LATE WEANING: THE MOST SIGNIFICANT RISK FACTOR IN THE DEVELOPMENT OF IRON DEFICIENCY ANAEMIA AT 1–2 YEARS OF AGE

Sultan Ali N, Zuberi RW

Department of Community Health Sciences, The Aga Khan University, Karachi, Pakistan

Background: The global prevalence of iron deficiency anaemia in young children is quite high and children between the ages of 1–2 years are at maximum risk. The complications of anaemia are well known, and side effects may go unnoticed and may have an adverse effect on child's life. Therefore, prevention of anaemia becomes enormously important, and the need to look for parameters and predisposing factors that may lead to iron deficiency anaemia in small children is imperative. This study was designed to determine the association of iron deficiency anaemia with late weaning in 1–2 years of children. **Method:** A case control study was conducted from July 1993–July 1995, at the Community Health Centre (CHC), of the Aga Khan University Hospital, at Karachi, Pakistan. The study included 50 cases and 100 controls. A questionnaire was filled by mothers after taking consent. Data was analyzed by chi-square, t-tests, bivariate analysis and multiple logistic regression. **Results:** Through bivariate analyses, late weaning, family income, mother's education, the numbers of pregnancies, live births and living children, were found to be statistically significant. These variables were run through a multiple logistic regression model and late weaning was found to be the most significant. 60% of cases and 9% of controls were weaned late ($p<0.001$). The mean age of weaning was 7.04 months among cases and 4.46 months among controls ($p<0.001$). **Conclusion:** Among all the variables studied, late weaning was the most important predictor of iron deficiency anaemia in 1–2 years of age.

KEY WORDS: Anaemia, iron deficiency; weaning; feeding methods; feeding behaviour.

INTRODUCTION

The global prevalence of iron deficiency anaemia in young children is 43%[1] but children between the ages of 1–2 years are at highest risk[2]-5. It is estimated that among 12–18 month old infants of economically deprived families in America, the incidence of iron deficiency is approximately 40%[6]. Several surveys of infants in various urban areas of the United States also revealed a prevalence of between 17% and 44%, the highest being among infants of lower socio-economic status[4]. Study done in an inner city community in United States reported that 17.5% of children aged 1 to 3 years had a haemoglobin level below 9.8 gm/dl. However, other studies have reported a prevalence of 44%–50% amongst children less than 2 years of age[7,8]. Substantial prevalence rates among disadvantaged children have been reported till early eighties[9]. However, the prevalence rate of anaemia was found to have decreased since the introduction of the Women Infant and Children (WIC) program. Thereafter only 2.0% of low-income children in the United States had a haemoglobin level of 10.3 gm/dl or less[10].

This marked improvement can be attributed to the nutritional supplementation with iron fortified foods. Similar results and conclusions have been reported elsewhere[11]. The prevalence of iron deficiency anaemia among one year old children of disadvantaged families in Montreal was found 25%[12]. In Glasgow slum dwellers, the incidence of iron deficiency anaemia was found to be 59% in children between the ages of 6–24 months[13]. The Pakistan National Nutrition Survey found that 65% of children between the ages of 7–60 months were anaemic[14], with haemoglobin of less than 11 gm/dl. A study conducted at three urban slums of Karachi, Pakistan reported that 70% of children of 6–60 months of age were anaemic[15]. Another local study in Pakistan found the prevalence of anaemia to be 78% in the same age group[16].

The complications of anaemia are well known, but subtle complications and side effects may go unnoticed and may have an adverse effect on a child's life. Many studies have reported an association between anaemia and poor mental performance[17] and abnormalities of behaviour[18,19], which can be improved after treatment if detected early. Some studies have also shown that severe iron deficiency causes neurologic impairment[20,21] and that this impairment may be irreversible[12]. Therefore, prevention of anaemia becomes enormously important, and the need to look for parameters and/or predisposing factors which may lead to iron deficiency anaemia in small children is imperative. Different socio biological variables and dietary patterns contributing to this problem should be looked into. National Nutrition Survey data indicates 68% of young children aged 7–9 months do not consume any food apart from milk[14]. It also states even by 12–17 months age 30–50% of children eat no food. More than half of the children studied were receiving only tea, milk or other liquids at the end of the year[14]. No studies were found which had studied the relationship of the time of weaning with the presence of iron deficiency anaemia.

This study was designed to determine the association between iron deficiency anaemia and late weaning. One of the aims was to identify the most important risk factor (with the greatest impact) among all the indicators investigated, so that evidence-based recommendations can be made for prevention of iron deficiency anaemia in small children.

MATERIAL AND METHODS

A case control study was conducted from July 1993 to July 1995 at the Community Health Centre (CHC) of The Aga Khan University, Karachi, Pakistan, to identify any association of iron deficiency anaemia with late weaning in 1–2 years old children. Children presenting at the clinic for any reason (an illness, a routine check-up, or an immunization, etc.) and whose mothers were willing to have a blood test of their children were included in the study. Sample size included 50 cases and 100 controls. Informed consent was taken from mothers for their children’s blood tests, and a questionnaire was administered to them, focusing on the weight of the child at birth, the age at which weaning was introduced, and presence or absence of recurrent diarrhoea or respiratory infections over the preceding three months. Parental education, monthly income and no of pregnancies, live births and living children were also considered as other variables. A three months recall period for past infections was deliberately kept to decrease the recall bias and this period has also been used in other studies[22,23].

Recurrent diarrhoea was defined as more than three episodes of acute diarrhoea in the last three months[22], and acute diarrhoea as stool frequency of more than 5 times per day with a decrease in stool consistency lasting for more than two days[22]. Recurrent acute respiratory infection was defined as more than two episodes of acute respiratory infections in the last three months[23]. Haemoglobin level of less than 11 gm/dl[15] and a serum ferritin level of 10 ηg/ml or less[20,24,25] was taken as iron deficiency anaemia in 1–2 years of age. Low birth weight was defined as a birth weight of 2500 g or less[26]. If weaning (process of adding new foods other than milk to baby’s diet and gradually reducing the amount of milk given) was started beyond 6 months of age, it was taken as late weaning[27].

Children with proven Haemoglobins of less than 11 gm/dl, and serum ferritin levels of 10 ηg/ml or less[20,24,25], were included in the study as cases. The children who were found to have Haemoglobins of 11 gm/dl or more, and serum ferritin levels of 10 ηg/ml or more[20,24,25], were included in the study as controls. Children who had a Haemoglobin of 11 g/dl or less and had serum ferritin levels of more than 10 ηg/dl, were excluded from the study. Several other groups of children were also excluded from the study, such as, pre-term babies, children with known haemoglobino-pathies (including alpha and beta thalassemia), congenital anomalies like cleft palate, congenital heart disease etc., as well as children taking iron supplements. Acute febrile illnesses, acute gastroenteritis, acute or chronic blood loss, by accident or injury or due to rectal polyps, etc. were also excluded.

Data was analysed by chi-square for categorical variables, t-test for continuous variables, and lastly by a multiple logistic regression model.

RESULTS

Table-1 shows the demographic health characteristics of cases and controls and their mothers.

Table-1: Demographic health characteristics of cases and controls, and their mothers

Characteristics	Cases (Anaemic) n_1=50	Controls (Non-Anaemic)

		n_2=100
Children:		
Sex, (%) male	29 (58%)	53 (53%)
Mean age and standard deviation (SD) in months	17.74 (3.66)	17.81 (3.65)
Mean birth weight and (SD) in gm	3155.45 (499)	3021.95 (466)
Low birth weight, less than 2500 gm (%)	2 (6%)	7 (8%)
Mothers:		
Mean age and (SD) in months at the time of interview	28.26 (5.52)	27.10 (4.46)
Mean age and (SD) in months at the time of marriage	20.0 (5.08)	21.40 (3.40)
Education		
No schooling, (%)	13 (26%)	9 (9%)
Schooling, (%)	37 (74%)	91 (91%)

The mean birth weight of cases was slightly more than the control group but did not have any statistical significance. Low birth weight (less than 2.5 kg) was present in 6% of the cases and 8% of the controls, but also did not show a statistically significant difference. Recurrent diarrhoea was found in 16 % of cases and 10% of controls, and recurrent respiratory infections were found in 10 % of cases and 7% of controls. None of these differences were statistically significant.

The variables which showed a statistically significant relationship with the outcome variable were late weaning, monthly income, number of pregnancies, number of live birth, number of living children and mother's education (Table-2A & 2B). These six variables were run through a multiple logistic regression model (Table-3). Using the backward selection method, variables were dropped one by one from the full model. The final model showed that the variable with the greatest significance was late weaning.

Table-2: Univariate analysis of different potential risk factors with the development of iron deficiency anaemia in children of 1–2 years of age.

2-A) Comparison of Continuous Variables among Cases and Controls

VARIABLES	Cases Mean (SD)	Controls Mean (SD)	*P*
Birth weight (gm)	3155.45 (499.14)	3021.95 (466.27)	0.172
Current age of child (months)	17.74 (3.66)	17.81 (3.65)	0.912
Duration of breast feeding (months)	11.57 (5.97)	8.53 (6.32)	0.05
Duration of bottle feeding (months)	11.22 (7.20)	12.97 (6.05)	0.252
Age (months) at weaning started***	7.04 (2.89)	4.46 (1.16)	<0.001
Monthly income (Rs)*	5810.00 (4590.99)	8182.00 (5575.33)	0.010
Mother's age (year) at the time of marriage	20.00 (5.08)	21.40 (3.40)	0.082
Mother's age (year) at the time of interview	28.26 (5.52)	27.10 (4.46)	0.168
No. of Pregnancies*	3.26 (2.31)	2.44 (1.59)	0.027
No. of live birth*	3.08 (2.28)	2.23 (1.38)	0.018
No. of living children*	2.92 (2.23)	2.20 (1.32)	0.039

**p*<0.05   ***p*<0.01   ****p*<0.001

Variables with asterisk are statistically significant.

2-B) Comparison of Categorical Variables among Cases and Controls

VARIABLES	Case $n_1=50$	Controls $n_2=100$	Odds Ratio at 95% Confidence Interval
Regarding the Baby:			0.82
Female	21	47	(0.39-1.71)

Male	29	53	
Recurrent Diarrhoea			
	8	10	1.71
	42	90	(0.57-5.15)
Recurrent RTI			
	5	7	1.48
	45	93	(0.38-5.57)
Parental Education:			
Mother's Education*			
	13	9	3.55
	37	91	(1.28-9.98)
Father's Education			
	2	3	1.35
	48	97	(0.15-10.37)

*When the 95% confidence interval does not include 1.

Table-3: Full logistic model: identification of the most significant variable associated with anaemia in children of 1-2 years of age

Variables	**Coefficient (SE)**	**Significance**
Late Weaning	3.1464 (0.6118)	0.0001
Monthly income	0.5699 (0.4649)	0.2203
Mother's Education	-1.4232 (0.7916)	0.0722
No. of Pregnancies	-0.2521 (1.1035)	0.8193
No. of live Birth	1.7121 (1.7268)	0.3214
No. of living children	-0.8451 (1.3621)	0.5349
Constant	-1.8748 (0.3477)	0.0001

DISCUSSION AND CONCLUSION

The analysis of the data showed that there was no significant association between birth weight and iron deficiency anaemia at the age of 1–2 years. In fact, low birth weight was not significantly different between cases and controls. One study has even reported that the group of children who had anaemia at the age of twenty-two months, not only did not have low birth weight but were heavier at birth than the group without anaemia[28].

However, another study has reported that low birth weight had been weakly associated with iron deficiency anaemia in children[14]. This study showed that 38% of the low birth weight infants and 23% of the normal weight infants had iron deficiency anaemia (*p*-0.089), which cannot be considered to be statistically significant.

Studies have been reported that upper respiratory and other mild infections commonly predispose children to a drop in the Haemoglobin but not to the extent of producing iron deficiency anaemia[29]. It was documented that there was not a significant difference in the mean Haemoglobin among the children who had been well or who had recurrent infections in the last three months. Neither group had iron deficiency anaemia. In addition, another study has found no evidence to support that children with anaemia had suffered more ill health in the recent past[28]. Our study supports the work done by Grindulis *et al*[28], as it also found *no* association between a history of recurrent diarrhoea or recurrent respiratory tract infection and iron deficiency anaemia in children of 1–2 years of age. The incidence of recurrent diarrhoea or recurrent respiratory infections was not significantly different among cases and controls.

Regarding parents' education, the fathers' education did not show a statistically significant association with childhood anaemia in the offspring (Odds Ratio of 1.35 with a 95% confidence interval between 0.22 and 8.33). However, maternal education had a significant association with the development of iron deficiency anaemia in their children (Odds Ratio of 3.55 with a 95% confidence interval between 1.40 and 9.02). Therefore, educated mothers are needed to rear healthy children for the nations. Thus more emphasis should be given to female education.

The difference in the family monthly incomes between cases and controls was statistically significant in our study. Other studies have been previously reported that socio-economic status is an important factor in the development of iron deficiency among children[30,31]. The present study also highlights that a low family income is an important risk factor for children to develop anaemia.

This study showed that out of 50 cases who were anaemic, 60% were late weaners but only 9% were late weaners in the control group ($p<0.001$). The mean age of weaning among the cases was 7.04 months and among controls was 4.46 months ($p<0.001$).

Those variables which showed statistically significant relationships with the outcome variable in the bivariate analysis, were run through a multiple logistic regression model.

Using the backward selection method, variables were dropped one by one from the full model. The final model showed that late weaning was the most significant variable of all. To conclude, late introduction of weaning foods was the most important predictor of iron deficiency anaemia in children of 1–2 years of age.

The quality and quantity of weaning foods taken by the children could not be properly assessed, as this was an extremely difficult parameter to measure. Secondly, parasitic infestations were not identified by stool tests and excluded in those who did not present with diarrhoea, leading to chronic blood loss and anaemia.

This study showed that late weaning is one of the most significant risk factor for developing iron deficiency anaemia. Iron deficiency anaemia is a major public health issue because it has important consequences including impairment of child development. The disease is preventable because the main cause of iron deficiency in this age group is a lack of adequate iron intake, especially between the ages of 6 to 12 months. Public health officials must be made aware of the problem and must take serious action to ensure adequate iron intake in the first year of life. This is particularly important for developing countries, inner-city communities, and underprivileged areas. A variety of iron-containing nutritious foods are readily available in most households to feed the children adequately. The use of tea for young children should be discouraged since it is high in oxalates which decrease the bio-availability of iron for the human body[32]. Mothers should be educated regarding the types of nutritious foods available and counselled for appropriate weaning in order to prevent iron deficiency anaemia in early childhood.

REFERENCES

1. DeMaeyer E, Adiels-Tegman M. The prevalence of anaemia in the world. World Health Stat Q 1985;38:302-16.

2. Katzman R, Novack A, Pearson H. Nutritional anaemia in an inner-city community. JAMA 1972;222:670-3.

3. Vaszqez SP, Windom R, Pearson HA. Disappearance of iron deficiency anaemia in a high-risk infant population given supplemental iron. N Engl J Med 1985;313: 1239-40.

4. Hoekelman RA, Fredman SB, Nelson NM, Seidel HM. Primary Paediatric Care: Iron deficiency anaemia. 2nd ed. Boston: Mosby Year Book; 1992.

5. Behrman RE, Kleigman RM. Nelson Essentials of Paediatrics: Haematology. 2nd ed. Philadelphia: Saunders Company; 1994.

6. Stanfield P, Brueton M, Chan M, Parkin M, Waterston T. Diseases of children in the subtropics and tropics: Haematological disorders. 4th ed. Kent: Edward Aronld; 1991.

7. Haddy TB, Jurkowski C, Brody H, Kallen DJ, Czajka-Narins DM. Iron deficiency with and without anaemia in infants and children. Am J Dis Child 1974;128:787-92.

8. Czajka-Narins DM, Haddy TB, Kallen DJ. Nutrition and social correlates in iron deficiency anaemia. Am J Clin Nutr 1978;31 :955-60.

9. Aukett MA, Parks YA, Scott PH, Wharton BA. Treatment with iron increases weight gain and psychomotor development. Arch Dis Child 1986;61:849-57.

10. Yip R, Binkin NJ, Fleshood L, Trowbridge FL. Declining prevalence of anaemia among low income children in the United States. JAMA 1987;258: 1619-23.

11. Miller V, Swaney S, Deinard A. Impact of the WIC program on the iron status ofinfants. Pediatrics' 1985;75: 100-5.

12. Lehman F, Gray-Donald K, Mongeon M, Di Tommaso S. Iron deficiency anaemia in one-year-old children of disadvantaged families in Montreal. Can Med Assoc J 1992; 146: 1571-7.

13. Campbell AGM, Mclntosh N, Forfar, Arneil. Textbook of Paediatrics: Disorders of blood and reticuloendothelial system. 4th ed. Edinburgh: Churchill Livingstone; 1993.

14. National Nutrition Survey 1985-87: Nutrition Division, National Institute of Health, Government of Pakistan; 1988.

15. Molla A, Khaurshed M, Molla AM. Prevalence of iron deficiency anaemia in children of the urban slums of Karachi. JPMA 1992;42(5): 118-21.

16. Thaver IH, Baig L. Anaemia in Children, Can simple observations by Primary Care Provider Help in Diagnosis? JPMA 1994;44:282-4.

17. Lozoff B, Jimenez E, Wolf AW. Long term Developmental outcome of infants with iron deficiency. N Engl J Med 1991;325:687-94.

18. Lozoff B. Behavioural alterations in iron deficiency. Adv Pediatr 1988;35:331.

19. Walter T, De Andraca I, Chadud P, Perales CG. Iron deficiency Anaemia: Adverse Effects on Infant Psychomotor Development. Pediatrics 1989;84:7-17.

20. Dallman PR, Reeves JD, Driggers DA, Lo EY. Diagnosis of iron deficiency: The limitations of laboratory tests in predicting response to iron treatment in 1-year-old infants. The J Pediatr 1981;99:376-81.

21. Cook JD, Lynch SR. The liabilities of iron deficiency. Blood 1986;68:803-9.

22. Behrman RE, Kleigman RM, Arvin AM, Nelson WE. Nelson Textbook of Paediatric: Iron deficiency anaemia. 15th ed. Pennsylvania: W. B. Saunders Company; 1996.

23. World Health Organization. Guidelines for Training Community Health Workers in Nutrition. Switzerland: D. WHO. Geneva; 1981.

24. Dallman PR, Yip R, Johnson C. Prevalence and causes of anaemia in the United States. Am J Clin Nutr 1984;39:437-42.

25. Dallman PR. Iron deficiency in the weaning: A nutritional problem on the way to resolution. Acta Paediatr Scand 1986;323:59-67.

26. Cunningham FG, MacDonald PC, Gant NF, Levens KJ, Gilstap LC. Williams Obstetrics: Pre term and Post term pregnancy and foetal growth retardation. London: Prentice- Hall International Inc; 1993. 27.

27. Ali SM. Nutritional Anaemia. Mother and Child 1985;22(1):32-5.

28. Grindulis H, Scott PH, Belton NR, Wharton BA. Combined deficiency of iron and vitamin D in Asian toddlers. Arch Dis Child 1986;61: 843-8.

29. Reeves JD, Usaf MC, Yip R, Kiley VA, Dallman PR. Iron deficiency in infants: The influence of mild antecedent infection. J Pediatr 1984;105:874-9.

30. Oski FA. Iron deficiency in infancy and childhood. N Engl I Med 1993;329: 190-3.

31. Sargent JD, Stukel TA, Dalton MA, Freeman JL, Brown MJ. Iron deficiency in Massachusetts's communities: socio-economic and demographic risk factors among children. Am J Public Health 1996;86(4): 544-50.

32. Robinson MJ, Lee EL. Paediatric Problems in Tropical Countries: Iron deficiency in childhood. London: Churchill Livingstone; 1978.

Address for correspondence:

Dr. Niloufer Sultan Ali, Assistant Professor, Department of Community Health Sciences, The Aga Khan University Hospital, PO Box 3500, Stadium Road, Karachi-73800, Pakistan. Tele: +92 21 4930051/4821, Fax: 4934294.

Email: niloufer.ali@aku.edu