NUTRITION EDUCATION AND KNOWLEDGE, ATTITUDE AND HEMOGLOBIN STATUS OF MALAYSIAN ADOLESCENTS

Hafzan Yusoff[1], Wan Nudri Wan Daud[1] and Zulkifli Ahmad[2]

[1]Department of Community Medicine, School of Medical Sciences; [2]School of Dental Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

Abstract. A higher occurrence of iron deficiency anemia is present in rural Malaysia than urban Malaysia due to a lower socio-economic status of rural residents. This study was conducted in Tanah Merah, a rural district of Kelantan, Malaysia. Our objective was to investigate the impact of nutrition education alone, daily iron, folate and vitamin C supplementation or both on knowledge, attitudes and hemoglobin status of adolescent students. Two hundred eighty fourth year secondary students were each assigned by school to 1 of 4 different treatment groups. Each intervention was carried out for 3 months followed by 3 months without treatment. A validated self-reported knowledge and attitude questionnaire was administered; hemoglobin levels were measured before and after intervention. At baseline, no significant difference in hemoglobin was noted among the 4 groups (p=0.06). The changes in hemoglobin levels at 3 months were 11, 4.6, 3.9 and -3.7% for the supplementation, nutrition education, combination and control groups, respectively. The changes at 6 months were 1.0, 6.8, 3.7 and -14.8%, respectively. Significant improvements in knowledge and attitude were evidenced in both the nutritional education and combination groups. The supplementation and control groups had no improvement in knowledge or attitudes. This study suggests nutritional education increases knowledge, attitudes and hemoglobin levels among Malaysian secondary school adolescents.

Keywords: hemoglobin status, knowledge, attitude, nutrition education, adolescents, Malaysia

INTRODUCTION

Anemia is a global public health problem affecting both developed and developing countries. The Global Database on Anemia has estimated anemia affects approximately 1.62 billion people worldwide, which corresponds to 24.8% of the world's population (WHO, 2008a). Iron deficiency anemia (IDA) is the most widespread micronutrient deficiency in the Western Pacific region, with preva-

Correspondence: Hafzan Yusoff, Department of Community Medicine, School of Medical Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia.
Tel: +6017 9371499; Fax: +6097645952
E-mail: hafzan_yusoff.ud07@student.usm.my

Wan Nudri Wan Daud, Department of Community Medicine, School of Dental Sciences, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia.
Tel: +6097671067; Fax: +6097645952
E-mail: wnudri@kb.usm.my

lences of 23.1, 30.7 and 21.5% amongst preschool children, pregnant women and non-pregnant women, respectively (WHO, 2008b).

Generally, adolescents are susceptible to iron deficiency anemia because of increased iron requirements due to rapid growth. Female adolescents require more iron after reaching menarche. Preventive measures should be undertaken to ensure females enter their reproductive years without iron deficiency and with a lower risk of developing iron deficiency anemia. Anemia prevention among adolescents is important for physical and cognitive development.

There have been a few local studies of IDA done, many of them on infants, young children and pregnant women (Hassan *et al*, 2005; Siti-Noor *et al*, 2006; Aini *et al*, 2007; Haniff *et al*, 2007; Al-Mekhlafi *et al*, 2008). There have only been 3 studies focusing on adolescents, all have been conducted in Sabah and Sarawak (Tee *et al*, 1999; Foo *et al*, 2004a, b). Foo *et al* (2004a) found dietary iron, energy intake and gender were determinants of iron status among Malaysian adolescents in rural areas. They also stressed the importance of adequate iron and energy intake. Iron intake among adolescents has been reported as unsatisfactory, with the majority failing to meet the Malaysian Recommended Nutrient Intake (RNI) of iron (Foo *et al*, 2004b). Their source of iron was primarily plant-based, which is known to have lower iron availability. This highlights the need for nutrition education and other intervention programs, such as iron supplementation, to be implemented among adolescents in Malaysia in an effort to eradicate iron deficiency anemia among adolescents. A study by Tee *et al* (1999) suggested long term weekly iron-folate supplementation to improve iron status among adolescents.

The effectiveness of nutrition education for producing healthy food choices, (Allen *et al*, 2007) and to enhance nutritional knowledge and attitudes among adolescents and primary school children has also been proven (Ruzita *et al*, 2007). Most nutrition education studies in Malaysia have involved chronic and cardiovascular diseases. We believe a similar approach may be feasible for iron deficiency anemia among Malaysian adolescents.

MATERIALS AND METHODS

This study was conducted in 2 stages. Hemoglobin screening was carried out during Stage 1, involving 16 to 17 year old secondary school studying in year 4 of high school at Tenah Marah. Multistage cluster sampling was used to choose respondents (Fig 1). The hemoglobin concentration for each student was determined using a STAT-Site M ^{HGB} meter from capillary blood obtained via finger-prick. The prevalence of anemia was determined and then male students with a hemoglobin of <13 g/dl and female students <12 g/dl were asked to participate in the second stage of this study. The Stage 2 was a randomized community trial conducted over 6 months comprised of 3 months of interventions followed by 3 months without interventions. Students at schools that did not receive interventions were used as controls.

A total of 280 respondents (223 female, 57 male) were recruited into Stage 2. The respondents were randomly assigned by school into 1 of 4 groups: Group 1 - iron supplementation (*n*=68), Group 2 - nutritional education (*n*=89), Group 3 - both iron supplementation and nutritional education (*n*=67) and Group 4 - the control (*n*=56) group. The study protocol

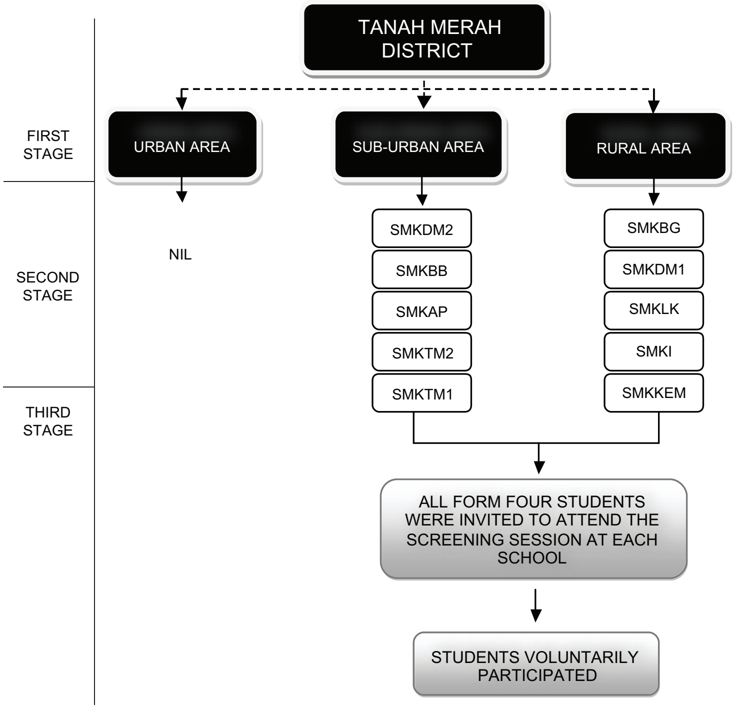

Fig 1–Multistage cluster sampling process for respondent recruitment.

was approved by the Research Ethics Committee of the Universiti Sains Malaysia. Consent for school selection and the study was also obtained from the Ministry of Education through the Education and Planning Research Division (EPRD). Written informed consent was obtained from parents and verbal consent was obtained from students for intervention activities and all measurement procedures, including venipuncture.

There were 2 major intervention components in this study: 1) iron, folic acid and vitamin C supplementation, and 2) nutrition education. The supplement used was a commercially available supplement in capsule form. Each capsule contained 250 mg ferrous gluconate, 1 mg folic acid and 50 mg vitamin C. A one week supply was comprised of seven capsules packed in a bag and labeled with the students' name and class. The supplements were distributed to the respondents through the class teacher. In order to enhance compliance, they were each provided with a sheet telling them to take the capsule daily and a calendar to be ticked off each day after taking the supplement. The supplements were taken daily either at night before going to sleep or in the morning with breakfast.

The respondents were asked to take the supplement after food to avoid stomach ache or other side effects. The compliance rate with the supplementation was determined by reviewing to the mini calendar to see if it had been ticked; these were returned each month by the respondents. A total of 84 capsules were given to each respondent during the 3 month study. The compliance rate was 89.3%.

The nutrition education consisted of 4 lectures and question and answer (Q & A) sessions, 1 exhibition, 4 video presentations, 2 group discussions, 6 brochures and 2 posters. All intervention activities and materials prepared specifically for this study, underwent a validation process before being used in the intervention. Six topics were covered by nutrition education: introduction, symptoms and risk factors for IDA, IDA among adolescents, prevention and treatment, IDA and nutrition, iron-rich foods and the role of iron inhibitors and enhancers and iron supplementation. Only respondents in the nutrition education and combination groups received the nutrition education.

Prior to intervention respondents

were asked to complete a demographic questionnaire. A questionnaire about knowledge and attitudes was also administered to each respondent before intervention and just after the program (at 3 months). This 48 item questionnaire was specifically developed for this study and had gone through validation and reliability testing. The questionnaire was pretested with 30 secondary school students in Ayer Lanas, Jeli Kelantan, Malaysia and the internal consistency of each item was checked with a Cronbach's alpha reliability coefficient of 0.924.

Hemoglobin levels were measured at baseline, 3 and 6 months. Hemoglobin levels were determined using a Sysmex KX21 hematology analyzer using venous blood draws or with a STAT-Site M^{HGB} meter using a capillary blood draw.

Changes in knowledge, attitudes and hemoglobin levles were used as the main parameters to determine the effectiveness of the intervention program. All data were analyzed using SPSS version 11.5. The results were presented as means and standard deviations. The General Linear Model Repeated Measures ANOVA (Split-plot ANOVA) and one-way ANOVA were used to interpret data.

RESULTS

The overall prevalence of anemia based on WHO criteria (WHO/UNICEF/UNU, 2001) of the 855 respondents at baseline was 59.6% (n=510). Forty-four percent (n=376) and 15.2% (n=130) of female and male respondents, respectively, had mild to moderate anemia, and 4 respondents (all female) had severe anemia. Anemia was more prevalent among respondents from rural schools (64.5%) compared to those from suburban schools (56.5%).

Table 1
SPANOVA analysis of knowledge and attitude scores.

Parameter	Group								*p*-value
	GP1 (Supplement)		GP2 (Nutrition education)		GP3 (Combination)		GP4 (Control)		
	Baseline	6 Months	Baseline	6 Months	Baseline	6 Months	Baseline	6 Months	
Knowledge	33.04 (31.64,34.45)	30.41 (29.68,31.14)	33.17 (31.94,34.40)	48.39 (47.76,49.03)	33.46 (32.05,34.88)	48.82 (48.09,49.56)	32.61 (31.06,34.15)	30.21 (29.41,31.02)	< 0.01
Attitude	31.36 (29.98,32.73)	29.78 (29.33,30.23)	30.01 (28.81,31.21)	33.35 (32.95,33.74)	31.84 (30.45,33.22)	33.88 (33.43,34.34)	30.30 (28.79,31.82)	28.73 (28.24,29.23)	< 0.01

Table 2
SPANOVA analysis of hemoglobin.

Group	EMM (95% CI)			*F*-value[a]	Sig-*F*[a]
	Pre	Post 1	Post 2		
Group 1 (Supplement)	11.01 (10.73-11.29)	12.24 (11.98-12.50)	11.12 (10.86-11.37)	66.13	<0.001
Group 2 (Nutrition education)	10.78 (10.54-11.02)	11.28 (11.05-11.51)	11.51 (11.29-11.73)		
Group 3 (Combination)	11.15 (10.88-11.43)	13.40 (13.14-13.67)	13.38 (13.13-13.64)		
Group 4 (Control)	10.64 (10.34-10.95)	10.24 (9.96-10.53)	9.06 (8.78-9.34)		

Pre, Month 0; Post 1, Month 3; Post 2, Month 6; EMM, Estimated Marginal Means
[a] SPANOVA (Null hypothesis: Mean hemoglobin values change from Pre to Post 2 were not different among the 4 groups); Sig-*F* < 0.001, reject null hypothesis-there is a significant treatment/group effect.

Changes in nutrition knowledge scores

The pre-intervention knowledge scores did not differ significantly (p = 0.183) among the groups. At 3 months, an increase in knowledge was seen in Groups 2 and 3. However, Groups 1 and 4 had a decline. SPANOVA (Split-plot ANOVA test) analysis (Table 1) revealed a significant effect of the study phase [F (1,276) = 468.1, $p < 0.001$] and a significant effect on the treatment group [F (3, 276) = 307.3, $p < 0.001$]. The mean pre- and post-intervention knowledge scores differed significantly by group. The mean overall knowledge score pre-intervention was 65.2%, and post-intervention was 81.6%.

Changes in nutrition attitude scores

The pre-intervention attitude scores did not differ significantly (p = 0.881) by group. However, the post-intervention attitude scores improved significantly in Groups 2 and 3 by 3 months, and decreased in Groups 1 and 4. Table 1 shows the SPANOVA (Split-plot ANOVA test) analysis revealed no significant effect of the study [F (1,276) = 3.8, p = 0.05] but a significant [F (3, 276) = 20.5, $p < 0.05$] effect was seen between the pre- and post-treatment groups. A significant difference in mean attitude scores was found among groups during the study.

Changes in hemoglobin

No significant differences in hemoglobin levels pre-treatment were seen amongst the groups (p = 0.06). Hemoglobin levels differed significantly between pre-intervention and post-intervention 1 (3 months) and post-intervention 2 (6 months). At 3 months, a significant increase in hemoglobin was seen in all groups except Group 4, which experienced a fall. At 6 months, the hemoglobin levels in Group 1 decreased but in Groups 2 and 3 they continued to increase until the end of the study. SPANOVA (Split-plot ANOVA test) analysis (Table 2) shows the significant main effect of the study [F (1.98, 546.6) = 314.7, $p < 0.05$] and the significant effect between the study and the treatment groups [F (5.94, 546.6) = 256.4, $p < 0.05$].

DISCUSSION

This study revealed anemia is a significant public health problem among secondary school students in Kelantan, Malaysia with an overall prevalence of 59.6%. This figure is much more higher than a previous study by Tee *et al* (1998) who documented an anemia prevalence of 17.8% among adolescents (n=701) aged 13 to 17.9 years from 69 villages and 7 estates in 9 states of Peninsular Malaysia. A study by Foo *et al* (2004b) of 165 adolescents (12-19 years old) from fishing communities in Tuaran District, Sabah, Malaysia found an anemia prevalence of 17%.

The substantially higher prevalence of anemia in this study may be due to differences in the type of study conducted. Our study was school-based but the Tee *et al* (1998) and Foo *et al* (2004b) studies were both community-based. School-based studies may have higher enrollment than community based studies; therefore a high proportion of children and adolescents may be reached (WHO, 1998). In this study, the teachers in each school played a vital role in encouraging student participation and assisting in implementation of the intervention program. This study may have had more adolescents than those of Tee *et al* (1998) and Foo *et al* (2004b), and a consequently higher prevalence of anemia among this target group.

Prior to the study, a brief explanation was given to respondents about the blood sampling procedure (finger-pricks) and the risks, including pain and bleeding. Since most adolescents had never experienced finger pricks before, the explanation may have lessened their fear towards the procedure and increased their interest in taking part in the study. A souvenir and participation certificate were also given to enhance respondent participation. Respondents' decisions to participate may have been influenced by their peer groups. These hypotheses are supported by the findings of a study done on 306 subjects from 3 age groups: adolescents (13-16 years old), youths (18-22 years old) and adults (24 years and older) that found respondents took more risks, focused more benefits and made riskier decisions when in peer groups than when alone (Gardner and Steinberg, 2005).

The anemia prevalence in this study (59.6%) was lower than reports in Nepal (65.6%) (Baral and Onta, 2009), Sudan (98.6%) (Abdelrahim *et al*, 2009), and India (75%) (Koteche *et al*, 2009), but higher than studies in Iran (21.4%) (Akramipour *et al*, 2008) and Brazil (24.5%) (Borges *et al*, 2009).

More than half respondents (51%) possessed a poor knowledge of anemia pre-intervention. The definition of anemia was unknown to most of them. More than 90% had heard of anemia, but nearly half of them failed to correctly define anemia. Three months after intervention onset there was a significant improvement in knowledge levels and attitudes of respondents in the nutrition education groups (Groups 2 and 3). Respondents in Groups 1 and 4 conversely had a decline over the same period. Our findings demonstrate the positive effect of nutrition education on knowledge and attitudes of adolescents in agreement with other studies (Kaur and Singh, 2001; Sakti *et al*, 2003; Gupta and Kochar, 2009; Moore *et al*, 2009).

At 3 months, there was a rise in hemoglobin in Groups 2 and 3, though the percent change was less than Group 1. No improvement was seen in Group 4 (control). The improvement in hemoglobin levels in Group 1 is most likely due to iron supplemention. The improved hemoglobin in Groups 2 and 3 is most likely due to diet modification.

Despite the improvement of hemoglobin levels in Group 1 at 3 months, this group experienced a sharp decline at 6 month, probably because of withdrawal of iron supplementation. Groups 2 and 3 showed a sustainability of hemoglobin throughout the study period. These results suggest the protective effect of nutrition education on hemoglobin status. Nutrition education was effective since it improved the knowledge and attitudes of subjects in Groups 2 and 3. The temporary effect of iron supplementation on Group 1 was evidenced; its mechanism of action has been previously described by Lynch (2000).

The findings underscore the significance of nutrition education. Information on iron deficiency prevention via healthy diet should be given to adolescents. The iron supplemention helps correct iron deficiency temporarily. The combination of these two acts synergistically in preventing negative iron balance, preserving iron stores and maintaining hemoglobin within the normal range. These findings are supported by several studies showing nutritional education is effective in improving hematocrit, hemoglobin and serum ferritin levels among adolescents (Khoshnevisan *et al*, 2004; Moore *et al*, 2009).

The inclusion of attention-grabbing educational materials, such as videos, in this study may have contributed to improvement in knowledge scores among Groups 2 and 3. Similar results were reported by Ruzita *et al* (2007) among primary school children.

Habits, likes and dislikes are established early in life and are carried into adulthood, at which time changing health habits is more challenging. Conveyance of precise information to promote healthy eating habits and lifestyles should be initiated as early as possible to prevent iron deficiency anemia in adulthood. Implementation of nutrition education including addressing iron deficiency anemia in secondary schools in Malaysia was recommended. Nationwide anemia assessment should be carried out by the health authorities in conjunction with the Ministry of Education. A well-planned and implemented school-based nutrition education program is associated with improvement in knowledge, attitudes and hemoglobin levels among adolescents in Malaysia.

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