Research in Developmental Disabilities 31 (2010) 25–32

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Prevalence and associated risk factors of anemia in children and adolescents with intellectual disabilities

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ARTICLE INFO

Article history:
Received 25 July 2009
Accepted 25 July 2009

Keywords:
Anemia
Hemoglobin (Hb)
Intellectual disability

ABSTRACT

Anemia is known to be a significant public health problem in many countries. Most of the available information is incomplete or limited to special groups such as people with intellectual disability. The present study aims to provide the information of anemia prevalence and associated risk factors of children and adolescents with intellectual disability in Taiwan. We analyzed physical examination charts of 937 children and adolescents with intellectual disability at the age of 6–18 years from three special schools. We collected information on their demographic characteristics (age and gender), disability condition (type and level), BMI (weight and height) and measured blood hemoglobin concentration (Hb). There were 11.6% of children and adolescents with intellectual disability with anemia (boy <13 g/dl, girl <12 g/dl), and the factors of gender, age, disability level and BMI are significantly correlated to anemia in bivariant analyses in the study. In the logistic regression analysis, the model revealed that the factors of gender (OR=0.63, 95% CI=0.41–0.95), and age (OR=3.21, 95% CI=1.77–5.82) were variables that could significantly predict the anemia occurrence of the participants. The study highlights the anemia prevalence in children and adolescents with ID is a mild public health problem

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0891-4222/$ – see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ridd.2009.07.017

among people with intellectual disabilities, but to prevent the problems become worst; the health authority should include providing children and adolescents with adequate nutrition and appropriate health protections during early childhood.
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1. Introduction

Anemia is a global public health problem affecting populations in both rich and poor countries with major consequences for human health as well as social and economic development (de Benoist, McLean, Egli, & Cogswell, 2008). The definition of anemia has attracted considerable interest recently because of epidemiologic studies that suggest that anemia may be associated with poorer outcomes in a variety of disorders (Beutler & Waalen, 2006). In many studies the definition of anemia used is that suggested by a WHO expert committee nearly 40 years ago. However, there is a general lack of accurate data on its prevalence throughout the world (Blanc et al., 1968).

In the US, the prevalence of anemia is usually defined in terms of the percentage of individuals with hemoglobin (Hb) values below a 95% reference range (Dallman, Yip, & Johnson, 1984). Measuring Hb concentration is relatively easy and inexpensive, and this measurement is frequently used as a proxy indicator of iron deficiency anemia (de Benoist et al., 2008). Using these reference standards, the prevalence of anemia among the US 15,093 individuals with complete laboratory results was highest in infants (5.7%), teenage girls (5.9%), young women (5.8%), and elderly men (4.4%).

Although hematological complications associated with ID are rare in the previous studies (Pavithran & Raji, 2003). However, the individuals with ID form one of the most vulnerable groups of the disabled population, being more likely to have poorer health status and accompanied with comorbidity, require more medical resources and experience greater difficulty with healthcare accessibility than the general population (Hsu et al., 2009; Lin et al., 2009a; Lin, Lin, Yen, Loh, & Chwo, 2009; Lin et al., 2007, 2006; Lin, Wu, & Lee, 2004; Lin, Yen, Li, & Wu, 2005; Yen, Lin, Loh, Shi, & Hsu, 2009). Hurtado, Claussen, & Scott (1999) conducted a population-based study in the US and found that an increased likelihood of mild or moderate ID was associated with anemia. For each decrement in Hb concentration, the risk of mild or moderate retardation increased (1.28) after several potential confounders were controlled for. Birth weight, maternal education, sex, and age of the mother also predicted anemia, but the odds ratio in each of these cases was >1.28 in a logistic regression model. Ohwada, Nakayama, Nara, Tomono, and Yamanaka (2006) analyzed from a health checkup data of a public facility for people with ID ($N=477$), they found that the prevalence of anemia (Hb value ≤ 13.4 g/dl for males and ≤ 11.2 g/dl for females) among male participants was higher than in female participants for each disability category (ID, 41.1%, 4.2%; cerebral palsy, 37.5%, 4.8%; Down's syndrome, 15.0%, 0%; severe motor and ID, 61.9%, 16.7%).

Anemia is an indicator of both poor nutrition and poor health (de Benoist et al., 2008). Many studies have indicated that severe anemia affects mental and physical development in children (Lozoff, 1989; Lozoff et al., 1987; Lozoff, Jimenez, & Wolf, 1991). Although there were many studies that assessed the anemia provision for the general children in Taiwan (Shaou, Yi, & Pan, 1998; Wang & Shaou, 2006), the special group - people with ID, the anemia prevalence is unknown and associated risk factors have not been sufficiently studies. To provide the evidence-based information for assessing anemia is to inform stakeholders on the type of measures to be taken to prevent and control anemia, the present study aims to provide the information of anemia prevalence and its determinants of children and adolescents with ID in Taiwan.

2. Methods

A cross-sectional physical examination chart review was conducted in three special schools for children and adolescents with ID in 2008. The school age students accepted physical examination as they enrolled into schools at the first year, the examination includes body physical exam, biochemical

(blood, urine and stool specimen) and X-ray checkup. The study was designed to include all eligible aged 6–18 years children and adolescents with ID from all three special schools. Ethics approval was received from all the study special schools.

There were 937 children and adolescents with ID who participated. We collected information on their demographic characteristics (age and gender), disability condition (type and level), BMI (weight and height) and measured blood hemoglobin concentration (Hb). Hb-the red, iron-containing chromoprotein within a circulating mature red blood cell that has the primary physiologic function of oxygen transport and also plays a role in carbon dioxide transport. Measurement of hemoglobin itself is a direct means of determining the presence of anemia, which is most frequently associated with iron deficiency (Hollowell et al., 2005). When iron-deficient erythropoiesis occurs, hemoglobin concentrations are reduced to below-optimal levels. As individual hemoglobin levels are below two standard deviations (−2SD) of the distribution mean for hemoglobin in a normal population anemia is considered to be present (WHO, 2001). Anemia in the study was defined as Hb level below 13.0 g/dl in men, and 12.0 g/dl in women according to World Health Organization standards (Blanc et al., 1968). Data were analyzed with SPSS, version 14.0, a data analysis program. The number, percentage and chi-square method were used to describe the participant characteristics and analyzed their association with anemia. Multivariate analysis of logistic regression method, odds ratio (OR) and 95% confidence interval (95% CI) were used to evaluate the potential risk factors associated with anemia.

3. Results

The characteristics of study participants are reported in Table 1. Of the 937 children and adolescents with ID in this study, 559 were boys and 378 were girls, and the average age was 15.7

Table 1
Characteristics of study subjects.

Characteristics	*N*	%	Mean ± SD (range)
Gender (*N*=937)			
Boys	559	59.7	
Girls	378	40.3	
Age (*N*=937)			15.70 ± 0.75 (6.0–18.0)
6–12	82	8.8	
13–18	855	91.2	
Disability type (*N*=936)			
ID	614	65.5	
Multiple[a]	323	34.5	
Disability level (*N*=936)			
Mild	81	8.7	
Moderate	452	48.3	
Severe	313	33.4	
Profound	90	9.6	
Height (*N*=918)			155.30 ± 14.21 (90.00–185.00)
Boys	548		159.74 ± 13.31 (104.00–185.00)
Girls	371		148.76 ± 12.92 (90.00–176.00)
Weight (*N*=918)			53.04 ± 18.06 (8.70–121.50)
Boys	548		56.04 ± 18.77 (13.00–121.50)
Girls	371		48.62 ± 15.99 (8.70–108.00)
BMI (kg/m^2) (*N*=916)			21.57 ± 5.72 (8.67–50.41)
Underweight	274	29.9	
Normal	314	34.3	
Overweight	119	13.0	
Obesity	209	22.8	

[a] ID accompanied with other disabilities.

Table 2
Hemoglobin concentration level of the study subjects (N=937).

Characteristics	N	%	Mean ± SD (range)
Hb concentration			14.06 ± 1.58 (6.00–18.70)
Boys	559	59.7	14.85 ± 1.21 (7.70–18.70)
Girls	378	40.3	13.13 ± 1.56 (6.00–17.90)
Normal[a]	828	88.4	
Abnormal[b]	109	11.6	

[a] Normal (non-anemia): boy >13 g/dl, girl >12 g/dl.
[b] Abnormal (anemia): boy ≤13 g/dl, girl ≤12 g/dl.

years. 65.5% of the study participants were ID solely while 34.5% were ID accompanied with other disabilities (multiple disabilities) as well. In terms of disability level, most of the persons with ID in this study belonged to the moderate and severe level of disability (48.3% and 33.4%, respectively). With regard to the physical figure of the participants, the results of a body mass index (BMI) analysis indicated that 34.3% were normal, 13.0% were overweight, 22.8% were obese and 29.9% were underweight.

Table 2 summarized the average Hb concentrations distribution of the study subjects. The Hb mean ± SD (g/dl) of the study participants was 14.06 ± 1.58 (range = 6.00–18.70). Boys and girls were 14.85 ± 1.21 (range = 7.70–18.70), 13.13 ± 1.56 (range = 6.00–17.90), respectively. There were 11.6% of children and adolescents with ID, who were anemic (boy <13 g/dl, girl <12 g/dl) in the study. The Hb values were significantly increased by age in boys ($p < 0.001$), but were not increased in the girls (Fig. 1).

Table 3 analyzed Chi-square correlation between anemia and subject's characteristics in the bivariant analysis. Gender, age, disability level and BMI are significantly correlated to anemia ($p < 0.05$). Girls (prevalence = 14.3%) were more inclining to be anemic than boys with ID (prevalence = 9.8%), and children of age 6–12 years (prevalence = 28.0%) were nearly three times more likely to be anemic than 13–18 year olds (prevalence = 10.1%). With regards to the disability level, we found the more severe the disability level is the more the possibility to be anemic in the study subjects. Finally, the body figure analyzed found different BMI will vary significantly on anemia prevalence in those children and adolescents with ID. Those underweight subjects were of significant higher prevalence in anemia than those subjects were normal, overweight or obese. The factor of disability type, ID solely or multiple disabilities was not significantly related to anemia prevalence in the subjects ($p > 0.05$).

The logistic regression model which evaluated the associated risk factors will determine the anemia occurrence by controlling the interaction of factors. Table 4 shows that the factors of gender (OR = 0.63, 95% CI = 0.41–0.95), and age (OR = 3.21, 95% CI = 1.77–5.82) were the variables that can significantly predict whether they were anemic or not. Those children and adolescents with ID were

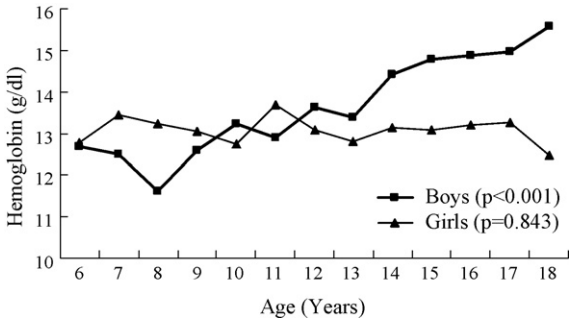

Fig. 1. Hemoglobin concentration at different age.

Table 3
Chi-square correlation between hemoglobin concentration and subject's characteristics.

Characteristics	*N*	Hemoglobin concentration		χ^2
		Normal *N* (%)	Abnormal *N* (%)	(*p*-Value)
Gender	937			4.34
Boys		504 (90.2)	55 (9.8)	(0.037)
Girls		324 (85.7)	54 (14.3)	
Age	937			23.56
6–12		59 (72.0)	23 (28.0)	(<0.001)
13–18		769 (89.9)	86 (10.1)	
Disability type	937			2.53
ID		550 (89.6)	64 (10.4)	(0.111)
Multiple		278 (86.1)	45 (13.9)	
Disability level	936			5.19
Mild+moderate		482 (90.4)	51 (9.6)	(0.023)
Severe+profound		345 (85.6)	58 (14.4)	
BMI	916			6.74
Underweight		232 (84.7)	42 (15.3)	(0.034)
Normal		278 (88.5)	36 (11.5)	
Overweight/Obesity		300 (91.5)	28 (8.5)	

Table 4
Logistic regression model for the association between anemia and subject's characteristics (*N*=915).

Variables	β	S.E.	OR	95% CI	*p*-Value
Constant	−2.00	0.23	0.14		<0.001
Gender					
Girls			1		
Boys	−0.47	0.21	0.63	0.41–0.95	0.027
Age					
13–18			1		
6–12	1.17	0.30	3.21	1.77–5.82	<0.001
Disability type					
ID			1		
Multiple	−0.05	0.26	0.95	0.58–1.58	0.85
Disability level					
Mild+moderate			1		
Severe+profound	0.22	0.25	1.24	0.76–2.03	0.39
BMI					
Normal[a]			1		
Underweight	0.27	0.25	1.30	0.80–2.14	0.29
Overweight/obesity[b]	−0.28	0.27	0.76	0.45–1.28	0.30

[a] Normal (non-anemia): boy >13 g/dl, girl >12 g/dl.
[b] Abnormal (anemia): boy ≤13 g/dl, girl ≤12 g/dl.

girls and those who were of younger age (6–12 years) were more likely to be anemic after controlling factors of disability type, disability level and BMI in the study.

4. Discussions

Anemia is known to be a significant public health problem in many countries. Iron deficiency anemia affects a significant part, and often a majority, of the population in nearly every country in the world (WHO, 2001). The present study found that the Hb concentration of the children and

Table 5
Mean hemoglobin by gender and age between the present study and the third National Health and Nutrition Examination Survey in US (NHANESIII)[a].

Age	Our data			NHANESIII			Test
	N	Mean (g/dl)	SD	*N*	Mean (g/l)[b]	SD	*t*-Value
Boys	559						
6–8	16	12.50	0.89	709	128.8	8.0	−1.74
9–11	8	13.03	0.80	773	132.8	8.4	−0.91
12–14	36	13.80	1.05	540	141.4	10.8	−1.97
15–18	499	14.85	1.28	836[c]	150.7	10.3	−4.03*
Girls	378						
6–8	21	13.10	1.25	675	128.2	7.7	1.03
9–11	7	13.06	0.70	734	131.0	7.8	−0.16
12–14	25	13.00	1.03	621	132.9	10.0	−1.45
15–18	325	13.13	1.56	950[c]	131.5	10.0	−0.27

[a] Hollowell et al. (2005).
[b] g/l = g/dl × 10.
[c] Age group: 15–19.
* $p < 0.001$.

adolescents with ID (6–18 years) was 14.06 g/dl, for boys and girls were 14.85 g/dl and 13.13 g/dl, respectively. According to the Taiwan Nutrition and Health Survey 1993–1996 we found that the mean of Hb in 7–12 years was 13.1 g/dl in boys and 12.7 g/dl in girls, and in those of 13–18 years was 14.5 g/dl in boys and 12.8 g/dl in girls (Shaou et al., 1998). The National Nutrition and Health of Primary School Students 2001–2002 (Wang & Shaou, 2006) found that the mean Hb values of children aged 6–12 years were 13.1 g/dl in boys and 13.0 g/dl in girls. It is difficult to assess the difference due to the difference in age groups among those studies. Comparing to the third National Health and Nutrition Examination Survey in US (NHANESIII) in Table 5, the mean Hb value in children and adolescents with ID was not significantly different from the general population of 6–14 years (Hollowell et al., 2005).

In total, 11.6% of children and adolescents with ID were anemic (boy <13 g/dl, girl <12 g/dl), and the gender, age, disability level and BMI are significantly correlated to anemia in bivariant analyses in the study. Comparing to national data in Taiwan, Wang and Shaou (2006) found that the prevalence of anemia Hb <11 g/dl for 6 years old and Hb <12 g/dl for 7–12 years old children was 11.4% in boys and 13.2% in girls in Taiwan. According to WHO (2001) suggested, in a normal population, 2.5% of the population would be expected to be below the 2SD thresholds. Hence, iron deficiency anemia would be considered a public health problem only when the prevalence of Hb concentration exceeds 5.0% of the population. It is needed to pay attention for the anemia prevalence of children and adolescents with ID in Taiwan.

Other studies, such as the overall anemia prevalence in school-aged children (5–15 years) was 13.6% in India, the boys (12.0%) had lower prevalence than girls (15.3%) (Muthayya et al., 2007). Wang, Ma, Xu, and Zou (2003) also found anemic prevalence among female high-school graduates was 11.3%, much higher than 1.5% of males in China. Wen et al. (2008) conducted a survey based on a standard medical screening programme and found that the anemia prevalence (Hb <13 g/dl in men and Hb <12 g/dl in women) was 7.3% in adult population in Taiwan. Liu, Chang, and Lee (1994) who analyzed 2518 elderly people found that the age adjusted prevalence of anemia (Hb <12.5 g/dl in men and 11.5% in women) was 6.5% in men and 8.3% in women. Prevalence rates increased significantly with age in women.

The present study also reveals that the factors of gender and age were significantly correlated to the occurrence of anemia in logistical regression model. In Japan, one study based on health checkup data found that factors related to an increase in anemia among adults with ID included gender (male), BMI, use of anticonvulsants or major tranquilizers, and a high zinc sulfate turbidity test value in a multivariate analysis (Ohwada et al., 2006). Not all demographic factors were associated with anemia. A possible explanation for this observation is that the cut-off for hemoglobin values is based on WHO standards instead of ID individuals. The prevalence of anemia in a population is therefore a statistical

rather than a physiological concept (WHO, 2001). Most of the available information is incomplete or limited to special groups. Therefore, it is necessary to collect local data to evaluate the norms of Hb in the general population to assess the prevalence of anemia in the special groups.

The study highlights that the prevalence of anemia was 11.6% in children and adolescents with ID in Taiwan is regarded as a mild public health problem according to WHO standards (WHO, 2001). The efforts to prevent the problems become worst; the health authority should include providing children with adequate nutrition and appropriate health protections during early childhood.

Acknowledgements

This research was financially supported by the Bureau of Health Promotion, Ministry of Health, Taiwan (DOH97-HP-1601). We would also like to thank all the staff in the three special schools who support this study.

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