUAC change. MUAC is reported to be a possible mortality predictor, if applied early (6-23 months) and repeatedly [18]. MUAC may also be an indicator showing that a child may benefit from food supplementation [19]. However, MUAC was reportedly not a valid predictor of incidence of diarrhoeal disease in a prospective study in Ethiopia [20]. Thus, MUAC seems to be more insensitive to reflect and predict morbidity than other conventional anthropometric measurements, e.g. W/H, but may, according to other research, be usefull for other, defined, purposes.

Change in MUAC over time did not reflect the load of diarrhoea and ARI illness, except from a minor association between diarrhoea and MUAC velocity in infants. As other researchers have pointed out, MUAC measurements may have other purposes, where it is more appropriate, e.g. in predicting mortality risks in follow-up over time, and to indicate potential benefit from dietary supplementation. More intense morbidity measurements and repeated MUAC assessments over time may also be able to demonstrate smaller, and maybe temporary, impact of morbidity on MUAC change.

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