A comparative analysis of effects of black and purple tea on iron absorption in adolescent pregnant population

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ABSTRACT

Adolescent pregnancy is a major public health issue in developing countries. It is associated with unique nutritional requirements as well as risk of micronutrient deficiencies. Some of the foods and drinks ingested during pregnancy have been known to affect the absorption of much needed micronutrients and consequently compromise the health of both the mother and the growing foetus. There is scientific evidence to suggest that tannins and phytates in tea and in cereal-based foods inhibit iron absorption and predispose the mother to iron-deficiency disorders such as anaemia and predispose the unborn infant to low-birth weight. In Kenya, the most predominantly grown and consumed tea type is black tea. Studies have shown that consumption of black tea with meals can decrease iron absorption by up to 50%. Purple tea is reported to contain anthocyanins, which have antioxidant effects that provide anticancer benefits, improve vision, and better cholesterol and blood sugar metabolism. If purple tea is to be preferred to the traditional black tea, one has to ascertain that the iron inhibiting tannins are either in low quantities or altogether absent from the purple tea. Eating and drinking habits among pregnant women may exacerbate anaemia prevalence and or other more serious foetal problems. This paper discusses the feeding habits of a pregnant adolescent population and assesses the possible effects of tea drinking on iron absorption and maternal health. The paper found out that black tea drinking in pregnancy, and during meals, is rampant and negatively affects iron absorption. Knowledge about the health benefits of purple tea is not only scanty and where (the knowledge) is available the tea is not readily available for purchase. The paper recommends awareness of nutrition education to improve the feeding habits.

Key words: Adolescent pregnancy, Anaemia, Nutrition education, Purple tea, Tannins.

INTRODUCTION

Background information

Nutritional iron deficiency is estimated to affect 1.5 – 2 billion people worldwide (WHO, 2004). Iron deficiency and iron deficiency anaemia are major public health problems affecting an estimated two billion people with adverse consequences in women of reproductive age and young children (WHO, 2008). The clinical manifestation of iron deficiency is anaemia or low blood haemoglobin concentration. Anaemia affects nearly half of all pregnant women in the world; 52% in developing countries compared to 23% in the developed countries (UNICEF/WHO, 2001). Iron deficiency occurs when an insufficient amount of iron is absorbed to meet the body's requirements (Mahan and Stump, 2008).

Dietary iron is available in two valence states, Fe2+ (ferrous) and Fe3+ (ferric). The majority of ferrous iron is found in haem iron and the majority of ferric iron is found in non-haem iron. Haem iron is present in the haemaglobin and myoglobin of animals and as a result is found in meat, liver, offal and other meat products. This form of iron is relatively available and typically

20% to 30% of haem iron is absorbed from the diet, although this can rise to 40% in situations of iron deficiency. The level of haem iron absorption is relatively unaffected by other dietary factors. Non-haem iron is found in plant foods such as cereals, vegetables, pulses and dried fruit, and compared to haem iron it is relatively poorly absorbed, typically less than 10% and often under 5%. The absorption of non-haem iron is much more influenced by an individual's iron status and several factors in the diet that can either inhibit or enhance its absorption.

There is clear evidence to show that tea drinking limits the absorption of nonhaem iron. However, there are few studies which have assessed the influence of tea drinking on indicators of iron status. Different varieties of tea, however, affect absorption of iron differently. Black tea has been documented to reduce iron absorption by up to 50%. Purple tea is said to contain anthocyanins, which have antioxidant effects that provide anticancer benefits, and improve vision, cholesterol and blood sugar metabolism.

The impact of improving micronutrient status on health outcomes has been recognized and is gaining increasing attention (Andang'o, 2007). It has been observed that although the rate of tea drinking is low among the youth aged between 15 and 25, there is a higher occurrence of tea drinking among the expectant adolescent mothers.

Statistics show that nutrient intake, infection prevention and pregnancy outcome among the women in Kenya (Northern Rift Valley) is poor and is dependent upon various social-cultural and economic factors (Ettyang *et al.,* 2005). Adolescent mothers face health risks during pregnancy and childbirth which accounts for 11% of the Global Burden of Disease for maternal conditions and 13% of all maternal deaths (WHO, 2000).

Statement of the problem

It is estimated that two out of every three persons in the developing world are affected by iron deficiency anaemia which accounts for at least 20% of maternal mortality (WHO, 2008). Iron deficiency anaemia ranks 9th among 26 risk factors included in *The Global Burden of Disease* (Global Report, 2009). In Africa, just like in Asia and South America, anaemia is a major public health concern affecting over 80% of women in many countries (WHO, 2004). In sub-Saharan Africa, the prevalence of anaemia in pregnancy (Hb < 11.0g/dL) ranges from 57% to 80% while severe anaemia (Hb < 7.0g/dL) reported at 9.8% (*ibid*). One out of every two women in Kenya is affected by some form of anaemia (MOH/UNICEF, 2001). According to a 1999 survey conducted in Kenya, the prevalence of anaemia was 56% among women of childbearing age, in the Western region of the country, 47% were reported anaemic (KNCAPD, 2003).

Iron deficiency ultimately results in anaemia. The higher tea drinking ratio among the expectant adolescents and the effect of tea inhibiting iron absorption highlight the need to establish the extent to which tea affects the nutrition status of the expectant adolescent mother. Various studies have reported either significant negative correlations between tea drinking and blood indicators of iron status or more cases of anaemia in tea drinkers compared with non-tea drinkers. Many of the studies reviewed report additional relationships between iron status indices and other factors (both dietary and non-dietary), highlighting the complexity of influences on iron absorption and iron status. Purple tea is said to contain anthocyanins, which have antioxidant effects that provide anticancer benefits, and improve vision, cholesterol and blood sugar metabolism. If purple tea is to be preferred to the traditional black tea, one has ascertain that the iron inhibiting tannins are either in low quantities or altogether absent from the purple tea.

Iron deficiency during pregnancy is known to be associated with premature delivery, low birth weight and increased perinatal mortality. In addition, infants born to iron-deficient mothers have a higher prevalence of anaemia in the first six months of life (Lynch, 2000). It, therefore, becomes imperative to tackle nutrition at this phase in adolescence and at an appropriate entry point at which under-nutrition may be reduced (WHO, 2001).

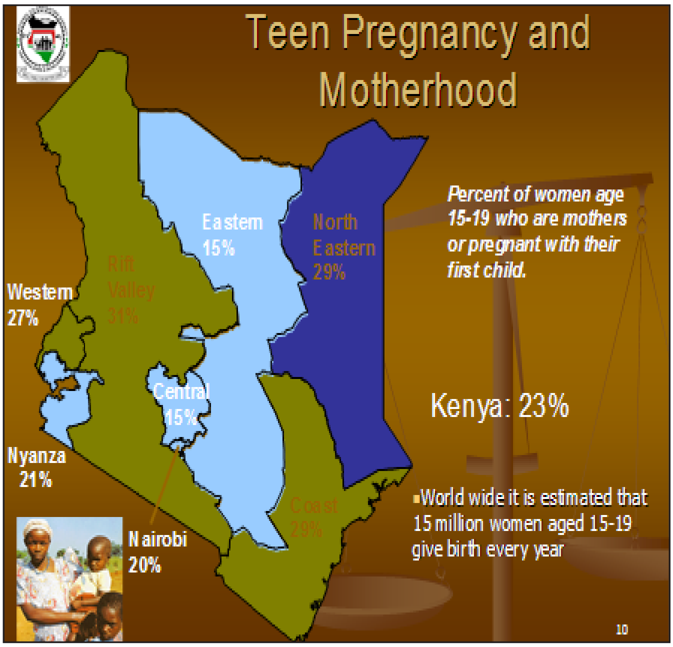


Figure 1: Teenage pregnancy in Kenya.

Justification for the study

Adolescence is a critical period of physical growth in the human life cycle. Behaviours that occur during this time such as hygiene, diet, exercise, and sexual have lasting effects and form the basis of health into adulthood (World Bank, 2007). The health and nutritional status of adolescents especially during gestation influences pregnancy and infant outcome. Tinker and Koblinsky (1994) reports that adolescent mothers (15 – 19 years) are at two to five times more at risk of mortality than women aged above 20 years. Inadequate quality and quantity of food is the prime determinant of the adolescents' nutritional problems. Even as most black tea is produced and also available for sale in the country, the same has been blamed for interfering with iron absorption. Purple tea, on the other hand, is praised for its health attributes. How the ingestion of the different varieties of tea affect the iron absorption is important knowledge so that informed decisions can be made by the drinkers. This condition may be as a result of household food insecurity, intra household allocation of food that does not meet their full range of dietary needs and lack of nutrition knowledge (Görgen, 1993).

There is a need to widen the scope of literature on tea drinking and adolescent pregnancy especially in Kenya. Most literature is associated with obstetric and prenatal health risks for the mothers and their babies. The results of the study are useful for stakeholders at the district and provincial levels. The baseline data may be used for policy formulation at the national levels. Results on adequate dietary iron will impact on improved maternal health and subsequently support achievement of the 5th Millennium Development Goal – improving maternal health (Global Report, 2009).

Research question

Research question for the study was: Is the nutritional requirement for tea drinking adolescent expectant mothers met by the iron nutrient?

Broad objective

The broad objective of the study was to compare the effects of black and purple tea drinking on the dietary iron intake of the adolescent expectant mothers.

Specific objectives

The specific objectives of the study were to:

1. To assess the adequacy of nutrient intake of the tea drinking adolescent expectant mothers.
2. To determine the haemoglobin (Hb) level of adolescent expectant mothers drinking different varieties of tea.
3. To compare the effects of drinking black tea with those of drinking purple tea on dietary iron intake of the adolescent expectant mothers.

LITERATURE REVIEW

Background information

Adolescent pregnancy has become an important public health issue because of associated poor pregnancy outcomes. In the developing world, knowledge about nutrient intake in the pregnant adolescents is limited (Scholl and Reilly, 2000).

Adequacy of nutrient intake of expectant adolescent

Iron stores of expectant adolescents are not well developed because of poor nutritional intake, recurrent infections, menstrual blood loss, and repeated pregnancies (Hashizume *et al.*, 2004). A pregnant woman needs about 2.0 mg to 4.8 mg of iron per day and must consume approximately 27 mg of diet to meet the daily iron needs. An average vegetarian diet does not provide more than 10 to 15 mg of iron per day. The amount of iron absorbed from diet, coupled with that mobilized from body iron stores, is usually insufficient to meet the demands imposed by pregnancy. The effects of iron deficiency occur in a cyclic pattern and unless intervention takes place before the 24th months of a child's life, irreversible effects are known to follow in the subsequent years of the individual (Mahan and Stump, 2008).

Bioavailability of iron

Meat products, especially liver and kidney, fish, peas, enriched breads, egg yolk and pasta products, are rich sources of iron. Bioavailability of iron-containing foods is strongly influenced by enhancers in the diet (such as ascorbic acid present in citrus fruits, fruit juices, green leafy vegetables, cabbage and some germinated or fermented foods such as soya sauce) and inhibitors (examples include: phytates – present in cereal bran, cereal grains, high-extraction flour, legumes beans, white and red baked beans, nuts and seeds; calcium – present particularly in milk and milk products; tannins – present in tea, coffee, and cocoa; phosphates – in egg yolk; and oxalates – in vegetables). Separating tea drinking from mealtime by at least two hours may reduce this inhibition (Mukherji, 2002).

Anaemia in pregnancy

WHO defines anaemia in pregnancy as that occurring at haemoglobin level < 11g/dl, and classifies haemoglobin counts into four different categories and which consequently defines the different levels of anaemia (Table 1).

Table 1: Cut-off points for defining anaemia in pregnancy.

Condition	Haemoglobin Count
Anaemia	Less than 11 grams per decilitre
Mild anaemia	Between 10 and 10.9 grams per decilitre
Moderate anaemia	7.0 – 9.9 grams per decilitre
Severe anaemia	Less than 7.0 grams per decilitre

Source: WHO (2004)

The symptoms of anaemia manifest as fatigue, paleness, shortness of breath, light-headedness, general weakness, low birth weight and pre-term deliveries (Kilpatrick *et al.,* 2004). A number of authors agree that the risk of anaemia is greater in adolescents during pregnancy (Konje *et al.,* 1992), than any other time. Severe anaemia was documented as severe anaemia among pregnant adolescents from Wakisho District, Uganda and as an important cause of maternal mortality among adolescents with the prevalence of severe anaemia (Hb < 7 g/dl) (Atuyambe *et al.,* 2005).

Epidemiological data sourced from Kenyan survey done in May-October 1999, in 12 districts by the Central Bureau of Statistics estimated a prevalence rate of 66.9% anaemia in pregnant women (CBS, 2004). WHO database on anaemia rates Kenya at 55.1% (Hb < 110g/l) (WHO, 2008).

Nutritional status of expectant adolescent

Many adolescents have poor diet quality and poor knowledge of appropriate nutrition (Lenders *et al.,* 2000). Maternal Mid Upper Arm Circumference (MUAC) is a potential indicator of maternal nutritional status-assessing lean body mass and can also be used to access women at risk of poor pregnancy outcome. A study in Bangladesh among pregnant adolescents showed the mean MUAMA was 32.2 $\pm$ 4.2 cm (Rah *et al.,* 2008).

Factors that may affect nutrient intake of the expectant adolescent

Butte and King (2005) suggest that the nutritional status of adolescent mothers is usually compromised by a web of many risk factors which include limited availability of food. Other factors include low levels of education and limited access to curative and preventive cure (Hashizume *et al.,* 2004).

Education level and adolescent nutrient intake

Kaufman *et al.* (2001), in a research in South Africa, concluded that the level of education seems to influence the overall quality of diet and the adequacy of micronutrient intake during pregnancy. Candida *et al.* (2005) carried out a study to examine nutritional status and birth outcomes of adolescent mothers in Tanzania. Majority (58%) had attained primary level of education and over 20% had never been to any formal school or received formal education.

Income levels and nutrient intake of expectant adolescents

Dietary intake in pregnancy is influenced by a complex range of psychological, socio-demographic and cultural factors. Social class may affect the quality of diet on the whole with the low income groups consuming poor quality diet (Singh, 2001). A study in Indonesia by Claude (2007) reported that young pregnant women from economically challenged environments were more at risk of malnutrition.

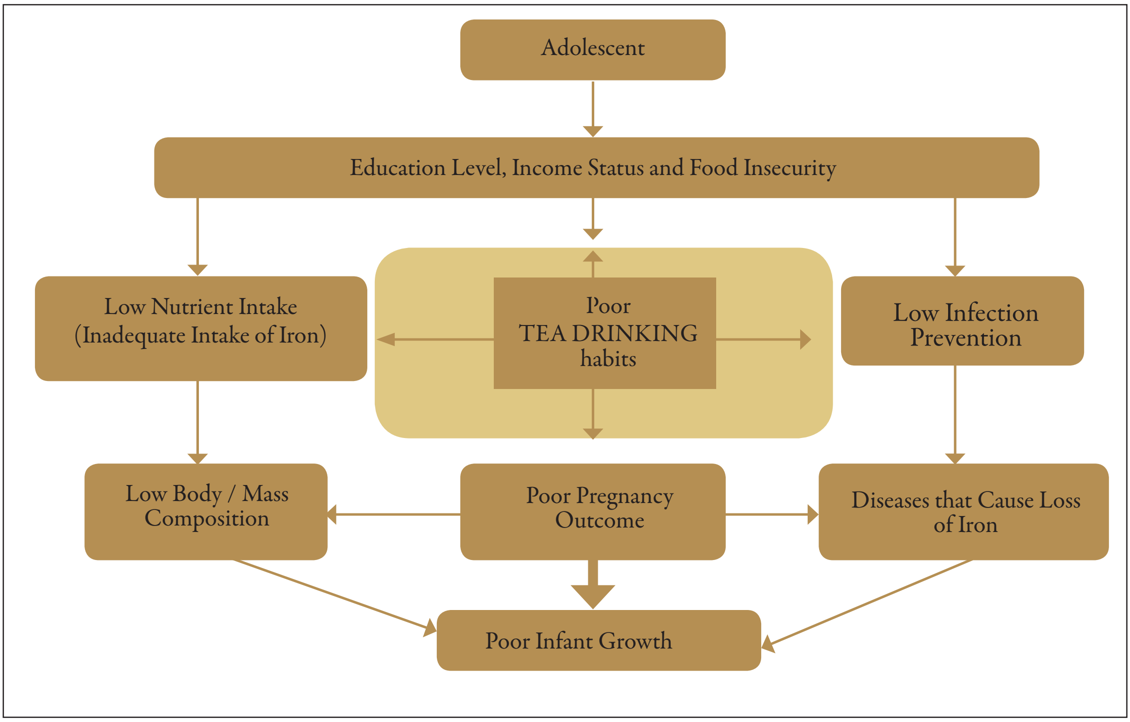
Knowledge gaps

Though much research on adolescent pregnancy has been carried out globally, very few have focused on Africa and especially in rural Kenya. There is very limited information on the relationship between black tea, purple tea and other tea intake, nutrient intake and the pregnancy outcome for adolescents in Kenya. Prenatal care, educational level and economic conditions of the pregnant adolescent have been studied independently and in a discrete manner as factors that affect nutritional intake.

There is also lack of information about the relationship between the health education provided to the mothers attending antenatal care (ANC) and their nutritional status.

CONCEPTUAL FRAMEWORK

The study adopted and modified the conceptual framework developed by UNICEF (1998). The framework presents the relationship between adolescent pregnancy, feeding habits, nutrient intake and pregnancy outcome (Figure 1). It is conceptualized that the adolescent may end up with poor pregnancy outcome due to poor eating or drinking habits. Low food intake may be influenced by unavailability of, or limited access to healthy food. Low food intake translates into low nutrient intake, compromises infection and ultimately leads to poor pregnancy outcome. This study deduced that quality nutrition in terms of appropriate and adequate food intake is recommended for the adolescent mothers.



Source: Modified from *Determinants of Malnutrition: The State of the World's Children*, UNICEF, 1998.

Figure 2: Conceptual framework showing the relationship between the low nutrient intake and the factors that cause and are affected by it in adolescent pregnancy.

In summary, improvement in adolescent nutrition may provide a promising intervention point at which intergenerational (vicious) cycle of malnutrition is broken.

METHODOLOGY

Study area

The study was conducted in two sub-district health facilities (both in Eldoret West District) namely: Turbo Sub-district Health Centre and Huruma Sub-district Centre. Both health facilities are located along the main highway, Eldoret-Bungoma Highway; approximately 35 kilometres and ten kilometres from Eldoret town, respectively. The two centres were purposively sampled as they registered highest uptake of antenatal visits.

Research design

The study employed a descriptive cross sectional study targeting expectant adolescent mothers attending ANCs at the Huruma Sub-district and Turbo Sub-district centres. Data was collected between May and June 2010.

Study population

The study population comprised of all the adolescent expectant mothers (15 – 19 years) in Huruma and Turbo Sub-district centres.

Sample size determination

In order to get a 95% confidence interval and sampling error of 5%, the sample size was determined using the following formulae suggested by Kothari (2003).

$$n = Z2pq/d2$$

Where Z = 1.96 (statistical constant)

d = error of margin (5%)

$$p = \frac{\text{proportion of adequate nutrient}}{\text{intake in the study population}} = 0.5 \text{ since it is unknown}$$

$$q = (1\text{-}p)$$

$$n = (1.96)\ 2^{*}.0.5^{*}(1\text{-}0.5)/\ (0.05)2$$

$$= 384$$

Sampling technique

Information on the ANC attendance records of two months was obtained for the purpose of estimating the expected attendance number of adolescent mothers who were to form the study participants in the duration of study. Sampling was done proportionately to the number of client flow of the centres. Huruma Clinic was projected at 357 first time visits while Turbo Clinic had 278 giving a total of 635 as the consolidated expected first-time visits at the centres. The proportionate sample size allocated to the two centres was as follows: i) Huruma health facility 357/635*384 = 216; and ii) Turbo health facility 278/635*384 =168

Convenience sampling was done to recruit the study participants to the required sample size and was determined as follows; as they came for their first ANC, were available, met the inclusion criteria, and after consenting.

Inclusion criteria

The study participants had to have the following characteristics: i) Expectant adolescent aged between 15 and 19 years; ii) In their third trimester of pregnancy; and iii) Attending ANC for the first time.

Exclusion criteria

Expectant adolescents with the following characteristics were excluded: i) Sick and unable to respond to the questionnaire; and ii) Participants who had not received iron and / or folate supplements.

Data collection

Data was collected by the researcher who was assisted by six research assistants. Interviews were conducted for FFQ questionnaires and socio-demographic data. The research assistants were trained to take anthropometric measurements of MUAC and Triceps and administer the questionnaires. Pretesting of 30 questionnaires was piloted on adolescent expectant mothers at the Uasin Gishu District Hospital for validity and reliability of the instruments used. Two trained and experienced Medical Laboratory Technologists from the health centres carried out the Hb tests and recorded results in the subjects' ANC cards for the researcher's reference.

Anthropometric assessment

Mid Upper Arm Circumference

Mid Upper Arm Circumference (MUAC) measurement was considered as the preferred nutritional index in expectant women since it does not change significantly during pregnancy (IOM, 2002). The subjects were requested to loosen their clothing around the shoulder area and stood erect with arms hanging at the sides and the palms facing the thighs.

Triceps Skinfold

The skinfold site was located and marked at the mid line of the back surface of the arm (over the tricep muscle) at the mid-point between the lateral projection of the acromial process and the margin of the olecranon process.

Mid Upper Arm Muscle Area

Mid Upper Arm Muscle Area (MUAMA) was calculated from triceps skin fold thickness (TSF) and mid upper arm circumference.

RESULTS

Socio-demographic information

Among the 384 study participants, 304 (79.4%) were married. Their mean age was 17.6 ± 1.3 years. The mean parity was 0.7 ± 0.8. Nearly half of the participants (195; 50.8%) had attained primary education. More than three-quarters of the study participants (297; 77.3%) were earning less than Ksh 5,000 per month from their small-scale businesses.

Table 2: Reasons for taking tea.

% of respondents	Reason for taking tea during pregnancy	Remarks
15	To reduce morning sickness	Without milk
10	To prevent insomnia	Taken before sleeping
13	Belief that herbal tea (mint and ginger) would promote more effective contractions especially in the third trimester	
8	Did not take tea during first trimester	Fearing miscarriages

Behavioural and clinical characteristics of adolescent expectant mothers

Only 90 (23.4%) participants responded to have received nutrition education during their gestation period and 55 (14.3%) had received de-worming treatment away from the ANC clinics. Those that-tested positive for malaria test were 143 (46.6%) and negative test for malaria were 164 (53.4%). In total, 307 (79.9%) participants were tested for malaria while 77 (20.1%) were reluctant to have malaria test done on them. More than half 215 (56%) of the study participants reported to have consumed a fruit or vegetable with their meal.

Adequacy of nutrient intake of adolescent expectant mothers

The study found out that the participants with the least inadequate nutrients from a multi-response query were 34.7% for iron, 38.5% for vitamin B_{12} and 39.8% for protein. The highest inadequacy levels were found in vitamin C 83.3%, energy 74.2%, folate 65.1% and calcium 58.9%.

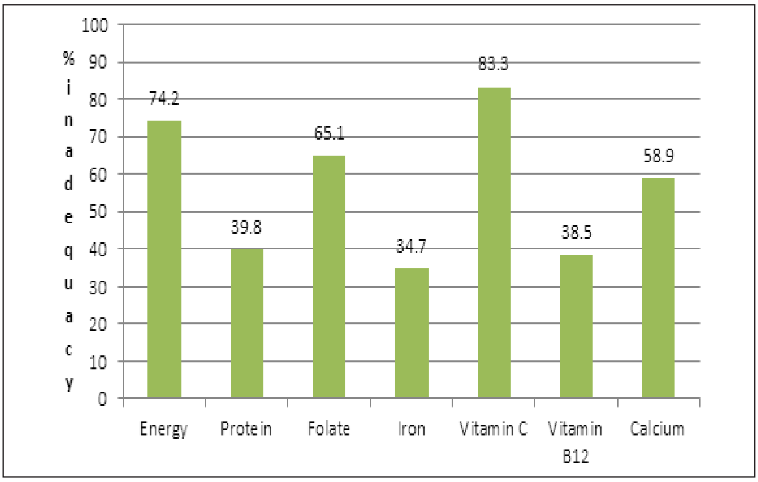


Figure 3: Prevalence of inadequate nutrient intake.

Using a probability approach, the sample was used to infer to the general population and the results indicated that the population with the highest inadequacies were 72.1% for vitamin C, 50.3% for folate and 44% for proteins. The least population with inadequacies recorded were for iron at 37.5%.

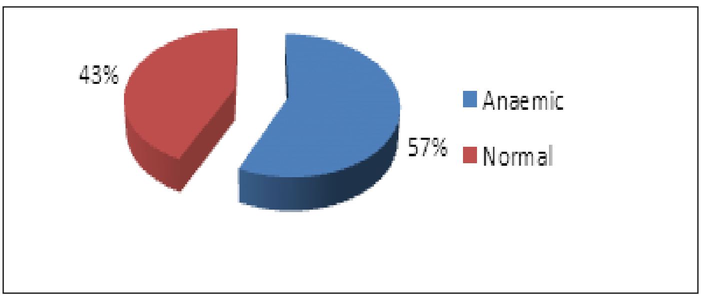


Figure 4: Prevalence of anaemia among tea drinking expectant adolescents.

Among the study population, 219 (57%) were anaemic (Hb < 11g/dL).

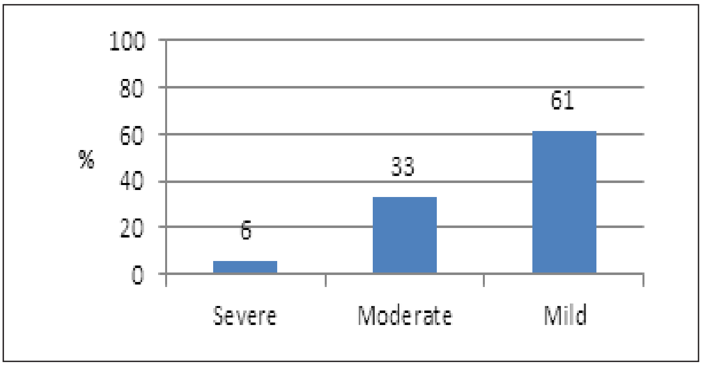


Figure 5: Anaemia category levels.

Anaemia was further classified as follows: 134 (61%) were mildly anaemic (Hb 10 – 10.9 g/dl), 72 (33%) moderately anaemic (Hb 7.0 – 9.9 g/dl) and 13 (6%) were severely anaemic (Hb < 7g/dl).

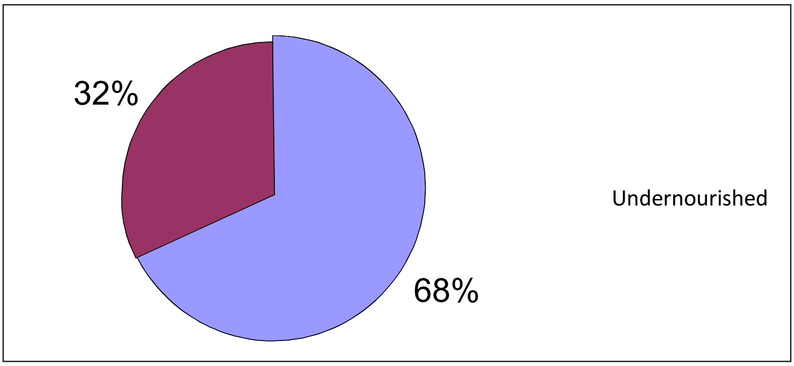


Figure 6: Nutritional status of the tea drinking expectant adolescents of North Rift Valley based on MUAC (cut-off 230 mm).

Approximately a third, 123 (32%) of the adolescents pregnant mothers studied were considered undernourished basing on MUAC cut-offs for pregnant adolescents at 230 mm (Sphere Minimum Standards). MUAMA was 35.5 $\pm$ 11.6 cm.

Table 3: Multivariate analysis of predictors of iron intake.

Variable	B	S.E.	Sig.		95.0% C.I. for OR	
				OR	Lower	Upper
Nutritional Education	0.501	0.253	0.048	1.650	1.005	2.708
Fruit consumption	0.401	0.230	0.081	1.493	0.952	2.342
Constant	-0.072	0.234	0.758	0.931		

Controlling for consumption of a fruit/vegetable with a meal and having received nutrition education during pregnancy was a significant predictor of inadequate intake of iron (P = 0.048). Those without education were almost two times more likely to have low intake of iron as compared to those who received nutrition education during pregnancy (OR: 95% CI: 1.65: 1.005-2.708).

DISCUSSION

Tea drinking and iron status

Despite tea's inhibitory effect on non-haem iron absorption, it does not necessarily mean that high tea consumption is associated with an unfavourable iron status at the population level. In an attempt to draw a conclusion about the effect of tea on iron status, a wide variety of studies with different designs, from different countries, and carried out in different age and gender groups, have been conducted. Results from these studies are conflicting; some have found a higher risk of anaemia amongst tea drinkers compared to non-tea drinkers, while others have shown no such association both in children and adults.

There are many factors that influence an individual's iron stores such as genetic factors, dietary components, and timing of tea consumption in relation to consumption of non-haem food source as well as iron stores themselves. All of these need to be taken into account when determining the strength of the association between tea consumption and iron status and as such could account for the conflicting results seen in the population studies. Some authors have also concluded that people could adapt to low iron intakes or low iron bioavailability over time and maintain good iron status. This needs to be explored in more detail. Furthermore, it is not clear whether tea drinking is a marker of other dietary practices which lead to poor iron status or whether tea has an independent detrimental effect on haemoglobin and ferritin levels. In addition, the relevance of the results from studies conducted in developed countries on tea drinking on iron status in Kenya needs to be addressed.

Some studies examining the role of tea drinking on iron status have concluded that tea consumption does not influence iron status in healthy individuals who are eating a well-balanced diet and who have adequate iron stores as determined by serum ferritin concentrations. It was only in populations of individuals with marginal iron status where there seems to be a negative association between tea consumption and iron status.

Behavioural and clinical characteristics

Only 90 (23.4%) had received nutrition education during pregnancy and this is in agreement with a study by Lenders *et al.* (2000) which showed that majority of adolescents with poor knowledge of appropriate nutrition and habits may not change during pregnancy. The participants who reported to have received de-worming treatment were only 55 (14.4%). Most (85%) had not received any de-worming treatment and, therefore, this number may have been associated with the prevalence of anaemia. A study in Bangladesh by Faruk (2000) showed that maternal infection is associated with poor birth outcomes.

The study findings were that those with a positive malaria test were 146 (47%) which was comparatively higher than study carried out in Tanzania whose prevalence of malaria amongst pregnant adolescent mothers was 41.3% (Wort *et al.,* 2006). This may be attributed to the fact that this study was carried out during the rainy season when malaria incidences are prone to be high.

Adequacy of nutrient intake

The nutrients selected for evaluation were folate, proteins, energy, vitamin C, vitamin B_{12}, calcium and iron. In a study conducted in Limpopo South Africa, estimating prevalence of dietary inadequacy based on 24 hr recall questionnaire showed higher percentages of inadequacy for iron, folate, vitamin C and vitamin B_{12} in comparison to this study that used FFQ (Bopape *et al.,* 2008).

The highest percentage of inadequacies were; vitamin C (83.3%), energy (74.2%), folate (65.1%), calcium (58.9%), protein (39.8%), vitamin B_{12} (38.5%) and iron (34.7%). Similar findings revealed mean intakes of folate and vitamin C falling below the recommended standards (Giddens *et al.*, 2000). A systematic review of seven studies, reported the mean nutrient intakes for pregnant adolescents falling below the DRI for energy, iron, folate, calcium nutrients which are recognized to be vital for foetal growth and development during pregnancy (Moran, 2007).

The mean nutrient intake in a study in China for pregnant women living in rural areas showed low intakes of protein and iron. Of the participants, 54% were at risk of inadequate intake of energy and folate (97%) and iron (64%) while in this study the population at risk of inadequate intake was folate (50.3%) and Iron (16%). This variation may be due to geographical differences.

Kamau-Mbuthia and Elmadfa (2007), in a study of pregnant women attending antenatal clinic in Nakuru, Kenya, also found inadequate nutrient intake for energy, total folic acid, calcium, iron and zinc. Adequate intake was found for protein, fat, carbohydrate, dietary fibre, vitamins A and C. Young pregnant women and those of low socio-economic status were at risk of inadequate intake of some of the nutrients.

Prevalence of anaemia in adolescent pregnancy

The study showed anaemia prevalence of 57% basing on WHO cut-off points (Hb < 11g/dL) which was higher than the WHO (2008) global average prevalence rate of 47.5% and 51.8% in India. This may be attributed to regional differences. However, anaemia prevalence was consistent with three studies in South Africa where Sserunjogi (2003) found prevalence of anaemia at 57%, Hoque *et al.* (2007) at 57.3%, and Bopape *et al.* (2008) reported similar anaemia prevalence as Sserunjogi at 57%.

African diet in Sub-Saharan Africa is mainly cereal based and although non-haem iron may be present in fairly large amounts, absorption is often low as a result of high phytate content. Van den Broek *et al.* (2000) conclude that this may then explain the existence of anaemia.

In a study in Tanzania, Candida *et al.* (2005) showed 5% of severe anaemia in 180 adolescents (15 – 19 years) and no significant differences were observed between rural and urban settings which is consistent with the current study that show 6% presenting with Hb < 7 g/dl as severe anaemia.

Severe anaemia is an important cause of maternal mortality among adolescents (Brabinn *et al.,* 2001). In this study, the prevalence of severe anaemia may be attributed to low-socioeconomic status and low level of education of the respondents to comprehend the importance of good nutrition especially during pregnancy and maternal infections as well. In Kenya, the prevalence of anaemia was rated by WHO (2008) at 55.1% which is slightly lower than the finding so the current study.

Nutritional status of the expectant adolescents

About a third of the respondents were considered to be under-nourished and over half with inability to access income (<Ksh 5,000). This may have contributed to their undernourished status where a study in Indonesia (Claude, 2007) also recorded that young pregnant mothers were found more vulnerable to malnutrition because of lack of economic power to access food.

The mean MUAMA for this study was 35.5 ± 11.6 cm, which was higher compared to a study in Bangladesh with a mean of 32.2 ± 4.2 cm (Rah *et al.*, 2008).The difference could account for regional anthropometric differences in terms of the body anthropometric measurement.

Factors affecting dietary iron intakes

From the study, 86 (66.7%) of the respondents who earned less than Ksh 1,000 had inadequate intake of iron implying that the lower the income the more the nutrient inadequacy. Studies carried out by Buvinic (1998) in Latin America showed that adolescent nutrient intake is associated with adverse socioeconomic conditions and poorer earning opportunities for the adolescent mother compared to adult mothers.

The girl's education level had a significant impact on dietary intake in that she is more exposed and may access a diversity of food. The same observations have been described in pregnant Finnish and Indian women (Erkkola *et al.*, 1998).

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The study found out that majority of the adolescent mothers were married at an early age (79.2%) with a mean 17.6 ± 1.3 years. Education level of half (50.8%) of the respondents was at primary level and this may be attributed to early pregnancy and possibly discontinuation of education. More than half (77.3%) of the respondents were earning less than Ksh 5,000 per month, indicative of low socio-economic status. The adolescents' inadequate nutrient intake included vitamin C, folate and protein at 72.1%, 50.3% and 44%, respectively. There were high consumptions of foods from the various food items with records of high nutrient inadequacies as well. Bioavailability of nutrients may explain for this disparity. The prevalence of anaemia was 57% and therefore classified as a severe public health concern. Almost a third of the expectant adolescents were undernourished. Nutrition education and fruit and vegetable consumption were found to be significant to dietary iron intake (P = .0.036 and P = 0.017, respectively). Lastly, controlling for consumption of fruit and vegetable, nutrition education was found to be a predictor factor to dietary iron intake and consumption of fruit and vegetable (a confounder).

Recommendations

Practical advice for tea drinking in relation to iron status is as follows. There is no evidence to suggest that tea drinking should be restricted in healthy individuals who are not at risk of iron deficiency and are consuming a well-balanced, mixed diet. People who have poor iron status should avoid drinking tea with meals and up to at least one hour after the meal. Any adverse effects that tea may have on iron absorption are then likely to be minimised. This restriction should apply to all people who are in the following at-risk age groups: children under 6 years of age, adolescent girls, women aged 18 – 49 years, and women aged 75 years and over, as well as those who are known to have poor iron status. Moderate tea drinking (3 – 4 cups) spread throughout the day is unlikely to have any adverse effect on iron status. The inhibitory effect of tea on iron absorption may be partially overcome by the simultaneous consumption of animal tissues and vitamin C. In summary, tea consumption will not result in iron deficiency for healthy individuals who are consuming a varied and balanced diet.

The absorption of iron from food is generally low and is influenced by a number of factors including the quantity of iron consumed, the chemical form (haem versus non-haem), interaction with other dietary factors and the individual's physiological condition (status of iron stores, period of growth, menstruation or pregnancy).

Haem iron present in good amounts in meat, offal and meat products is readily absorbed and is unaffected by tea drinking. Non-haem iron found in cereals, vegetables, dried fruit, legumes and nuts is less well absorbed and its absorption is influenced by a wide variety of dietary factors which include enhancers such as vitamin C (present in fruit and fruit juice) and animal tissue (meat), and inhibitors for instance phytate (bran) and tea (polyphenols).

Therefore, for those who have a poor iron status or are at high risk of iron deficiency it would be prudent to avoid drinking tea with meals. Otherwise moderate tea drinking (3 – 4 cups) spread throughout the day is unlikely to have any adverse effect on iron status. At community level, repackaging nutrition education as "youth-friendly" for the expectant adolescents through the primary health care programmes is recommended.

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