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Assessing Handling of Complementary Foods towards Prevention of Iron Losses among Infants in Keiyo South Subcounty, Kenya

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Abstract
The use of concepts such as Hazard Analysis Critical Control (HACCP) system is still problematic at household level hence the hygienic status of complementary foods cannot be assumed. Unhygienic complementary foods at the commencement of feeding are a major cause of diarrhea. Gastrointestinal disorders that result in inflammation of the small intestine may result in diarrhea, poor absorption of dietary iron, and iron depletion. A cross sectional study design was adopted in this survey. Data was collected from both the swabs from the hands of 136 mothers were as well as from interview schedules. The data was collected at Biretwo, Cheptebo and Sego health facilities and the lab work at University of Eldoret. Solutions were made in 10ml of distilled water, selenite broth and 10 ml of tetrathionate broth. All samples were collected in sterile containers and then transported immediately in an ice chest to the laboratory for analysis. Ten milliliters of each sample was homogenized in 90 ml sterile diluent using a stomacher for 30s, at a preset speed. Tenfold serial dilution was made with the same diluent and 0.1ml aliquot of each appropriate dilutions was spread-plated while 1ml was poured-plated in duplicates on various media for enumeration of isolates. Tetrathinate, selenite, salmonella-shigella agar, mackonkey and blood agar was used to isolate various microorganisms incubated at 30^{O}C for 48-72 hours. Phenotypic characterization was then conducted. Data was analyzed using Statistical Package for Social the Sciences (SPSS) computer software version 17, 2009. The results indicated that the highest number of mothers (76.4%) had their hands contaminated with *Salmonella*. None of the mothers had *Clostridium, Listeria, Brucella* or *Campylobacter* species. This was against the prevelance of iron deficiency anemia of 53.5% among infants aged six to nine months. Other bacterial species that were found were *Staphylococcus, Streptococcus and Klebsiella* spp. Hygienic handwashing was significant factor and also predicted iron deficiency anemia hygiene hand washing (t=-2.000; p=0.047). Hygiene programs that focus on proper ways of preparing and handling complementary foods that minimize risks of bacterial contamination should be taught to mothers.
Keywords: Food, Handling, Complementary, Infants

Introduction

Complementary feeding is the process where an infant gradually becomes accustomed to an adult diet. During this time supplementary foods other than milk are introduced to meet the nutritional demands of the infant. Unfortunately, there is risk of the food not being nutritionally sufficient and contamination of pathogenic microorganisms including those that cause diarrhea. Malnutrition and infection are intertwined in the malnutrition infection cycle. Hence hygienic status in handling complementary foods cannot be assumed. Unhygienic complementary foods are a major cause of diarrhoea. Likewise, gastrointestinal disorders that result in inflammation of the small intestine may result in diarrhoea, poor absorption of dietary iron, and iron depletion (Annibale *et al.*, 2001).

Environment and sanitation included factors like hand washing using soap, water treatment, storage of feeding utensils and foods, toilet possession and appropriate waste disposal facilities. Immediate causes include illness in the past two weeks and inadequate intake of iron-rich foods. This will lead to iron deficiency anemia and if timely interventions are not carried out might lead to death.

Healthy full term infants are born with a supply of iron that lasts for 4 to 6 months. After the fourth month of exclusive breastfeeding, infants are at risk of iron deficiency. This is also when complementary foods are being introduced (American Society of Pediatrics, 2008).

However, a careful analysis of food borne diseases has shown that two main errors in food preparation increase risk, because they permit the survival and/or growth of pathogens to disease-causing levels. These errors are the preparation of food several hours before consumption, combined with its storage at temperatures that favour growth of pathogenic bacteria and in some cases, the formation of toxins; and insufficient cooking or reheating of food to reduce or eliminate pathogens (Motarjeni, 1993).

Many pathogens that cause diarrhoea in humans, including *V. cholerae, Shigella spp., Campylobacter,*

E. coli, Poliovirus, Entamoeba histolytica, can be recovered from flies and many pathogens can survive on the integument of flies for a period of 10 days. Pathogens can also be carried in the food by flies and deposited on food when they regurgitate or deposit excreta. Thus flies are a potent source of contamination in foods and water (Motarjeni, 1993).

In a study on bacterial populations in complementary foods and drinking water in households with children aged 10-15 months in Zanzibar, it was concluded that the high contamination of complementary foods occurred as a result of poor hygiene of those who prepare food, household equipment, and the environment where the preparation of food takes place (Kung'u, 2010). Therefore, general high standards of hygiene should thus be ensured to prevent contamination from occurring.

The use of concepts such as Hazard Analysis Critical Control (HACCP) system is still problematic at household level hence the hygienic status of complementary foods cannot be assumed. Unhygienic complementary foods are a major cause of diarrhea. Gastrointestinal disorders that result in inflammation of the small intestine may result in diarrhea, poor absorption of dietary iron, and iron depletion. This research assessed the hygienic practices of mothers during complementary feeding to reduce iron losses among infants aged six to nine months in Keiyo South Sub County,Kenya.

2. Methodology

2.1 Study area

This study was carried out in Keiyo South Sub County. It borders Eldoret East district to the west, Baringo central to the east, Eldama Ravine to the South and Keiyo North to the North. The district is divided into three main agro-ecological zones which run parallel to each other in a North- South direction; highland, the Elgeyo Escarpment and Kerio Valley basin.It was carried out at three health facilities located in the valley namely Biretwo, Cheptebo and Sego. The lab work was conducted at University of Eldoret.

2.2 Study population

Keiyo South Sub County has a population of 109,160 with 33,583 households. It has a population of 3464 children under one year of age. The number of households with children under one year is about is about 11,168 (KSSP, 2010).

=Z 2 pq/d2 (fishers et al,1984)

Where n - the desired sample size when the population is more than 10,000

Z-The standard normal deviation at the required confidence level

p- The proportion in the target population estimated to have characteristics being measured.

q=1-p

d= level of statistical significance set.

N= (1.962) (0.03) (1-0.03) divided by (0.05)2

= 136 infants .

2.3 Study design

The study design adapted the Cross Sectional design. Determination of the level of bacteriological contamination of complementary foods during feeding was achieved by collecting swabs from hands of mothers who brought infants to the clinics at the respective health facilities.

2.4 Sampling procedure

Simple random sampling was used to select three health facilities from the health facilities, within Keiyo South Sub County, which were immunizing. The names of the health facilities within Keiyo South Sub County were written on a piece of paper, folded and mixed up. The health facilities in which the study was carried out were selected. Systematic random sampling was then used to select infants who had met the inclusion criteria, till the sample size was attained. All the names of 6 to 9 months old were obtained from the hospital registers and their respective next visit dates. Simple random sampling to select the starting point, then every nth child from the register was selected. Nth (5) was selected by dividing the sample size by the total number of children in the registers. From every facility 45 infants were then selected apart from Cheptebo were 46 infants were selected. This was done until the sample size of 136 was achieved. The bacteriological contamination tests were carried in all 136 samples collected, from the hands of mothers.

2.5 Data collection

2.5.1 Sample collection

Swabs from hands of 136 were collected from the participants of the survey. Solutions were made in 10ml of distilled water, selenite broth and 10 ml of tetrathionate broth. All samples were collected in sterile containers and then transported immediately in an ice chest to the laboratory for analysis.

2.5.2 Enumeration and isolation of Microorganisms

Ten milliliters of each sample was homogenized in 90 ml sterile diluent [1% peptone (Difco,Detroit,Michigan,USA),0.85% Nacl,pH 7.0] using a stomacher (stomacher-Bagmixer, Buch and Holm) for 30s, at a preset speed. Tenfold serial dilutions (10-1 10 -9) was made with the same diluent and 0.1ml aliquot of each appropriate dilutions was spread-plated while 1ml was poured-plated in duplicates on various media for enumeration of isolates. Tetrathinate, selenite, salmonella-shigella agar, mackonkey and blood agar was used to isolate various microrganisms (Oxoid Ltd, Basingstoke, Hampshire, England) incubated at 30 degrees celcius for 48-72 hours (Akabanda et al, 2010).

2.5.3 Phenotypic characterization

Colonies on individual culture plates will be examined for shape, size, elevation, surface characteristics, and edges. The hanging technique was used to observe cell motility and arrangements while Grams stain was used for cell shape.

The triple Sugar Iron (TSI) (Oxoid Ltd, Basingstoke, Hampshire, England) Agar test was used to determine sugar formation, CO2 and H2 S production (Harrigan, 1998).Urea hydrolysis will be tested using Christensen's urea agar according to Christensen (1946). The IMViC (Indole, catalse, oxidase, coagulase, Methyl Red, Voges- Proskauer and Citrate) test was done to determine the various end products using standardized procedures.

2.5.4 Data collection of the survey

A pilot study was conducted in one health facility, using a small sample of subjects and swabs to ensure validity and reliability of the instruments. Then the actual data collection commenced. Primary data was collected by use of an interviewer administered questionnaire. This ensured accuracy, as interpretation of questions and translation to Kiswahili and vernacular language was done. Blood samples were collected by finger prick to measure Hb using the Hemo-Control Photochrometer. First, the hand and finger of the subject was rubbed to stimulate blood flow, after which the fingertip was cleaned with an alcohol swab. The fingertip was then dried to the air before being pricked with a sterile lancet. The first drop of blood that appeared was wiped away using a cotton swab; the second drop was then be collected into the Hemo-Control microcuvette. The finger was not squeezed to obtaining blood. When the microcuvette was full, any spilled blood was carefully wiped away using a cotton swab from its edges before inserting it into the HemoCue device. All the used up items were safely disposed into a safety box awaiting final disposal.

2.6 Data management and analysis

Information on the questionnaires was edited for any wrong entries to reduce errors and omissions. Coding and ordering, that is assigning numerical or other symbols to answers so that responses were put into a limited number of categories or classes. Classification of attributes was also done.

The dependent variable was hemoglobin status. The independent variables were sanitation factors like water source, storage of food, hand washing and toilet possession

The data was entered in SPSS version 17, 2009 and analyzed for means, frequencies and cross tabulations. Univariate analysis was carried out to determine proportion of infants with low haemoglobin. Bivariate analysis by pearsons chi-square to show any relationships between sanitation and iron status.

2.7 Ethical Considerations

Approval to carry out this study was granted by the Institute of Research and Ethics Committee (IREC), Moi University, the Keiyo South Subcounty Provincial administration and the DMOH Keiyo South Sub County. Interpretation of the study in English and translation to Kiswahili or even vernacular language was done. Consent to participate was sought from the participants by signing a consent form. Code numbers were used to identify candidates to maintain confidentiality. Swabs were also allocated codes. The research did not pose any risk to anybody.

3.0 Results

3.1 Prevalence of Iron Deficiency Anemia (IDA)

Table 1: Prevalence of anemia in infants

Classification of IDA	Values (g/dl)	Frequencies	Percentages
Normal	Over 11	63	46.3
Mild	10-10.9	39	28.7
Moderate	7-9.9	32	23.5
Severe	Below 7	2	1.5

Infants who had normal Hb levels were 46.3%, whereas those who had mild and moderate anemia were 28.7% and 23.5% respectively. In general anemia cases (Hb 10-10.9, 7-9.9 and below 7) were 73, making the prevalence of those who were positively screened for iron deficiency to be 53.7%.The mean hemoglobin values were 11.6 g/dl± 1.71.

3.2 Water for food preparation

Results from this study indicate that sanitation was viewed from these dimensions: food, personal and household levels in Table 2. Results further show that 72.8 % of all the mothers fetched water for food preparation from taps, 0.7% from springs and 6.6% had access to well water. Results also showed that almost half (47.1%) of the mothers treated their water by boiling (39%). Mothers who practiced hygiene hand washing were 99.3% (Table 2).

Table 2: Environmental Sanitation

Variable	Frequency	Percentage
Water source		
Wells	9	6.6
Rivers/Lakes	27	19.9
Springs	1	0.7
Tap water	99	72.8
Water Treatment		
Yes	64	47.1
No	72	52.9
Methods used to treat water		
Boiling	53	39
	11	8.1
Not treating	72	52.9
Hand washing using soap		
Yes	135	99.3
No	1	0.7

3.3 Storage of Infants food

Majority (91.2%) of the mothers had no cold storage facilities and covered left over foods. More than half (55.9%) of the mothers stored utensils used for feeding infants in a raised unenclosed place (Table 3).

Table 3: Storage of infant's food

Storage of cooked foods		
Refrigerate	1	0.7
In the open covered	124	91.2
No cold storage uncovered	4	2.9
No left overs	7	5.1
Storage of utensils		
Cupboard	58	42.6
Raised unenclosed place	76	55.9
Low surface not enclosed	2	1.5
Others	0	0

3.4 Relationship between sanitation and IDA

Results from this study shows that of those infants who had anemia , water source did not have a significant relationship (χ^2 =4.207; df=3; p=0.240) with IDA. Generally, most sanitation factors had no significant

relationship with IDA (Table 4).

Table 4 Relationship between sanitation factors and IDA

Variable	χ^2	df	p
Water source	**4.207**	**3**	**0.240**
Wells			
Rivers			
Springs			
Tap			
Water treatment	**2.438**	**1**	**0.118**
Yes			
No			
Toilet possession	**0.463**	**1**	**0.496**
Yes			
No			
Storage of foods	**3.689**	**2**	**0.158**
Refrigerated			
Not refrigerated but covered			
Not, not covered			

p < 0.05 significant

3.5 Sanitation factors having a significant relationship with IDA

Table 5 shows that hand washing using soap had the strongest statistical relationship with IDA (χ^2= 4.796; df= 1; p =0.029.)

Table 5: Sanitation factors with a significant relationship with IDA status

Sanitation Factor	χ^2	df	p
Hand washing	**4.796**	**1**	**0.029***
Yes			
No			
Waste disposal	**9.858**	**1**	**0.002***
Yes			
No			
Storage of utensils	**9.219**	**3**	**0.027***
Cupboard			
Raised			
Near floor			
Others			

*** Significant (p=< 0.05)**

3.6 Predictors of Iron deficiency anemia

The hygiene factors which were predictors of IDA in this study were: proper waste disposal (t =3.005; p =0.03), hygiene hand washing (t=-2.000; p=0.047). Only waste disposal was a positive predictor .

3.7 Bacteriological contamination of hands

From bacteriological analysis of swabs from the mother's hands, the following data was derived:

Table 6: Bacteriological contamination

Type of bacteria	Frequency	Percentage
Clostridium	0	0
Listeria	0	0
Brucella	0	0
Camplobacter	0	0
Streptoccoccus	3	2.2
Staphyloccus	9	6.6
Eschericia	18	13.2
Pseudomonas	1	0.8
Salmonella	104	76.4
Klebsiella	1	0.8

The highest number of mothers (76.4%) had their hands contaminated with salmonella. None of the mothers had *clostridium, listeria, brucella* or *campylobacter* species. Other species which were found were *staphloccus, streptococcus and klebsiella* spp (Table 6).

4 Discussion

Foods which are nutritious should also be wholesome, and safe to prevent infection. Food should therefore be prepared hygienically and safely. Water sources which were used from the study were wells, rivers/lakes. Over half (52.9%) of them did not treat the water. This poses a risk if this water is given to infants. It increases the risk of diarrhoea, and consequently major iron losses. Most (99.3%) mothers did wash hands during food handling using soap. This practice should be encouraged because it reduces incidences of diarrhoea. Most of the foods leftover were covered but not refrigerated. This allowed for food deterioration and a high risk of bacteriological contamination. Most mothers did not store food in refrigerators, yet others did not even cover the foods. Other mothers stored food in no cold storage facilities and did not cover the foods (2.9%). This possibly raised the risk of contamination. These findings are consistent with results from studies in Zambia where mothers who used soap reduced the incidence of food borne infections by 30%. This conforms with studies that early complementary feeds has been associated with inadequate prepared or poorly stored foods (Oni, 1996). For instance in Nigeria, alternative feeds have resulted in higher instances of diarrhoea while in Guinea- Bissau the incidence of diarrhoea is higher in partially breastfed children (Molbak, 1994). Majority had toilets and compost pits. This aids to prevent wastes contaminating foods via flies.

From this study, 76.3% of mothers had *salmonella* spp on their hands. Surfaces such as tables, taps, door handles can be contaminated and pathogens transmitted to mother's hands. This could result in mother's transmitting this to infants, during feeding if proper hygiene practices such as hand washing are not employed.

Contaminated weaning foods may lead to food borne diseases that can cause severe and long-lasting damage to health, including acute, watery and bloody diarrhoea (leading to severe dehydration or ulceration), meningitis, as well as chronic diseases affecting the renal, articular, cardiovascular, respiratory, and immune systems (Archer, 1984; Archer, 1988; Davies, 1984). One study has reported that about 2% of adults infected with an arthritogenic strain of *Salmonella spp.* may consequently suffer from reactive arthritis (Archer, 1988). A proportion of patients especially children, who are affected by enterohaemorrhagic *E. coli* can develop haemolytic uraemic syndrome (HUS), which is characterized by acute renal failure (Gross, 1990; Taylor, 1990). However, the most serious implications of food borne infections are their effects on nutritional status.

A food borne disease can lead to a reduction in food intake owing to anorexia. In addition, in certain cultures parents may also contribute to a reduction in their child's food intake by withholding or substituting certain foods during illness (Ekanem, 1990). A poor food intake, aggravated by loss of nutrients from vomiting, diarrhoea, malabsorption and fever over an extended period, leads to nutritional deficiencies with serious consequences for the growth and immune system of the infants and children. Thus, an infant whose resistance is suppressed becomes vulnerable to other diseases (including respiratory infections) and is subsequently caught in a vicious cycle of malnutrition and infection

The sources of contamination are diverse and include night soil, polluted water, flies, animals and pets, unclean utensils and pots, dust and dirt. Raw foods are frequently a source of contaminants because some might naturally harbour pathogens or come from infected animals. Food handlers may be the source of contamination either as carriers of pathogens or through poor hygienic practices. However, a careful analysis of food borne diseases has shown that two main errors in food preparation increase risk, because they permit the survival and/or growth of pathogens to disease-causing levels. These errors are the preparation of food several hours before consumption, combined with its storage at temperatures that favour growth of pathogenic bacteria and in some cases, the formation of toxins; and insufficient cooking or reheating of food to reduce or eliminate pathogens.

Many pathogens that cause diarrhoea in humans, including *V. cholerae, Shigella spp., Campylobacter, E. coli, Poliovirus, Entamoeba histolytica*, can be recovered from flies and many pathogens can survive on the integument of flies for a period of 10 days. Pathogens can also be carried in the food by flies and deposited on food when they regurgitate or deposit excreta. Thus flies are a potent source of contamination in foods and water (Motarjeni, 1993).

Khing-Maung (1994) showed that flies could transmit fecal organisms from latrines to the food contributing to the increased risk of persistent diarrhoea in Burmese children. In a study carried out in Zambia, it was shown that personal hygiene practices of mothers were significantly related to high levels of bacterial contamination of drinking water and weaning foods (Imong, 1989).

Behaviors such as the child defecating on the floor, water or rags were being used to cleanse the child after defecating and mother not washing the child's hand or her hand with soap and water after defecation, or cleansing the child's perineum were directly related to higher risks of persistent diarrhea (Khing-Maung, 1994). The potential risk factors leading to diarrhea in young children were feeding on leftover foods, not washing

hands prior to cooking and feeding, consumption of the spilled food from the floor, use of dirty cloth for wiping hands, utensils and the use of non sterilized feeding bottles for the children.

Pathogenic agents can therefore contaminate food in many different ways, at various stages in the food chain and during the preparation of food. Under the non favourable conditions that exist in many countries especially in slum and rural areas, the risk of contamination of weaning foods during their preparation is even greater. However in terms of the causes of food borne diseases, the most critical factors are as follows: the preparation of food several hours prior to consumption, combined with inadequate storage conditions and insufficient cooking or reheating of stored food. In a study on bacterial populations in complementary foods and drinking water in households with children aged 10-15 months in Zanzibar, it was concluded that the high contamination of complementary foods occurred as a result of poor hygiene of those who prepare food, household equipment, and the environment where the preparation of food takes place (Kung'u, 2010). Therefore, general high standards of hygiene should thus be ensured to prevent contamination from occurring

Recent studies have confirmed a high prevalence of ID among certain groups, even in developed countries (Marxx, 1997). The prevalence of IDA in 2 –year-olds in the United Kingdom was 12%, and significantly higher in Asian Children (20-29%). In Africa, the general prevalence is at 39%. According to the survey conducted by the government and UNICEF (1999) in Kenya, 89% of the children under 6 years were anemic. Prevalence was as high as 91% in the Lake basin region (GOK and UNICEF, 2002).

The overall prevalence of anemia was 9.4% in a study conducted among European children (Male *et al, 2003*). This is much lower than findings from this study where the prevalence was 53.7%. The differences could be attributed to geographical conditions, age categorization and underlying causes of the disease. Anemia is the advanced stage of iron depletion, with the first stage being reduction of iron stores, iron depletion without anemia, then anemia. It is possible that the prevalence of iron deficiency could be higher than the 53.7% of anemia if further biochemical tests were conducted.

5 Conclusions and Recommendations

It was concluded that hand washing and waste disposal were the major hygiene factors that contributed the iron losses of which the prevelance of IDA was relatively high. It was recommended that health education be given to the mothers regarding hygienic food preparation to reduce food borne illnesses.

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