INFLUENCE OF INTRA-HOUSEHOLD FOOD DISTRIBUTION PATTERN ON POTENTIAL IRON INTAKE FROM IRON-FORTIFIED FLOUR BY SCHOOL AGE CHILDREN IN KISUMU NORTH DISTRICT, KENYA

BY

NYAMBANE ALBERT NYAGETIRIA

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MASENO UNIVERSITY

DECLARATION

I declare that this work is original and has not been submitted to any other university for examination. Where information has been derived from other sources, I confirm that this has been indicated in this thesis.

CANDIDATE

ALBERT NYAGETIRIA NYAMBANE

PG/MSC/0115/2011

SIGN___________________________ **DATE**________________

This thesis has been submitted for examination with our approval as the university proposed supervisors.

DR. PAULINE ANDANG'O

Maseno University
School of Public Health and Community Development
Department of Nutrition and Health

SIGN___________________________ **DATE**___________________

DR. DAVID OMONDI OKEYO

Maseno University
School of Public Health and Community Development
Department of Nutrition and Health

SIGN___________________________ **DATE**___________________

DEDICATION

With deep appreciation and gratitude, I dedicate this work to my mother and siblings for their support throughout the research period.

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ABSTRACT

Iron deficiency, mainly from iron deficient diets, impedes cognitive, psychomotor and physical development, especially of school age children. Flour fortification with iron, an effective intervention for increasing iron intake, is influenced by the amount of fortified food consumed. Intra-household food distribution (IHFD) patterns may influence how much food a child gets, hence amount of iron from fortified flour. However, information on such influence on iron intake of school age children, a group with high iron requirements that must be met by food intake, is lacking. The purpose of this study was to determine the influence of IHFD pattern on potential iron intake from iron-fortified flour by school age children (3 to 8 years). IHFD patterns were identified; the amount of iron a child could consume, assessed; and the association between the two determined in a study conducted in Kanyawegi Sub-location, Kisumu North District where piloting of small-scale flour fortification with iron was underway. The study was guided by a descriptive framework consisting of six IHFD patterns: Needs Rule, Resource Control Model, Bargaining Model, Cultural Rule, Functional Model and Contributions Rule. Using sequential exploratory mixed methods approach, information on types of IHFD patterns in the study area was elicited from focus group discussions (FGDs) among Community Health Volunteers and caregivers. Existing patterns were identified and subsequently used to develop a questionnaire. The questionnaire was administered to caregivers in 296 households with a school age child, selected by simple random sampling from a census-generated list. Households (n=154) drawn from those with identifiable IHFD patterns (n=264) were grouped into those that favour (n=77) and those that do not favour (n=77) the child. Flour products intakes were assessed in index children from the 154 households using 24-hour dietary recall. World Health Organization (WHO) and Kenya recommended fortification levels of 20 and 15 mg iron/kg flour, respectively, were used to calculate potential amount of iron each child could obtain through flour fortification, based on amount of flour consumed from flour based food products. Most households (75%) practiced IHFD patterns that do not favour the child, predominantly Cultural Rule and Functional Model. Median iron intakes (IQR) of children with IHFD patterns that favour the child was 6.4 (4.5, 9.0) mg and 4.8 (3.2, 6.7) mg iron; and 2.9 (1.7, 3.9) mg and 2.2 (1.4, 2.9) mg for those with patterns that do not favour the child, for WHO and Kenya fortification levels, respectively. Adjusted geometric mean difference in iron intake between the groups generated using multiple linear regression, was -55.5 (-61.9, -48.2) % (p=0.000). Although both WHO and Kenya levels support adequate iron intakes of 3-8 year old children in general; at Kenya fortification levels children may not meet their requirements where IHFD patterns that do not favour the child are practiced. Such children would obtain less than half as much iron through flour fortification, as children from households practicing IHFD patterns that favour the child. Therefore, IHFD pattern influences potential iron intake with lower benefits where patterns not favouring children are practiced. Such children may not meet their requirements therefore need additional targeted iron interventions.

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ABBREVIATIONS AND ACRONYMS

ACC	Administrative Committee on Co-ordination
BM	Bargaining Model
CBR	Contributions Rule
CBS	Central Bureau of Statistics
CDC	Centers for Disease Control and Prevention
CR	Cultural Rule
CHEWs	Community Health Extension Workers
CHVs	Community Health Volunteers
EU	European Union
FAO	Food and Agriculture Organization
FCND	Food Consumption and Nutrition Division
FFI	Food Fortification Initiative
FM	Functional Model
FGDs	Focus Group Discussions
FPAN	Food Policy and Applied Nutrition
GAIN	Global Alliance for Improved Nutrition
HiNi	High Impact Nutrition Interventions
HHs	Households
ICSU	International Council for Science
IDA	Iron Deficiency Anaemia
IHFD	Intra-household Food Distribution
IOM	Institute of Medicine
IFPRI	International Food Policy Research Institute
IQR	Interquartile Range
INSTAPA	Improving Nutrition through Staple Foods in Africa

JECFA	Joint Food and Agriculture Organization and World Health Organization Expert Committee on Food Additives
KNBS	Kenya National Bureau of Statistics
MI	Micronutrient Initiative
MP	Multiple Patterns
NaFeEDTA	Sodium iron edetic acid or Sodiun iron ethylenediaminetetraacetate
NAP	Nutrition Action Plan
NR	Needs Rule
PAHO	Pan American Health Organization
PIMAL	Pre-natal Iron and Malaria
SCF	Scientific Committee for Food
SDGs	Sustainable Development Goals
SCN	Sub-Committee on Nutrition
RDA	Recommended Dietary Allowance
RC	Resource Control Model
SCN	Standing Committee on Nutrition
SSF	Small Scale Fortification
SPSS	Statistical Package for Social Sciences
SUSTAIN	Sharing United States Technology to Aid Improvement of Nutrition
SUN	Scaling up Nutrition (Movement)
UN	United Nations
UNICEF	United Nations Children’s Fund
U.S.	United States
WHO	World Health Organization
WP5	Work Package 5

DEFINITION OF TERMS

Caregiver*:* Any person either father, mother, guardian, house help or any person that is responsible for taking care of the school age child from 3 to 8 years for example in providing food.

Flour consumption: Intake of food item made from flour that could be fortified with iron.

Household*:* A group of individuals who reside together, pool all or most of their income and eat from the same pot.

Iron-fortified flour*:* Fortifiable flour that could be enriched with sodium iron edetic acid (NaFeEDTA).

OPERATIONAL DEFINITION OF TERMS

***School age child*:** Any child, boy or girl aged between 3 to 8 years.

***Intra-household food distribution pattern*:** Flow of food to each individual in the household, measured in this study by indicators derived from needs rule, resource control model, bargaining model, cultural rule, functional model and contributions rule.

***Food distribution patterns that favour the child*:** Intra-household food distribution patterns which give preference to a child. In this study: needs rule, resource control model and bargaining model

***Food distribution patterns that do not favour the child*:** Intra-household food distribution patterns that give preference to members of the household other than the child. In this study: cultural rule, functional model and contributions rule

***Potential iron intake from fortifiable flour*:** Amount of individual's daily iron consumption from flour were it to be fortified at recommended fortification levels, estimated from a 24-hour dietary recall.

***Food distribution pattern group*:** A group of food distribution patterns that either favor or do not favor the child with regard to food intake. Needs rule, bargaining model and resource control model fall in the group that favor the child. Cultural rule, contributions rule and functional model fall in the group that does not favor the child in food intake.

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CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Iron deficiency is a serious, most common and widespread micronutrient deficiency in school age children (Stoltzfus, 2007; WHO, 2011) and may be caused by inadequate diet predominantly composed of high-phytate staple foods that make iron absorption difficult; poor dietary iron content (Al-Mekhlafi., *et al*., 2008) alongside increased requirements (United Nations World Population Prospects, 2014); and infections such as malaria (Osazuwa, 2010). It has been described as the single most prevalent nutrient deficiency worldwide associated with considerable morbidity across the life cycle and the second leading nutritional cause of disability (McLean *et al*., 2009). Iron deficiency compromises school age children's survival, growth, immunity, cognitive development, academic achievement and motor development (Cardoso *et al*., 2012; Manning, 2012; Wisantwisut, 2011; Al-Mekhlafi, 2011). In America, the Caribbean has an anaemia prevalence of 39% and Northern Europe has the lowest prevalence of 2% while Western Europe and North America have a prevalence of around 5% (KNBS and ICF Macro, 2010). Early statistics showed that anemia prevalence in young children was high, at 47.4% (Benoist *et al*., 2008) where Asia had the highest prevalence in school age children at 58.4% and Africa coming second at 49% (ACC/SCN, 1998).

The World Health Organization (WHO) has estimated that more than 2 billion people worldwide suffer from anemia with 50 % of all anemia cases being attributed to iron deficiency (WHO, 2011). In a recent study by Amare *et al*., (2014), anaemia prevalence in small children especially in most developing countries was 46%; indicating that iron deficiency anaemia is still high, if half of the anaemia prevalence is estimated to be due to iron deficiency. Evidence suggesting decrease in the effects of iron deficiency anaemia was still limited especially in developing countries including those in Africa by the year 2012 (Black *et al*., 2013). This deficiency is still highly prevalent in many parts of the world (Ngesa *et al.*, 2014) and especially among young children (Ebtesam *et al*., 2014). A study of six African countries: Mali, Tanzania, Mozambique, Ghana, Malawi and Kenya found that 40%-60% of school aged children suffered anaemia, suggesting a potential prevalence of 20-30% of iron deficiency anaemia. In Kenya, the burden of iron deficiency anemia is of public health significance among young children and has been found in school aged children especially in rural areas (UNICEF, 2010; KNBS and ICF Macro, 2010). Pullan *et al*., (2013) note that 40% of school age children in Kenya are anaemic; indicating persistence in the problem. This is because prevalence of iron deficiency anaemia if estimated to be about 50% of anaemia would be about 20%. However, with the additional iron deficiency without anaemia which is not accounted for, the total iron deficiency is likely to be more than 20%.

The rationale, economic costs and benefits of intervention strategies to control micronutrient deficiencies such as iron have been recognized hence positioning them on the global agenda (Bhutta, 2007; Horton *et al*., 2009) in the last decade. These strategies include iron supplementation and food-based approaches such as dietary diversity, biofortification and food fortification of appropriate vehicles. In addition to the food based strategies, helminth control is vital in the improvement of iron status (Gulani *et al*., 2007). Because countries are increasingly recognizing the need to combat iron deficiency which is a public health problem, they are implementing interventions to reduce the deficiency; particularly in one of the groups such as school age children who are most susceptible to its negative health effects. Poor compliance and cultural restrictions are likely to lower effectiveness of food supplementation in reducing iron deficiency (Suchdev *et al*., 2010) dietary diversity requires behaviour change and takes longer than any of the other approaches, to implement; and achieving efficacy in biofortification of high phytate (a natural substance found in all plant seeds, nuts, legumes and grains and impairs absorption of iron) foods is not easy (Petry *et al*., 2012). Food fortification, on the other hand, is considered a viable immediate option because it is efficacious and does not require active participation of the beneficiaries.

Food fortification aims at increasing iron intake through the addition of suitable iron fortificants to commonly consumed processed foods. Fortification is considered to be cost-effective and a valuable population-based strategy to deliver micronutrients including iron to particular at-risk groups including school age children (Zimmerman *et al*., 2004; Moretti *et al*., 2006). Effective fortification can also be achieved with little or no effect on the organoleptic properties of the food due to the very small amounts of the added micronutrients (Chen *et al*., 2005). Food fortification has the advantage that it can often be accomplished within the context of an indigenous diet and requires no change to the consumer's dietary behaviour and food habits.

In the developing countries, where there is the greatest need for micronutrient fortification, vitamins and minerals can be added to the foods most regularly consumed by a significant proportion of the population at risk. In many cases this is likely to be the staple cereal such as maize flour (Van *et al*., 2005; Chen *et al*., 2005; Micronutrient Initiative, 2010). This is because the vehicles normally fortified such as flours are those consumed by general populations and vulnerable target groups and can improve iron status relatively rapidly. In addition, fortification can combine many micronutrients in a single food vehicle and this may lower the risk of the multiple micronutrient deficiencies that can result from seasonal deficits in the food supply or a poor quality diet; hence, important in growing children who need a sustained supply of micronutrients for growth and development (FAO/WHO, 2002). Food fortification, especially when used to fortify high phytate foods, presents a valuable population-based strategy that could aid the fight against iron deficiency particularly in high risk groups such as small children.

Having recognized the value attached to food fortification with iron in the prevention of iron deficiency, national and international efforts to establish fortification programs have been initiated. In 2008, seventy-seven countries were routinely adding iron to wheat flour (FF1, 2008a), as compared to only two countries in 1990. Between 1990 and 2008, mass fortification of maize flour with iron occurred only in three African countries: Uganda, South Africa and Zambia (FF1, 2008b), but several countries are now developing national iron fortification programs. Currently, 82 countries and Punjab province of Pakistan have legislated mandatory flour fortification with critical micronutrients such as iron and folic acid; and because of both mandatory and voluntary efforts, about 31% of the World's industrially milled flour has undergone fortification with some iron or folic acid (FFI, 2015). This implies that countries, even in Africa, are now increasingly recognizing the role of iron fortification in reducing iron deficiency in the population. The Kenya government has legislated fortification of centrally processed maize flour with iron and other micronutrients (Ministry of Health, 2013). The WHO recommended an iron fortification level of 20 mg/kg flour (JECFA, 2000); which countries were advised to tailor to their specific needs based on available data. Kenya's recommended fortification level is 5-15 mg/kg flour (Ministry of Health, 2013). This legislation provides an avenue for even vulnerable groups to access iron even where diets may be deficient in iron.

Access to centrally processed flour may however be limited in developing countries especially in rural areas, whose population often rely on own-grown or locally produced food and are at the greatest risk of micronutrient deficiency including iron (Mildon *et al*., 2015). Several countries are now in the process of developing strategies for fortification of flour at small and medium enterprise level; although there are challenges related to quality control, to ensure that fortification protocols are adhered to for safety and effectiveness; and ensuring sustainable mechanisms for premix supply and logistics (Fiedler *et al*., 2013). Technically, iron was generally considered the most challenging micronutrient to add to foods (de Benoist, Davy, and Hurrell, 2006). However, the technology for fortifying flours with iron even if they are high in phytate contents, were made available (SUSTAIN, 2001; PAHO/CDC/MOD/Unicef/INTA, 2003; Micronutrient Initiative, 2006). Technologies for Small-scale Fortification (SSF) of flour with iron have been developed in pilot studies carried out in Malawi, Zimbabwe and Nepal (Philar, and Johnson, 2005). Small scale flour fortification strategy would increase the additional iron that could help individuals who do not have access to centrally processed flours to have access to iron through flour fortification.

School age children are particularly vulnerable to iron deficiency given that they have high iron requirements because of rapid growth with accompanying expansion of blood volume and muscle mass; increasing iron needs, making it difficult to consume enough iron (Herbert, 1992). They are likely to have low dietary intakes of bioavailable iron where commonly consumed foods are heavily based on unrefined cereal grains and legume seeds that naturally contain substances that impair intestinal absorption of iron (Dabone *et al*., 2011). Additionally, they are also easily infested with helminthes such as hookworms, *Trichuris trichura* and schistosomal worms that may reduce their iron stores thus increasing chances of iron deficiency (WHO, 2001; Ezeamama *et al*., 2008). Targeting school age children as one of the groups most in need is in line with the United Nation's Sustainable Development Goals (SDGs) 1, 2, 3, 4 and 12: end poverty in all its forms; end hunger; achieve food security and improved nutrition and promote sustainable agriculture; ensure healthy lives and promote well-being for all at all ages and ensure inclusive and equitable quality education; promote life-long learning opportunities for all and ensure sustainable consumption and production patterns respectively (ICSU, 2015): In addition, the poor iron intake of children at this stage is more likely to be due to environmental factors including diet and infections (Al-Mekhlafi., *et al*., 2008) than to normal physiological factors and therefore the need to assess their potential iron intake from fortifiable flour products. Additionally, school age children are old enough to consume sufficient amounts of fortifiable flour based product, but not yet at the stage of puberty with its influence on iron intake. When large amounts of the fortifiable flour product are consumed then the benefit of iron fortification of flours could be realized.

Thus, the amount of food that a child will be able to consume and the nutrient quality it will deliver, are key in determining whether or not they will have access to adequate amounts of nutrients such as iron.

The effectiveness of fortification of staple foods, in improving iron status is dependent on the amount of fortified food that an individual would consume in a household. Intra-household food distribution pattern would therefore affect how much iron one would consume even from interventions such as iron fortification of foods (Webb, 2002). Although food fortification of centrally produced flour is legislated in Kenya; and fortification at small-scale level is under discussion, it is not known whether the objective of supplying additional iron to vulnerable groups through this strategy will effectively meet the requirement of school age children (7 mg/day for children 3 years and 10 mg/day for children 4 to 8 years). This would give direction on whether or not additional targeted strategies may be required to adequately address the iron needs of this group. Given that intra-household food distribution may influence the amount of iron a child will receive, hence the effectiveness of fortification as a strategy; intra-household distribution patterns must first be identified; the potential amount of iron a child is able to consume assessed; and finally the association between the two determined because information on these three requirements is lacking.

Conventional methods of describing intra-household food distribution patterns include measuring the food intake of an index child relative to other members of the family and then analyzing their shares of the total (Rizvi, 1978). This has been shown in such countries as Dominican Republic (Rogers, 1996), Ghana (Lloyd and Gage-Brandon, 1993), The Gambia (Webb, 1989) and The Philippines (Senauer *et al*., 1988). They have also been described in other countries such as Guatemala (Engle and Nieves, 1993), India (Warrier, 1992), Nepal (Gittelsohn, 1991), Bangladesh (Chaudary, 1983; Abdullah and Wheeler, 1985), South Asia (Basu *et al*., 1986). These methods require expertise in measurement of food intake. Qualitative methods have also been applied in describing how households distribute food. These include: Needs Rule (Cassidy, 1987; Leventhal, 1980), Resource Control Model (Doss, 1997), Bargaining Model (Maluccio and Quisumbing, 2003), Cultural Rule (Maitland, 2007), Functional Model (Wheeler, 1988) and Contributions Rule (Cassidy, 1987; McKee, 1984). Some of these methods favour allocation of food to children, and some of them do not favour allocation of food to children. Those that favour the child include: Needs Rule, Resource Control Model, and Bargaining Model. Those that do not favour the child include: Cultural Rule, Functional Model and Contributions Rule. In this thesis it is proposed that these qualitative methods could be combined to develop a framework that may be used to identify food distribution patterns. Unlike quantitative methods of determining food distribution patterns, these qualitative methods may potentially be applied even by non-professionals to identify household food distribution patterns that may exist.

The study was conducted in Kanyawegi Sub-location where a study concerning piloting of small-scale flour fortification with iron was carried out by the Prenatal Iron and Malaria (PIMAL) study of a research project named Improving Nutrition through Staple Foods in Africa (INSTAPA) whose objective was to identify novel staple food-based strategies to improve micronutrient malnutrition for better health and development of women and children in sub-Saharan Africa, making this an ideal location to assess potential influence of intra-household food distribution patterns on iron potential iron intake of school age children age children. Neither food distribution patterns nor their influence on such interventions is known anywhere in the country so this was a suitable setting to conduct the current study to provide insights on whether fortification of flour could provide sufficient additional iron to improve iron intakes of children. It would supplement the findings of the aforementioned study and shed light on whether or not fortification alone is sufficient to meet iron needs of children or; if additional targeted interventions for this group may be necessary alongside legislation to fortify flour with iron. The relationship between intra-household food distribution pattern and the potential amount of iron consumed from iron-fortified flour by school children may be determined in any location where food intake and food distribution patterns are described.

1.2 Justification for the Study

Recognizing the need to address micronutrient deficiencies including iron deficiency, the Lancet series 2013 called for nutrition-specific interventions which also support Kenya's Vision 2030 for development (Gillespie *et al*., 2013). To improve nutrition through government ministries and with external organizations, Kenya set out the National Nutrition Action Plan which was approved by the government in November 2012. It also aimed at prioritizing High Impact Nutrition Interventions (HiNi) as part of Scaling up Nutrition (SUN) framework. One of the nutrition-specific interventions spelt out in the Scaling up Nutrition strategy is to reduce the prevalence of micronutrient deficiencies including iron in the population through food fortification. However, although flour may be fortified with iron, intra-household food distribution patterns is one of the factors likely to influence the effectiveness of fortification as a strategy to meet the iron needs of the vulnerable individuals including school age children. Information on such intra-household food distribution patterns is lacking. There is therefore need to identify such patterns, assess the potential iron intake based on the amount of flour that could be consumed and finally determine the influence of the patterns on flour intake hence iron of school age children.

1.3 Statement of the Problem

Iron deficiency is a problem especially among school age children and negatively affects their cognitive, psychomotor and physical development. Fortification is recognized as an easy, cost-effective strategy to address iron deficiency because it can reach wide proportions of populations including those in rural areas. Recognizing this, the government of Kenya has legislated fortification of centrally processed maize flour with micronutrients including iron. School age children are particularly vulnerable to iron deficiency given that they have high iron requirements because of rapid growth. Additionally, they are easily affected by worm infestations that reduce their iron stores leading to iron deficiency. Ability to consume sufficient amounts of fortified foods influences the amount of iron that can be obtained from such foods by vulnerable groups such as children whose consumption is lower than that of adults. Therefore, intra-household food distribution patterns may influence a child's access to iron where patterns that do not favour the child could reduce the potential benefits of such children from iron fortification of foods such as flour. Such evidence that could aid in assessing the effectiveness of iron fortification programmes to adequately meet the needs of vulnerable children is lacking. Intra-household food distribution patterns have not been identified; the amount of iron a child is able to consume based on the amount of food such a child is able to consume from foods fortified at recommended fortification levels has not been assessed in specific contexts, and the association between intra-household food distribution patterns and iron intake is not reported. Applying the fortification levels recommended by WHO and that legislated by Kenya would enable an assessment of iron fortification as a strategy to meet the needs of school age children.

1.4 Objectives

The study addressed the following objectives.

1.4.1 General Objective

To determine the influence of intra-household food distribution pattern on potential iron intake from iron-fortified flour by school age children in Kisumu North District.

1.4.2 Specific Objectives

1. To identify the types of intra-household food distribution patterns in households in Kisumu North District.

2. To assess the potential amount of iron from fortifiable flour that may be consumed by school age children in Kisumu North District.

3. To determine the relationship between intra-household food distribution pattern and the potential amount of iron that may be consumed by school age children in Kisumu North District.

1.5 Research Questions

1. What are the types of intra-household food distribution patterns in Kisumu North District?

2. What is the potential amount of iron from fortifiable flour that may be consumed by school age children in Kisumu North District?

3. What is the relationship between intra-household food distribution pattern and the potential amount of iron that may be consumed by school age children in Kisumu North District?

1.6 Significance of the Study

Identifying the types of intra-household food distribution patterns in Kisumu North District households could help in the understanding of how food is distributed in households of Kanyawegi Sub-location. Quantifying the amount of iron school age children could potentially obtain from iron-fortified flour based on the amount of flour school age children are likely to consume in a day could help to determine whether the amount of iron school age children could obtain from iron-fortified flour may be appropriate to meet their iron requirements. Determining the influence of intra-household food distribution pattern on the potential iron intake from iron-fortified flour by school age children could provide information on the adequacy of fortification alone to meet the iron needs of school age children or; if additional targeted interventions for this age group may be necessary alongside legislation to fortify flour with iron. This information could be useful to nutritionists in identifying households that practice food distribution patterns that do not favour the child whose children's iron intakes may be jeopardized so that additional targeted interventions may be recommended for them to meet their iron requirements. Non-governmental Organizations involved in flour fortification initiatives and policy makers could use this information to support effective iron fortification interventions. This study would also contribute to knowledge on food distribution patterns practiced in a rural Kenyan setting and how this may influence attainment of intended benefits of nutrition interventions such as fortification initiatives.

1.7 Assumptions of the Study

1. The Sub-location under study has a homogenous population with reference to social and economic status; hence the general diet in the area would be similar.

2. Iron intakes from the diet are within the ranges reported by other authors in similar populations; hence the study focuses only on additional iron from fortification.

1.8 Delimitations/Scope of the Study

1. The study was limited to eligible households in Kanyawegi sub-location, Kisumu North District.

2. The study uses descriptions to identify household distribution patterns rather than direct measurement of food intakes and their distribution among household members.

1.9 Limitations of the Study

Some households (10.8%) either could not be categorized at all due to low scores (7%) on the survey in which intra-household food distribution patterns were identified in households participating in the study or because they exhibited multiple individual food distribution patterns that qualified them to fall in both broad categories of food distribution patterns on which the study focused: those that favour and those that do not favour the child (3.7%). However, to address this limitation only households that exhibited food distribution patterns that facilitated clear categorization into one of the two broad distribution pattern categories were included in the study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Iron Deficiency and Strategies to Address It

In resource-poor communities, iron deficiency is the most common form of micronutrient deficiency in school age children and is caused by inadequate diet and infections, particularly hookworm and malaria (Osazuwa, 2010). Wisantwisut (2011) and Stoltzfus (2008) indicate that iron deficiency is likely to affect school children's survival, growth, and immunity, cognitive development and motor function, hence such children have lower test scores, reduced school learning and educational performance. The problem of iron deficiency can, however be addressed by such strategies as iron supplementation; food-based strategies including dietary diversity, biofortification and food fortification with appropriate vehicles; and clinical strategies such as helminth control (Unnevehr e*t al*., 2007). Supplementation with pharmacologic doses of iron can also effectively replenish iron within a short period, especially in groups at high risk of iron deficiency such as children. However, poor consumer compliance and ineffective health distribution systems to enhance delivery and coverage have been reported as major barriers to success for many supplementation programmes especially in developing countries (WHO/CDC, 2004; Oken, and Duggan, 2002). Logistical challenges and cultural taboos may also limit widespread screening for iron deficiency (Ojukwu *et al*., 2010; Suchdev *et al*., 2010. With these challenges, therefore, it may be necessary to embark on other strategies such as food-based ones which may provide sustainable and long-term solutions to address the problem of iron deficiency especially in young children.

Dietary diversity encompasses increasing the quantity and the variety of iron-rich foods consumed (Allen *et al*., 2006; Thompson, 2007). This may be done by promoting the production and consumption of foods rich in iron such as animal products, fruits and vegetables in adequate quantities, especially among those who are at risk for, or vulnerable to, micronutrient malnutrition. Dietary diversity could improve the intake of multiple micronutrients. It has also been suggested as part of an effective strategy aimed at reducing iron deficiency and offers key advantages in developing countries where most rural households largely depend on what they cultivate for their nutrition (Verrall, and Gray-Donald, 2005). Although increasing dietary diversity is generally regarded as the most desirable and sustainable option aimed at increasing the intake of micronutrients, it requires behaviour change and its implementation takes a relatively longer period than other strategies. Biofortification via processes such as agronomic practices, selective plant breeding, genetic engineering or a combination of these methods is a sustainable approach likely to improve the iron content of plant foods. Breeding may however be limited in achieving iron levels that are sufficiently high to substantially improve iron status. Genetic engineering may be a more practical approach to raise iron content or to enhance iron bioavailability by reducing phytate levels (Mendoza *et al*., 1998; Zimmerman and Hurrel, 2007). Nevertheless, there are still problems in attaining efficacious iron biofortification in crops especially in those rich in phytates such as beans (Petry *et al*., 2012). Fortification has been shown to be a cost-effective population-based strategy that is likely to deliver micronutrients including iron to, particularly, the groups at risk including school age children (Zimmerman *et al*., 2004; Moretti *et al*., 2006). Food fortification does not usually necessitate a change in customary dietary practices and has the potential to reach large proportions of deficient populations (Peter, 2008; Micronutrient Initiative, 2010). Therefore, because the other food-based strategies have limitations that may make them either less sustainable or not effective in the short term to address immediate problem of iron deficiency, food fortification with iron may provide a more viable and sustainable option especially in the short and medium term.

The aim of iron fortification interventions is to increase iron intakes and/or reduce iron deficiency especially in vulnerable groups. School age children are one of the vulnerable groups to iron deficiency because of their high iron requirements due to rapid growth (Ezeamama *et al*., 2008). In addition, because school age children especially in developing countries have low dietary intakes of bioavailable iron from the consumption of plant-based cereals and legumes foods, high in phytates that contain substantial amounts of iron absorption inhibitors; it is thus difficult for them to consume enough iron. Ability to consume sufficient amounts of fortified foods influences the amount of iron that can be obtained from such foods by vulnerable groups such as children whose consumption is lower than that of adults. These children are also easily infested with helminthes including hookworms, *Trichuris trichura* and schistosomal worms that may reduce their iron stores thus increasing chances of iron deficiency (WHO, 2001; Maitland, 2007). Hence benefits are likely to occur for these children with improved iron intakes from fortified foods. Therefore, an adequate supply of dietary iron is important in maintaining body iron stores and ensuring that there is adequate iron for normal body functioning. The potential amount of iron children are able to consume based on the amount of food they could consume from iron-fortified foods need to be assessed.

2.2 Intra-household Food Distribution

Intra-household food distribution pattern is a system determining the flow of food to each individual in the household. Bangladesh’s Rizvi (1978) indicates that intra-household food distribution occurs between preparation and eating so that the family members get their share of the total food. The amount of food school age children are likely to consume in a household would depend on food distribution method. Policy makers and academics have been undertaking studies on intra-household resource allocation including food since mid-1960s (Becker, 1965; Haddad *et al*., 1997). Inequality in household food distribution in most parts of the world has pointed out the need to examine patterns by which resources including food are distributed among the members of the household (Agarwal, 1997). A method of food distribution would help to quantify the amount of food household members are likely to receive in a household.

Disparity in household food distribution has persistently affected the health and nutritional status of some of the most vulnerable groups including children and hence has called for the need to analyze the economics of the household (Pinstrup-Anderson, 1983). Literature on intra-household food distribution patterns is scarce as can be indicated from studies carried out in South Asia (Gittelsohn, 1991; Gittelsohn, 1997; Kramer *et al*., 1997). The study of intra-household distribution of food is a relatively new field of study and Berti, (2012) on reviewing intra-household food allocation literature, found only four studies from Africa documenting food intake among members within the household with wide variations in allocation patterns between and within geographic regions. Although intra-household food distribution (IHFD) is growing, it is important to understand that food distribution patterns are not common, but differ from region to region and this may indicate why some areas may have biases in food distribution, a risk factor for malnutrition in some individuals especially small children whose food consumption is low.

Both quantitative and qualitative methods have been developed to describe intra-household food distribution (Gittelsohn, 1989). Most of the authors of IHFD literature have used two, three or more of the food distribution patterns in their works. The varied descriptive works, although used in different studies in varied contexts, reflect descriptions that either favour or do not favour preference in food allocation to children. These have therefore been combined in this study; to develop a framework based on these descriptions that favour and those that do not favour the child.

2.4 Types of Intra-household Food Distribution Patterns

The various patterns of intra-household food distribution were categorized into two based on whether they favour or do not favour the child with respect to food intake.

2.4.1 Patterns that Favour the Child

The food distribution patterns that favour the child in food intake included Needs Rule, Resource Control Model and Bargaining Model.

2.4.1.1 Needs Rule

This food distribution pattern predicts that individuals who have greater nutrient needs like children for growth and development would receive a higher proportion of the family's food. In some families especially in developing countries, some parents have been shown to use special consideration for example a need to allocate food to the most needy children (Cassidy, 1987; Scheper-Hughes, 1987). Such parents recognize their role in feeding children who are particularly needy. This view agrees with that of health professionals who, in most cases, are likely to direct more resources to the most needy. Peter *et al*., (1997), using data from rural highlands of Ecuador indicates that certain high quality foods would be allocated to individuals with higher nutritional requirements including school age children. Goody (1958), in analyzing the reasons for the break-up of families that used to consume their foods together in polygamous units among the La Dagaa of Gold Coast found that individual mothers' needs to supervise their children's food intake from separate rather than shared pots caused households that hitherto cooked together to divide into mother-child pairs. This implies that mothers are likely to understand the food needs of their children and hence they would provide food to their children based on their requirements. In Nicaragua, mothers were shown to encourage small children to eat more food (Engle and Zeitlin, 1996). This implies that the mothers understood the food requirements of children and thus ensure they are served more. In addition, Medina (1991) noted that the distribution of nutrients among members of the family in the Philippines is fair and household members are served based on their requirements. Therefore needs rule reflects a pattern that would favour food allocation to the child.

2.4.1.2 Resource Control Model

This pattern of food distribution focuses on material and power relations among household members. In this pattern, food allocation may be taken to reflect on who controls the food resources and or the food budget. Inequalities of power are evident in arrangements by which goods, services and income of both husband and wife are allocated in the family. Evidence from some African countries show that the impact of income on family nutritional well-being is dependent on the one who controls it and makes decisions on its use; female controlled income has greater influence on nutritional well-being of household members compared to male controlled income (Bhagowalia *et al*., 2012). This supports the findings of Doss, (1997), who, using Ghanaian data, observed that females' income is likely to have greater positive impact than males' income on infant, pre-schooler nutrition and child education. Further, Resource Control

Model indicates that when women contribute to household income and exercise control over food resources or the food budget their bargaining power increases and the nutritional intakes of children are more likely to be adequate probably because women spend most of their incomes on consumption goods for the entire household (Shroff *et al*. 2011; Blumberg,1988). Measures aimed at increasing women's economic productivity and access to income may reduce their dependency and thus strengthen their ability to realize their own preferences within the family, thus prioritizing the health and well-being of their children. If women prioritize the well-being of their children, they would provide more food to them and hence likely to benefit more from iron fortification interventions.

Studies show that children benefit when their mothers are empowered: Lloyd and Blanc (1996) compared school enrolment and completion rates in sub-Saharan countries and found that children of female-headed households fared better probably because they ate well which was likely to translate to the enhancement of their cognitive function. Using data from rural Nepal, Allendorf (2007) has shown that women’s household decision making is enhanced when they own the factors of production including land and thus the health of their children becomes comparatively better. Therefore, empowering women and allowing them gain control over economic productive resources such as productive assets in form of education and social networks that back-up their endeavors for income generation is likely to raise their economic influence as well as their ability to determine their destiny and hence children’s food intakes may improve too (Kabeer, 1999; England, 2000; Kishor, 2000). The impact of women’s work and income on food intakes of household members, either because they allocate more of their income directly on the food budget; or because they make food more equitable when they contribute to the food budget, implies that they would provide more food to children. Therefore this pattern qualifies as one that could favour food allocation to children.

2.4.1.3 Bargaining Model

Bargaining Model of food distribution considers household resource allocation behaviour as the outcome of power and preference. It has been shown that the preferences of men and women systematically differ; affecting the welfare of other household members and this was not visible until the bargaining model of food distribution was developed based on game theory which maintains that household members do not have common preferences but try to pursue their own interests (Manser and Brown, 1981). This implies that the household members have to bargain or negotiate for a share of household resources including food. In many sub-Saharan countries husbands and wives neither pool their resources nor maintain a common housekeeping or child-rearing budget and hence decision making occurs through interaction, negotiation and persuasion (Chiappori, 1992; Kanbur, 1991). Members who make greater contributions to household prosperity are likely to enjoy greater bargaining power and thus likely to influence decision making on what is eaten in the household; and may also influence an individual's share of family resources (Sen, 1990; Handa, 1996; Ott, 1995). For instance, the different male and female income effects on children's nutrition intake may imply different levels of caring about children's welfare and this is likely to be as a result of an individual's bargaining power in the household (Kapteyn and Kooreman, 1992; Kusago and Barhan, 2001; Garcia, 1991; Kennedy, 1991). In a study on Separate Spheres Hypothesis, Lundberg and Pollak (1993) argue that husband and wife contest to control separate spheres in the household and this is likely to shape their bargaining power in a marriage. Women normally contest for controlling consumption sphere of the household and this is where they spend most of their income. Additionally, wives are likely to do better in household resource allocation decisions if given opportunity to participate sufficiently in microcredit projects, household production and consumption decisions since this is likely to increase their bargaining power (Osmani, 2007; McElroy, 1990). Because mothers assume primary responsibility of child-care, empowering them could therefore translate to better food allocation to the children.

Bargaining Model has also been indicated in other studies. Using data from India, Panda and Agarwal (2005) use the ownership of land and housing as a measure of increased bargaining power. Women's bargaining power is increased if they have access to independent income since they would allow them participate in decision making regarding its use. Therefore, women who have ability to make decisions in the household are more likely to allocate more food to their children and this pattern qualifies as one that favour food allocation to children.

2.4.2 Patterns that Do Not Favour the Child

Patterns that do not favour the child in food intake included Contributions Rule, Cultural Rule and Functional Model.

2.4.2.1 Contributions Rule

Contributions Rule holds that household members with more earnings are likely to be favoured in household food allocation than those without earnings. This pattern; according to equity theorists, suggests that all rewards and punishments are distributed based on a just reward for the recipient's inputs and contribution, implying equal pay for equal work (Leventhal, 1980). Viewed in terms of food intake therefore, this pattern of food distribution implies that individuals who contribute more are given more food. Many studies have shown a contributions rule based on income; in Guatemala (Engle and Nieves, 1988) indicated that a worker is likely to be served a slightly larger portion of family calories than a non-worker. Additionally, workers have also been shown to often eat first and hence obtain sufficient food to ensure that they maintain their capacity for earning money or working to provide food for the family (Messer, 1983; Katona-Apte, 1983). This implies that under-investment in some children, who are not expected to be long-term contributors to the household, means consciously or unconsciously the family may allocate less food, or simply neglect them, while allocating more food to the other children who are seen as long-term contributors to household and or adults may lower the food intake of children who are viewed as having poor health.

In some African studies females for whom higher bride price is paid are more likely receive a larger share of household food whereas those who do not pay bride price may receive a lesser share of household food (Rogers, 1983). This implies that mothers whose spouses may have paid high bride price are seen as having made a big contribution to the family and hence likely to be served larger shares of food which she is also likely to provide to her children. It has been shown that many parents in the developing countries are likely to allocate more food to members who are likely to provide long-term benefit to the family for instance workers or healthier children with better chances for survival (Cassidy, 1987; Schepper-Hughes, 1983). This implies that the healthier children are likely to provide long-term contribution to the family whereas those with poor health are likely to receive relatively low food intakes as their contribution is seen as limited. Villasenor (1982) documents that in the Philippines, girls who earned money obtained more food than those who did not. School age children who are not working may be served less food which is likely to compromise the amounts they would consume. Although the focus of iron fortification programmes is to improve the iron intakes of the population and particularly the vulnerable individuals, allocating more food to household members who have more earnings is one of the factors likely to contribute to the problem of iron deficiency especially in school age children who are not contributing to the household. Allocating food to household members based on the contributions they make to the household implies that children who do not contribute to the household would be allocated less food and therefore this pattern does not favour food allocation to children.

2.4.2.2 Cultural Rule

The Cultural Rule of food behavior in a given society regards the system of food production, preparation and distribution as a model of the structure and relations of that society. Anthropologists have traditionally collected data on food provision, preparation and consumption practices through ethnographic descriptions of cultural settings and their work reveals context-specific belief systems which surround food (Maxwell, 1992). It could be observed that in many societies, men and older adults are favoured or would have priority over women and children in household food allocation and that the status of an individual in a household and society is reflected in the amount and kind of food one eats (Atiknson, 1980; Douglas, 1982). In Zimbabwe, it has been shown that children learn the order of eating early and who eats with whom, based on the social status of the food consumers (Farb and Armelogos, 1980). Work by Abdullah (1983) reveals that fine portions of meat, fish and fruits would be reserved for adult men. In this case men appeared to be better supplied with nutrients derived from animal sources- iron and fat-soluble vitamins which provide a high bioavailable iron while women and children better supplied with carotene and vitamin C from plant sources which supply less bioavailable iron. When food allocation follows status, the vulnerable children are likely to be allocated less implying that they may not grow properly to achieve their full potential.

In addition, intra-family food distribution is often related to hierarchical position with the head of the family, in this case the man receiving priority in eating, while children receive a smaller share of the family's food relative to their needs (FAO/WHO, 2002; Maitland, 2007; Oniang'o, Mutuku, and Malaba, 2003). Staple food items appear to be fairly distributed, but micronutrient-rich ones are preferentially allocated to favour valued individuals including adult males and small children of both sexes (Wheeler, 1991). This preferential allocation of micronutrient-rich food is likely to reduce children's food intakes relative to their requirements. Webb (1989) indicated that in The Gambia, children of newly married wives may be more malnourished than children of older wives who probably are considered as having higher social status in a similar household. If children are malnourished, then even the intake of micronutrients including iron is also likely to be jeopardized. Additionally, some cultural practices like the traditional fostering of children in West Africa to the extended family members increases the risk of malnutrition to fostered children especially girls due to discrimination against a newcomer in terms of access to adequate food and health care (Bledsoe *et al*., 1988). Discrimination in household food distribution would reduce the access of food to those who most need assistance such as small children. Because the cultural rule of food distribution preferentially allows food allocation to valued individuals and based on their status, the high risk groups such as children are likely to be allocated less food and this pattern does not to favour food allocation to children.

2.4.2.3 Functional Model

The Functional Model of food allocation regards a household as a unit that aims at surviving and reproducing itself and hence resources are allocated according to an individual's productiveness or the ability to earn or produce goods for the household. Alderman (1995) and Fuwa *et al*., (2000) have shown that consumption decisions are interlinked with production activities of a household and this influences household resource allocation behaviour.

This pattern of food distribution would see men, fertile women and older children as prime producers, young children as long-term investment and the elderly as slightly productive. Therefore, working adults and teenagers would receive the most favourable shares of food in order to work and produce for household sustainability (Wheeler, 1988) and this implies that the ability to produce goods forms the scale against which decisions on food allocation are likely to be made (Wheeler, 1991). On studying the flow of energy among sisal workers in Brazil, Gross and Underwood (1971), showed that male wage earners received preferential shares of calories; were fed first and in sufficient quantities so as to maintain their capacity to work and produce more. Members who have better health endowments have been considered being able to translate such endowments into health outcomes and hence they eat more energy by working more which is likely to increase household income (Alderman, 1995; Fuwa *et al*., 2000). Good health is likely to indicate increased productivity and thus such individuals may be given more food. This implies that the needs of small children are often not met when such a situation is considered and this may disadvantage young children who are likely to receive unfavourable share of food which may reduce their micronutrient intakes such as iron.

Food distribution may be biased in some families based on the kind of work done by individuals. Strauss (1986) and Deolalikar (1988) argue that in rural Bangladesh gender-segregated occupational choices where men engage in energy-intensive occupations in which health and food consumption influences productivity and wage rates while women engage in less energy-intense occupations in households influence a household's decision to allocate more calories to men as opposed to women. However, the two authors also show that calorie allocation among children in Bangladesh does not show much disparity. It has also been suggested that young children are discriminated against in food allocation in order to secure the family's future supply by allocating sufficient food to working males and especially in lean times of food shortage, but if food is in plenty approximately equal shares may be served (Safilios-Rothschilde, 1980; Schofield, 1974; Cantor Associates, 1979). Because school age children are neither earning nor producing for the household, distributing food based on their productive ability would imply that they will be allocated less food; hence this pattern does not favour allocation of food to children.

However, it was not clear whether the patterns that favour the child and those that do not favour the child would enable or not enable the child to consume adequate amounts of the food vehicle, in this case flour assumed to be fortified with iron so as to help estimate amount of additional iron that could be obtained from the amount of flour product the child would consume in a household. Data on the intra-household food distribution patterns is lacking.

2.5 Potential Iron Intake from Fortifiable Flour

The Joint Food and Agriculture Organization and World Health Organization Expert Committee on Food Additives (JECFA) recommended flour to be fortified with NaFeEDTA at 20 mg/kg flour (JECFA, 2000). The Food Fortification Initiative (2008) provided guidelines for flour to be fortified at a level of 20 mg iron as NaFeEDTA per kg flour that were also adopted by the World Health Organization (2009). NaFeEDTA is well absorbed, not reactive and is also chemically stable, which allows for long storage of foods; also the absorption of iron from NaFeEDTA is 2-3 times greater than that from either ferrous fumarate or ferrous sulphate in high-phytate foods (WHO/FAO, 2006). The WHO considers fortification to be safe and efficacious and therefore endorsed iron fortification of flours. The Scientific Committee on Food (2003) and JECFA (2007) reported the Acceptable Daily Intake (ADI) value of 1.9 mg/kg/day for NaFeEDTA. Daily iron requirements for children 3 years old are 7 mg and for children 4-8 years old it is 10 mg (IOM, 2001). The range of iron from NaFeEDTA that has been reported from children's food intake is between a low dose of 2.8 mg/day and high dose of 5.6 mg/day for children 3 to 8 years where their iron status appeared to improve substantially (Andang'o *et al*., 2007). Macharia-Mutie *et al*., (2010) have reported an additional amount of iron from fortification with a low dose of iron containing 2.5 mg/day in form of NaFeEDTA for children less than 5 years and this reduced iron deficiency in the target age group within a short period. In another study the value 2.5 mg/day for children 1 to 6 years was reported which also improved the iron status of the participating children (Zlotkin and Tondeur, 2007). Macharia-Mutie *et al*., (2010) indicate that a low dose of 2.5 mg iron has the additional benefit of reducing iron deficiency within a short period, but such a low dose may probably only be effective when in the form of NaFeEDTA.

The European Union has allowed the use of NaFeEDTA as a food additive in vitamin and mineral substances with the aim of fighting iron deficiency (EU, 2011). Mandatory legislation in countries such as Kenya is thus appropriate to allow the use of NaFeEDTA in fortification of flours, since its efficacy in improving iron intakes has been confirmed. The Government of Kenya has recommended flour fortification with iron at a level between 5-15 mg per kg flour

(Ministry of Health, 2013). Therefore, a range of iron intake that could be appropriate to guide the conduct of studies assessing the potential iron intakes of school age children could be between 2.5-5.6 mg/day.

2.6 Intra-household Food Distribution Pattern and Potential Amount of Iron Consumed

The basis of this thesis is an argument that IHFD patterns may influence effectiveness of iron interventions based on food fortification. Indicators determining IHFD patterns, drawn from the reviewed literature include: Needs Rule which would indicate that individuals who have greater nutrient needs like children may receive a higher proportion of the family's food. This implies that when nutrients are fairly distributed in the household even the iron-fortified food to be consumed especially by children is also likely to be adequate. Resource Control Model would indicate that female controlled earnings have greater influence on nutritional well-being of household members when compared to male controlled earnings. Because women spend most of their incomes on consumption goods for the entire household which also includes children, the nutritional intakes of children are more likely to be adequate in households where resource control model of food allocation is applied. Therefore, if flour were fortified with iron, then the mother is likely to allocate adequate amounts to the children when she has control over household income. Bargaining Model would indicate that women's bargaining power in household decision making is likely to improve when they have access to independent income. Women tend to spend more of their time and earnings on their children's needs including food and if flour-based food items consumed in a household were iron-fortified, then the mother is likely to negotiate for the children receive higher amounts of the fortified flour product.

Contributions Rule would indicate that individuals who make greater contributions to the family often receive a larger share of family food and this has been supported by the findings of Engle and Nieves (1988) in Guatemala. Hence, if the food individuals would consume were iron-fortified, then household members who contribute more would receive more food relative to other members including school age children. Cultural Rule would show that some members especially men and older adults have been shown to be favoured in terms of household food allocation or have priority in eating whereas small children receive little food or are served later although their requirements are high. This implies that the Cultural Rule of food distribution favours them at the expense of small children and this may lead to nutritional side-effects. Functional Model considers an individual's productiveness or ability to earn or produce goods for the household as the scale against which decisions on food allocation are likely to be made. Based on this, working adults, men, fertile women and older children, often viewed as key producers would receive favourable shares of food in order to work and produce for household survival. Young children are seen to be the most affected in this situation and especially if the food were iron-fortified as their food intake is lower than that of adults. This implies that the needs of small children are often not met when such a situation is considered and this may disadvantage them since they are likely to receive unfavourable share of food which may reduce their micronutrient intake such as iron.

Food distribution patterns that favour the child may improve the potential iron intake of school age children, implying that the children whose households apply such patterns would benefit more from iron fortified products. By contrast, food distribution patterns that do not favour the child may reduce the potential iron intake of school age children, implying that children from such households would benefit less from iron fortified food products. However, whether or not this argument holds is yet to be confirmed.

2.7 Conceptual Framework

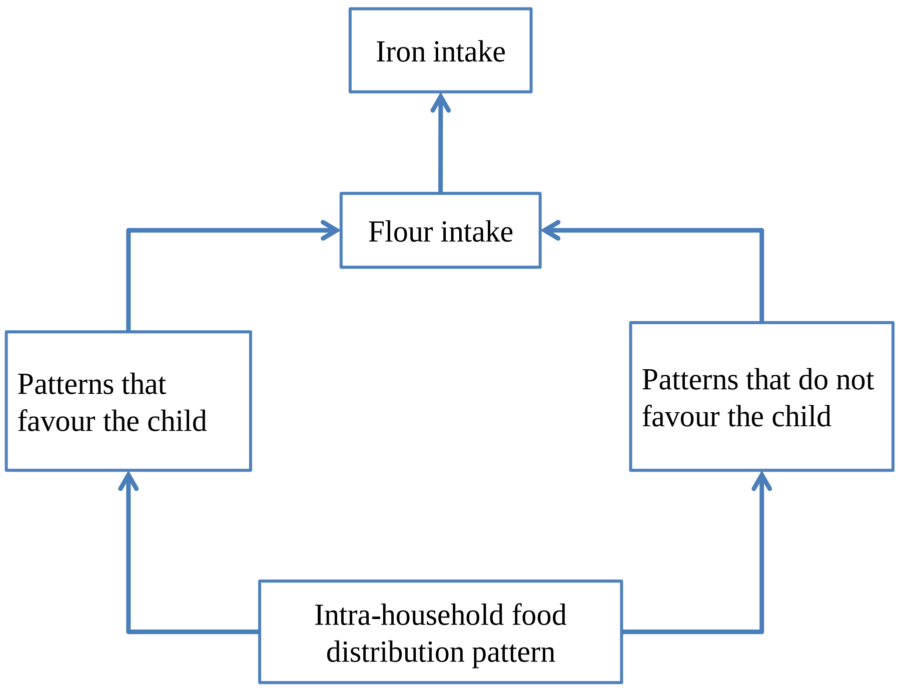


Figure 1: Conceptual Framework (Modified from UNICEF Conceptual Framework of Malnutrition, (UNICEF, 1998).

The conceptual framework that guided this study was adapted from the UNICEF conceptual framework of malnutrition (**Figure 1**). The UNICEF framework depicts inadequate access to food as an underlying cause of malnutrition and inadequate dietary intake as an immediate cause of malnutrition. In the adapted version, intra-household food distribution pattern determines how much food a child would get in a household including iron-fortified foods (access), this in turn determines how much iron a child would obtain from the food (adequacy of iron (dietary) intake). This is depicted in **Figure 1**.

In a qualitative framework, the reviewed intra-household food distribution patterns were conceptualized to fall into two categories: those that favour the child and those that do not favour the child. Intra-household food distribution patterns that favour the child may favour an increase in flour intake hence iron intake of children whereas those that do not favour the child may decrease flour intake hence iron intake (**Figure 1**). This is operationalized in **Figure 2**.

2.8. Operational Framework

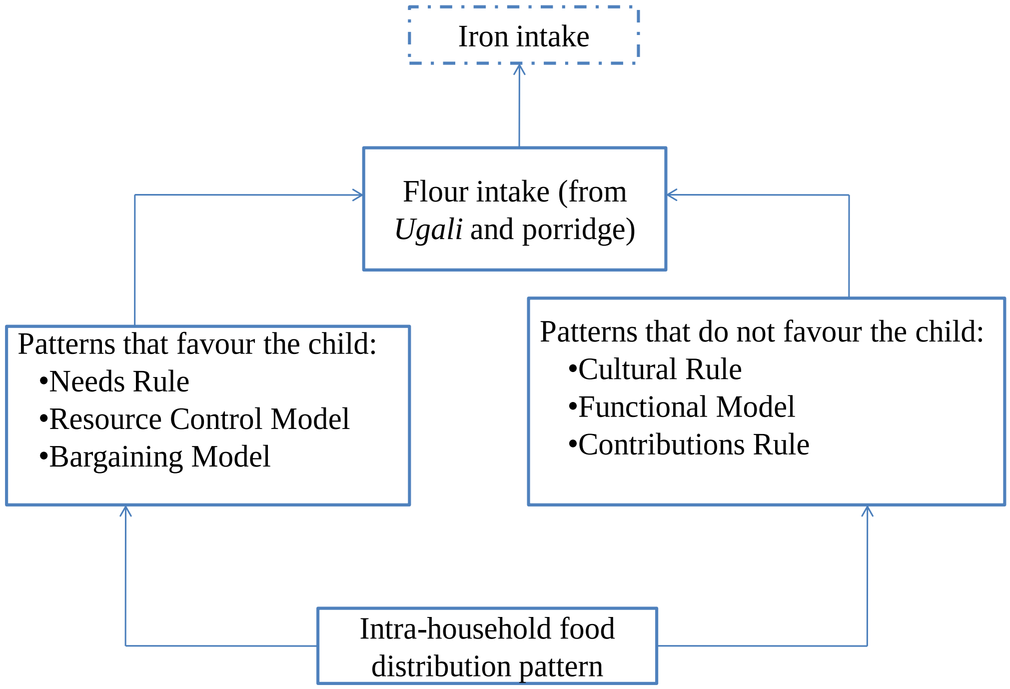


Figure 2: Operational framework depicting relationship between intra-household food distribution pattern and iron intake

CHAPTER THREE: RESEARCH METHODS

3.1 Study Area

The study was conducted in Kanyawegi Sub-location, South West Kisumu Location, Kisumu North District, Kenya [34^0 36′ 0″ E] (**Appendix 1**). The Sub-location is 30.3 km away from Kisumu town, experiencing average temperatures of 29^0C (84.2^0 F). It has a total area of 17.1 km^2 (CBS, 1999). The number of households with school age children in the Sub-location was 620 as established through household listing. The Sub-location is inhabited predominantly by the Luo ethnic group that live in characteristically dispersed homesteads. Their diet is monotonous and predominantly based on maize, with a low content of animal products. Hammer (*posho*) mills are common in the area. Customers bring 1-10 kg grain per visit for milling. Maize is occasionally pre-blended with sorghum or less frequently with millet or cassava. Portions are measured in 2 kg tins. In this area, malaria is endemic and transmission is perennial, with seasonal peaks occurring during the long and short rains (Verhoef, Unpublished Observations, 2009). The main economic activity carried out by inhabitants of the area is subsistence farming with additional income from fishing, and clay brickwork for construction. The study area is one of the three Sub-locations: Ojolla, Osiri and Kanyawegi where piloting of small-scale flour fortification with iron was carried out by the Prenatal Iron and Malaria (PIMAL) study of a research project: Improving Nutrition through Staple Foods in Africa (INSTAPA) was selected. The PIMAL study was part of INSTAPA Work Package 5 (WP 5), a European Union funded project whose mandate was to identify novel staple food-based strategies to improve micronutrient malnutrition for better health and development of women and children in sub-Saharan Africa. Hence assessing the influence of intra-household food distribution patterns on potential iron intake of school children fitted well within the main objective of the project.

Kanyawegi was randomly selected from the three Sub-locations to represent Kisumu North District.

3.2 Study Design

A cross-sectional study design based on sequential exploratory mixed-methods approach was used. The study involved three stages. In stage 1, focus group discussions were conducted among community health workers and caregivers to identify the intra-household food distribution patterns in the study area. From information obtained in the focus group discussions, an intra-household food distribution patterns survey questionnaire was developed. In stage 2, a survey using the developed questionnaire was conducted in all the eligible households to identify the intra-household food distribution patterns in those households. In stage 3, households were selected to participate in a comparative study where iron intake, assuming fortification at WHO and Kenya recommended levels were compared in households with food distribution patterns that favour and those that do not favour the child (**Figure 3**).

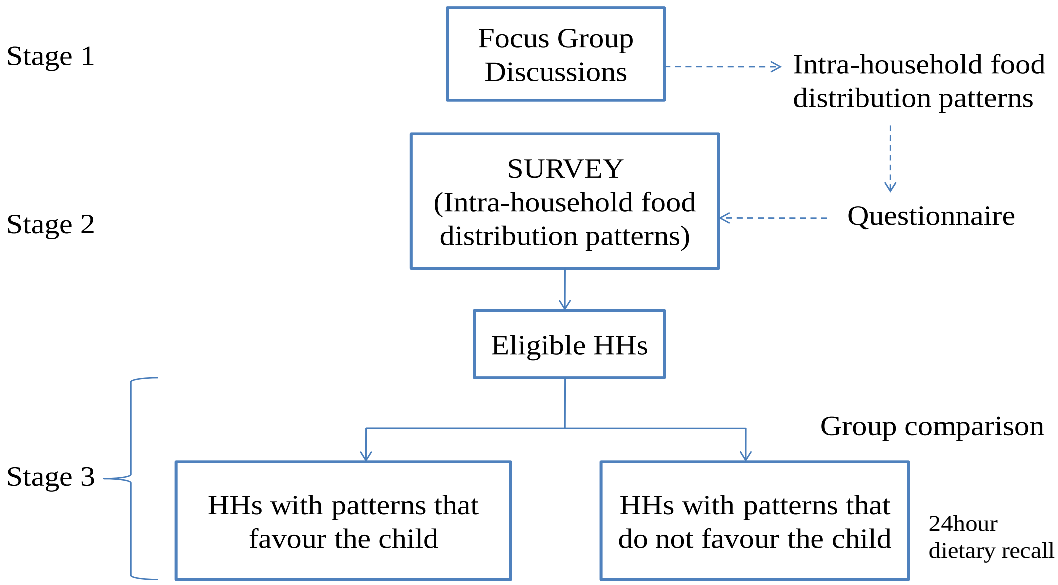


Figure 3: Flow diagram of the study design

3.3 Study Population

The target population consisted of index children in 620 households with school age children 3 to 8 in Kanyawegi Sub-location, Kisumu North District. School age children were selected because they are old enough to consume sufficient amounts of fortifiable flour based product, but not yet at the stage of puberty with its attendant influence on iron intake. School age children are at a stage of rapid growth where they require large amounts for iron due to increased blood volume and muscle mass. When large amounts of the fortifiable flour product are consumed then the benefit of iron fortification of flours could be met. Additionally, it is also at this stage that cognitive, psychomotor and physical development is occurring and need more iron as it plays a critical role in supporting these processes.

3.3.1 Inclusion Criteria

Households of permanent residents in the area with school children aged 3 to 8 years whose caregivers provided informed written consent to participate in the study.

3.3.2 Exclusion Criteria

Households with school age children 3 to 8 years who were ill to an extent that it would affect food intake during the study period.

3.4 Sample Size

This study involved two samples of participants: First a survey in which intra-household distribution patterns were identified; and from them, a sub-sample comprising of two groups of participants was selected for the comparative study. The two sample sizes were: survey sample size and comparative study sample size.

3.4.1 Survey Sample Size

In the sample size for the survey, a representative sample was determined based on Fisher's *et al.*, formula in (Mugenda and Mugenda, 1999).

$$n = \frac{Z^2 Pq}{d^2}$$

Where n-sample size, z = 1.96 for 95% confidence interval, p = proportion of households with school age children =50% (0.5), d = the level of statistical significance set = 0.05 (in this study it was q=1-p), degree of desired precision.

The sample size was determined as follows:

$$n = \frac{(1.96)^2 \times (0.5) \times (1-0.5)}{(0.05)^2}$$

$$= \frac{3.8416 \times 0.25}{0.0025}$$

$= 384.16$

Since the population was less than 10,000, the sample size was adjusted for using the formula for finite population correction:

nf = n/1 + n/N (Cochran 1963)

The number of households in Kanyawegi Sub-location with school age children (established through household listing), N = 620. The sample size that would now be necessary is given below:

nf = 384/1 + 384/620

$$= \frac{384}{1 + (384/620)}$$

= 237 households

The sample was further increased by 25% to compensate for non-response (Israel, 1992). This increase in sample size also helped to ensure that the numbers of eligible households in each of the two groups of food distribution patterns: those that favour the child and those that do not favour the child were adequate to detect a difference in iron intake.

25% (237) = 59.25

Total sample size for the survey = 296 eligible households

3.4.2 Comparative Study Sample Size

In the sample size for the comparative study, a sub-sample was drawn from the survey sample in Kanyawegi Sub-location. The number of households that were included in each of the two groups of food distribution patterns was determined based on the minimum sample per group required to detect a1mg difference in iron intake by school age children with 90% power (Kirkwood, 2007). A difference of 1 mg was considered because in persons with normal iron status, about 1 mg to 2 mg of iron which is 10% of the iron in a normal diet is absorbed each day from the duodenal lumen into the intestinal mucosal cell and this absorption balances with the physiologic iron loss (Andrews *et al*., 2009).

The formula for calculating sample size in the comparative phase was:

$$\frac{(u + v)^2 (\sigma^2 + \sigma^2)}{(\mu_1 - \mu_2)}$$

Where: u =1.28 corresponding to a β for the test of 90%

v=1.96, corresponds to an α of 5%, two-tailed test

σ^1 = the standard deviation of potential iron intake in food distribution patterns that favour the child

σ^2 = the standard deviation of potential iron intake in food distribution patterns that do not favour the child

$\mu_1 - \mu_2$ are the corresponding differences between means

Assuming mean iron intake for the group applying food distribution patterns that favour the child is estimated as 4 mg/day with a standard deviation of 2.1 mg/day; and mean iron intake for the group applying food distribution patterns that do not favour the child is estimated as 3 mg/day with a standard deviation of 1.5 mg/day then:

$$n = \frac{(1.28 + 1.96)^2 \times ((2.1)^2 + (1.5)^2)}{(4 - 3)^2} = 69.9$$

Hence 70 children per group

Total sample therefore = 140 school age children

The sample size was increased by 10% to account for non-response.

Total sample size for comparison 140 + 14 =154 eligible children

3.5 Sampling Procedures

Sampling procedures conducted for the Focus Group Discussions (FGDs), survey and comparative study are described in this section.

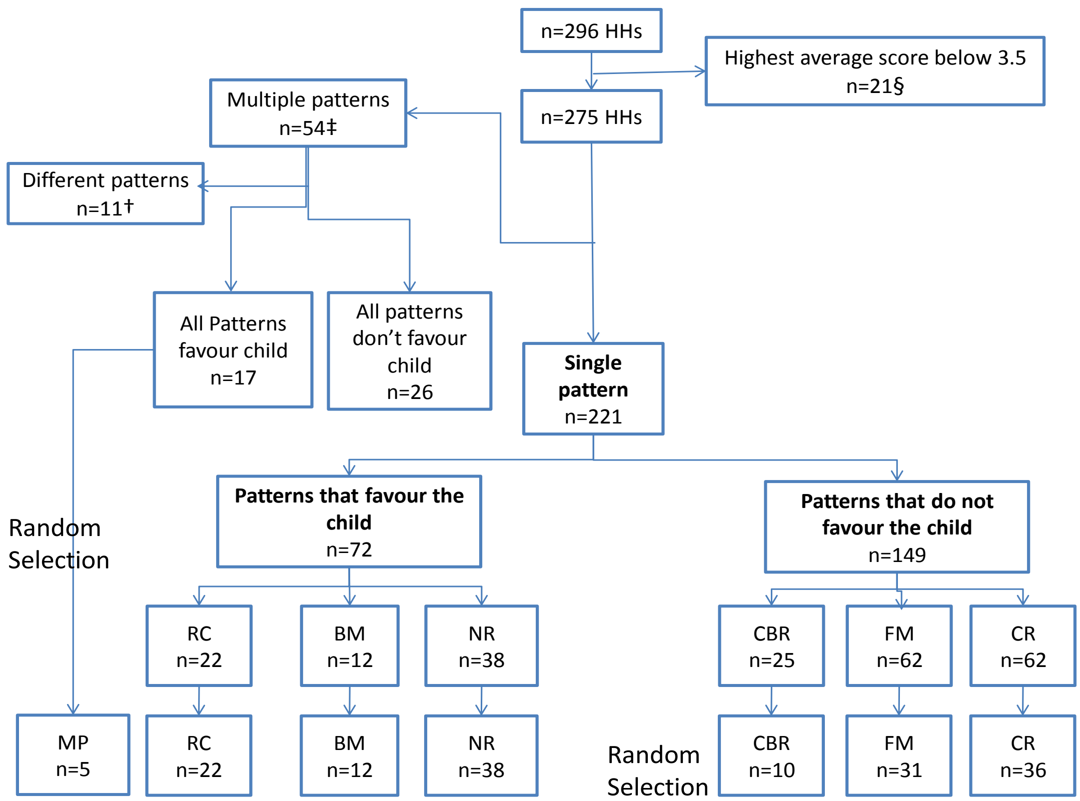
3.5.1 Focus Group Discussions (Qualitative Stage 1)

Purposive sampling was used to select 12 Community Health Volunteers (CHVs) for the first focus group. The CHVs chosen were fluent in the local language, live in Kanyawewgi Sub-location and work with households in which this study was conducted. Therefore, they were key informants likely to know the intra-household food distribution patterns in the area. In the second FGD, 10 caregivers attended out of the 12 selected. The third FGD, different from the second one had 12 caregivers attending the session. The caregivers were fluent in the local language, live in Kanyawewgi Sub-location and thus are likely to understand food distribution practices in their household. Community Health Extension Workers (CHEWs) working in the area helped to identify the CHVs and caregivers who participated in the FGDs. From the three FGDs conducted, a saturation point was reached, that is, no new pattern emerged after they were completed.

3.5.2 Survey (Stage 2)

Household listing was carried out by research assistants to establish the number of households with a school age child in the study area. To do this, the research assistants went from door to door listing any household with a school age child or children. On the household listing form, the research assistants wrote the three names of the father, mother and age of the school age child or children. For ease of location of the study households, a landmark which could either be a river, school, church, mosque, bridge, rock, tree or road or prominent person in the area was included in the form. If the children who met our eligibility criteria were more than one, then all of them were listed so that one could later be randomly selected to participate in the comparative study. After recording all the eligible households with school age children, the total number of households was 620. A household listing form is included in **Appendix 4**. Simple random sampling method, using a table of random numbers was then used to select 296 households to participate in the survey.

3.5.3 Selection of the Participants for the Comparative Study (Stage 3)



KEY: **RC**=Resource control model, **BM**=Bargaining model, **NR**=Needs rule, **CBR**=Contributions rule, **FM**=Functional model, **CR**=Cultural rule, **MP**=Multiple patterns
‡Two or more food distribution patterns combined; †Food distribution patterns that favor and those that don't favor child occurring in a household; § Scores below 3.5 the minimum allowed to establish a pattern

Figure 4: Flow diagram of the selection of participants for the comparative study

In total, there were 296 households eligible to participate in the comparative study. Of this, 21 households (7%) could not be clearly categorized as either favouring or not favouring the child because their scores fell below those that could be used to establish a pattern. This left 275 households that could be categorized. Fifty-four of these households had multiple groups (those that favour and do not favour the child) of food distribution patterns. For some of these households, these multiple patterns all either favoured the child (n=17) or all did not favour the child (n=26). Such households could be included in the study. Eleven of the households had attributes of both groups of food distribution patterns, those that favour and those that do not favour the child; hence could not be put into any broad category and could not be included in the study. Therefore, the total number of households that could not be included in the study were 32 (21 with low scores and 11 with different patterns). These households were 10.8% of the eligible 296 households.

Households that had clear categories of single pattern types that either favour or do not favour the child were 221, from which children were selected for inclusion in the study. Of these, those with food distribution patterns that favour the child were 72 while those with food distribution patterns that do not favour the child were 149. Because the sample size for the comparative study was 154 households, 77 households were required in each study group. The final sample for the comparative study were therefore selected thus: To increase the number of households with patterns that favour the child from 72 to 77, five households were randomly selected from the 17 households with multiple patterns, all that favour the child, described in the previous paragraph. Seventy-seven households were randomly selected from the 149 households with patterns that do not favour the child (**Figure 5**). Hence participating households were drawn from a total of 264[1] households that could be categorized into the two broad categories of interest.

[1] 275(Total households – 11 households that could not be placed into either of the two broad categories)

3.6 Data Collection Tools

Data was collected using focus group discussion (FGD) guide, intra-household food distribution pattern survey questionnaire and 24-hour dietary recall form (**Appendix 7c**).

3.6.1 Focus Group Discussion (FGD) Guide

The focus group discussion guide consisted of a series of guide questions that were used to probe for the types of intra-household food distribution patterns used in the study area. The focus group discussion guide is included in **Appendix 7a**.

3.6.2 Intra-household Food Distribution Pattern Survey Questionnaire

An intra-household food distribution pattern survey questionnaire was used to collect data on types of intra-household food distribution patterns in households. The questionnaire had statements on a Likert scale which were constructed in a continuum ranging from *1=strongly disagree; 2=disagree; 3=neutral (neither agree nor disagree); 4=agree and 5=strongly agree* to ascertain a feeding practice in a household. The survey questionnaire had eighteen question items where each pattern type had three responses comprising of the characteristics for the reference pattern (**Appendix 7b**).

3.6.3 The 24-hour Dietary Recall Form

The 24-hour dietary recall form was used to obtain information on flour-based food items consumed by the school age child over the previous 24 hours prior to the interview. This information was provided by the caregiver (**Appendix 7c**).

3.7 Pilot Study

The data collection tools were pre-tested on caregivers of children comprising 10% of the sample as indicated by Newman, (1972). The population on which the tools were tested were not part of those who participated in the actual study. The procedures that were used in pre-testing the data collection tools were identical to those used during the actual study. Pre-testing was useful in assessing ease of use of the instruments, clarity of the instruments, rate of response and to ensure that the questionnaire and recall form were designed with adequate space for responses.

3.7.1 Validity and Reliability of Data Collection Tools

Validity and reliability of data collection tools: focus group discussion guide, intra-household food distribution patterns survey questionnaire and 24-hour dietary recall were established as follows:

3.7.1.1 Validity and Reliability of the Focus Group Discussion Guide

Using the FGD guide, the intra-household food distribution patterns practiced in the community were identified, guided by the patterns that were derived from literature. Patterns emanating from the discussion were identified based on the attributes derived from the six patterns described in this thesis. The back translated version of the FGD guide was similar to the original. Back translation of the FGD guide was carried out by an independent person, a Community Health Extension Worker (CHEW) indicating that the tool was reliable. This enhanced the validity of information generated from the FGD. A Community Nutritionist working in the area with many years of experience working with the local area was the moderator who conducted all the FGDs to enhance reliability.

3.7.2.1 Validity of the Intra-household Food Distribution Patterns Survey Questionnaire

The food distribution patterns included in the questionnaire were those identified in the FGD and the questions used were based on the attributes of each pattern as derived from literature. Three independent persons reviewed, then selected and verified the most important and correct content in the survey questionnaire. Their views were useful in enhancing the validity of the questionnaire in identifying food distribution patterns in the study households. After the pilot study, all the question items were revised and some reworked. This contributed to enhancing validity of the questionnaire.

3.7.2.2 Reliability of the Intra-household Food Distribution Patterns Survey Questionnaire

For this questionnaire, reliability was ascertained by test-retest method. This was determined by administering the survey questionnaire within a gap of one week to the same caregivers and determining the correlation of the scores between the two sessions. The first pilot was carried out in 12 households and the second one was carried out in the same households to establish the extent to which the question items in the survey questionnaire were consistent in eliciting the same responses every time the questionnaire was administered. Internal consistency of the survey questionnaire was assessed using Pearson's correlation coefficient. Usually an acceptable cut-off is 0.7. In this survey questionnaire, a reliability coefficient, $r = 0.8$ ($p=0.021$) was obtained indicating that the questionnaire was reliable.

3.7.3.1 Validity of the 24-hour Dietary Recall

The 24-hour dietary recall method used in the current study had already been validated using a weighed food record to estimate portion sizes and use of volume to measure total amount of food including *Ugali* and porridge served, eaten, left by household members where their intakes had been reflected in this study area (Minke, Personal Communication, 2012). The results of the current study reflect the potential iron intake of a group, not individuals.

3.7.3.2 Reliability of the 24-hour Dietary Recall

Test-retest method was used to determine the consistency of the 24-hour dietary recall method in measuring the flour consumption of school age children. The recall was piloted in 10 households within a period of one week apart between the first and the second session. A Pearson correlation coefficient, $r = 0.9$ (p□ 0.0001) was obtained indicating that total flour for *Ugali* and porridge consumed in pilot households were highly correlated on the two occasions.

3.8 Data Collection Procedures

3.8.1 Focus Group Discussions (FGDs)

Three focus group discussions were conducted to elicit intra-household food distribution patterns in the study area. Oral informed consent was obtained from each participant prior to conducting a focus group discussion. The participants were informed a day before the discussion of the meeting. These discussions were carried out in Ober Kamoth Health Centre, a central place for all the discussants. On the day of discussion, the participants sat in a semi-circular arrangement so that they could freely see and hear each other as the discussion continued. On arrival at the venue, a moderator with ability to speak the local language allowed them to introduce themselves before the discussion began. The tapes for recording were checked and tried out before the discussion. When the discussion began, the moderator set the tape and took the participants through the questions translated into the local language one by one, ensuring that each of them gets a chance to speak. The moderator allowed them to exhaust the responses on the question before proceeding to the next one **(Appendix 7a)**. This went on until all the questions were discussed. After the FGD, the discussants were served with refreshments. The audio-taped focus group discussions were then transcribed by the moderator who listened to the taped information, wrote the information in '*dholuo',* local language of the people in the study area and later translated it to English.

3.8.2 Household Survey

A survey of all households with an eligible child in the study area was carried out using an intra-household food distribution patterns survey questionnaire developed from information obtained from focus group discussions. The research assistants administered this questionnaire in the 296 survey households. They were 5 in number, each covering one village of the Sub-location under study. The questions were read to the caregiver and their responses ticked in a Likert-type scale. The research assistants probed for the frequency and reason if the answer was either 4 or 5 or asked for a reason if the answer was either 1 or 2 (**Appendix 7b**). This exercise took three days. The research assistants were provided with questionnaires every morning of each data collection day. They then went to the households, filled them and returned them in the evening to a specified point where the researcher checked the questionnaires to confirm that they were properly filled in. They then remained in the custody of the researcher for safe keeping and to ensure confidentiality.

3.8.3 Comparative Study

The survey was followed by a comparative study where the purpose of the study was explained to the caregiver and the amount of flour consumed by the index child was measured using 24-hour dietary recall. The 24-hour dietary recall was conducted by the researcher and research assistants. The name, identification (ID) number, age and sex of the child were recorded on a form (**Appendix 7c**). Caregivers were asked about the amount of flour-based food the child consumed in the previous 24 hours starting with the most recent meal the child consumed just before the session and worked backwards to cover all the foods eaten and filled this information on the 24-hour dietary recall form (**Appendix 7c**). Recipe details of the other dishes the child consumed were recorded as well with each item on a separate line on the recall form (**Appendix 7c**). However, only flour based food items were measured because they were the fortifiable vehicles that would help to estimate amount of iron to be potentially consumed by children. The columns containing information on weight of food served to child, weight of food left by the child and weight consumed by the child was filled by the investigator. The research assistants were selected on the basis that they were literate with secondary education, able to read, write, fluent in the local language, communicate in English and Kiswahili and live in Kanyawegi Sub-location.

3.8.3.1 Measurement of *Ugali* Intake

Ugali is one source of fortifiable flour found to be commonly consumed in this area hence was measured. To estimate amount of *Ugali* the child consumed, the total volume of *Ugali* prepared in a household was first measured and then the amount the child consumed in the previous 24 hours estimated. In measuring the volume of *Ugali*, the caregiver was asked to provide the water which he/she used to prepare it. The water was poured into a measuring jar and its volume recorded. Flour used to prepare the *Ugali* was also poured into a measuring jar to a level it reached and the volume recorded. To determine the total volume of *Ugali* cooked in a household, the research assistant asked the caregiver to pour water into the cooking pot to the level where the *Ugali* reached after flattening it to cook for a while before removal from the cooker for service. The water was poured into the measuring jar and its volume was recorded to indicate final cooked volume of *Ugali*.

The total volume of *Ugali* the child was served to eat and any amount leftover, in the last 24 hours was estimated using plasticine or modeling clay. The plasticine was shaped as served and the caregiver asked to cut a portion equal to that which the index child was served. Any amount left over by the child was cut from the plasticine representing the served portion and the two portions packed separately in zip-lock plastic bags labeled as "portion consumed" and "portion left over". If a child consumed the whole portion served, only one zip-lock bag was used and labeled "portion consumed". The research assistants packed the plasticine pieces in labeled zip-lock bags and handed them over to the investigator by the end of each day's recall for moulding and determination of volumes and weights.

To obtain the volumes and weights of *Ugali*, the pieces of plastine representing "portion consumed" were moulded well by the investigator using a knife and a ruler into cubes. Three volumes for each piece of plasticine were determined and an average of the three was calculated by summing up all the three volumes and dividing the total by three. The average volume was taken as the volume of *Ugali* consumed by the child. *Ugali* of equivalent volumes as the volumes of plasticine pieces (prepared using the most common flour: water ratio used to prepare *Ugali* in the community, as determined in the pilot study) were weighed using a kitchen scale (Black and Decker SL 13YD, England) to obtain the total weight of *Ugali* in grammes consumed by the child (**Appendix 9**).

3.8.3.3 Measurement of Porridge Intake

Porridge was the other source of fortifiable flour found to be consumed in this area. To estimate amount of porridge the child consumed, the total volume of porridge prepared in a household was first measured and then the amount the child consumed in the previous 24 hours estimated. The caregiver was asked to provide flour and the water used to prepare the porridge. The flour was measured in millilitres using a measuring jar and its weight in grams recorded. To determine the total volume of porridge prepared in a household, the research assistant asked the caregiver to pour water into the cooking pot to the level where the porridge reached after it had been cooked. The water was poured into the measuring jar and its volume recorded. In measuring the total volume of porridge consumed by the child, the caregiver was then asked to estimate in a cup the amount of porridge the child was served every time the child took porridge within the 24-hour period and its volumes recorded (**Appendix 9**).

3.9 Measurement of Variables

3.9.1 Intra-household Food Distribution Patterns

Intra-household food distribution pattern was an independent variable and was identified in the focus group discussions in the study area. The pattern used in a household was identified from the survey questionnaire.

3.9.1.1 Types of Patterns

Attributes that reflected the practice of each food distribution pattern were used to develop the survey questionnaire. Some of the attributes for the food distribution patterns are included in **Appendix 6**. The patterns were identified from the survey questions (**Appendix 7b**) as indicated below:

Needs Rule: was identified in questions e, n and p

Bargaining Model: was identified in questions b, k and r

Resource Control Model: was identified in questions g, i and q

Contributions Rule: was identified in questions a, f and o

Cultural Rule: was identified in questions d, h and l

Functional Model: was identified in questions c, j and m

In each questionnaire, the scores for responses to each question relating to a specific pattern type were summed up. For each household, the type of pattern with the highest score was identified as that most commonly practiced in the household, hence the intra-household food distribution pattern applied in that household.

Total score = sum of all responses in a pattern; scores ranged between 1 to 5 points (**Appendix 8**).

Average score for each food distribution pattern was obtained by dividing the total score of all the responses of a pattern by 3, reflecting the three responses relating to the reference pattern.

Average score = Total score/3

3.9.1.2 Patterns that Favour the Child

Households exhibiting needs rule, resource control model and bargaining model were categorized as those with food distribution patterns that favour the child.

3.9.1.3 Patterns that Do Not Favour the Child

Households exhibiting contributions rule, cultural rule and functional model were categorized as those with food distribution patterns that do not favour the child.

3.9.2 Total Amount of Flour Consumed

Amount in grammes, of all flour consumed by the index child, was determined by converting reported flour estimates from portion sizes and household measures, in cubic centimeters (cm^3)

then weighed into grammes as follows. A table was generated to guide the conversions (**Appendix 9**).

The amount of flour in grammes consumed from *Ugali* per child was obtained thus:

$$\left(\frac{\text{Amount of flour in prepared } \textit{Ugali} \text{ in grammes}}{\text{Total volume of } \textit{Ugali} \text{ cooked (cm}^3\text{)}} \right) \times \text{Volume of } \textit{Ugali} \text{ consumed by the child (cm}^3\text{)}$$

To determine the weight of flour in grammes in porridge consumed by the child, the following formula was used:

$$\left(\frac{\text{Weight of flour in porridge in grammes}}{\text{Total volume of porridge cooked (cm}^3\text{)}} \right) \times \text{Total volume of porridge consumed by child (cm}^3\text{)}$$

Total amount of flour consumed by the index child in 24 hours flour based food items

= flour from *Ugali* + flour from porridge

3.9.3 Potential Iron Intake

Potential iron intake was a dependent variable and was calculated thus:

Total amount of flour consumed by the child (calculated from the flour composition of *Ugali* and porridge) x 20 or 15 mg iron/kg flour for WHO and Kenya respectively.

This was considered as the total amount of potential iron that each child would consume as additional iron from fortification.

3.9.4 Age

Age of the index child was indicated in years as reported by the caregiver or confirmed from the child's clinic attendance card if it were available.

3.10 Data Analysis

Data obtained from the focus group discussions were transcribed and analyzed using thematic analysis (Aronson, 1994). The data were organized into themes which reflected intra-household food distribution patterns (**Appendix 10**). Data was first entered into an excel worksheet, cleaned and imported into the Statistical Package for Social Sciences (SPSS) version 20 for analysis. A Z-test was conducted to identify the most dominant food distribution patterns in the study sample. Data distributions of continuous variables (age, sex, village and potential iron intake) were assessed for normality both visually (histograms) and using normality test (Shapiro-Wilk test). The Shapiro-Wilk test is more appropriate in checking for normality on small samples of n = 3 and can also handle sample sizes as large as 2000 and provides better power than the Kolmogorov Sminorv test (Thode, 2002). Potential iron intake based on amount of flour hence iron consumed by the target child was described using medians and interquartile range (IQR) because the data had a skewed distribution.

Independent samples Mann-Whitney U test was conducted to assess whether there were differences in flour consumption between male and female children. An independent samples Kruskal-Wallis test was conducted to assess whether the distribution of total flour consumed was the same across all age categories of children and their village of residence. Chi-square (χ^2) test was performed to investigate whether there were differences in the distribution of sex, age and village of residence in the two food distribution pattern groups.

Potentially consumed iron was found to be non-normally distributed and was log-transformed for analysis. Regression analysis was used to compare iron intakes in children whose households apply food distribution patterns that favour the child and those from households who use food distribution patterns that do not favour the child. Multiple linear regression was used to determine the relationship between intra-household food distribution pattern and potential iron intake from iron-fortified flour by school age children, in log-transformed data, adjusting for other factors such as age, village and sex that may influence iron intake. Regression coefficients were exponentiated to obtain geometric mean differences in iron intake. The exponentiated results were expressed as percent difference in iron intake in food distribution patterns that favour and those that do not favour the child in iron intake, which are easier to interpret than geometric mean differences.

3.11 Ethical Considerations

This study was conducted within the PIMAL study of the INSTAPA project Work Package 5. Permission for research was granted by Maseno University School of Graduate Studies (**Appendix 2**); ethical approval granted by Maseno University Ethics Review Committee (**Appendix 3**). During study entry, clearance was granted at the location, sub-location, village and the participating households. Informed verbal and written consent of the parents or caregivers of the households was also obtained before data were collected. Anonymity, privacy and confidentiality of the respondents was upheld. All the participants signed informed consent form before participating in the study (**Appendix 5**).

3.12 Data Quality Management

To ensure appropriate data quality management, the principal investigator checked the questionnaires daily for accuracy, consistency and completeness and provided feedback and correction regarding the collected data daily to the research assistants. Additionally, all documents related to the participants and that were intended to be used in the study remained under the custody of the principal investigator for safe keeping and to ensure confidentiality and could not be accessed by any unauthorized person.

CHAPTER FOUR: RESULTS

4.1 Intra-household Food Distribution Patterns in Kanyawegi Sub-location

The first objective sought to identify the intra-household food distribution patterns in Kanyawegi Sub-location and the objective was divided into two parts: first, intra-household food distribution patterns in the study area and second, intra-household food distribution patterns in the participating households.

4.1.1 Intra-household Food Distribution Patterns in the Study Area

Data was obtained through three focus group discussions (FGDs) and the patterns determined by thematic analysis. Four patterns were identified in FGD 1, six patterns in FGD 2 and five patterns in FGD 3 (**Table 4.1**). Data from which these results are obtained is presented in **Appendix 10.** The patterns were further classified into two main categories which included patterns that favour and patterns that do not favour the child with respect to food intake.

Table 4.1: Identified food distribution patterns in Kanyawegi Sub-location

Food distribution pattern	FGD1	FGD2	FGD3
Contributions Rule	×	×	-
Needs Rule	×	×	×
Resource Control Model	×	×	×
Cultural Rule	×	×	×
Bargaining Model	-	×	×
Functional Model	-	×	×

× Pattern identified - pattern not identified

4.1.1.1 Patterns that Favour the Child

Patterns that favour the child, as depicted from responses generated from FGDs including Needs Rule, Resource Control Model and Bargaining Model, are indicated below.

4.1.1.1.1 Needs Rule

Needs Rule was common to all FGDs as indicated by the following responses:

> "Mothers take care of children's food needs first. Sometimes the mother may be the provider of the family but she can take little or no food at all because she takes care of a family's food needs first" [FGD 1: CHVs].

> "Small children don't earn money, they cannot support themselves so they are given more food because they need it to grow and develop. They are also anxious, impatient and can easily begin to cry if not satisfied". [FGD 2: caregivers group 1].

> "School age children play a lot and some walk a long distance to school and thus they are given more food because they require it for energy. So the mother sits with children so that she may understand their eating habits, quantities and whether they have eaten enough. Children are grouped according to age and served each with his/her plate of *Ugali* and vegetables or '*omena*' (sardines) because others eat faster than others and it is also hygienic to serve them in their own plates". [FGD 3: caregivers group 2].

Children's need for "*more food*" was expressed repeatedly in all the discussions the basic reasons given being their "*need to grow and develop*", "*require it for energy*", "*mother's concern on whether the children have eaten enough".*

4.1.1.1.2 Resource Control Model

Resource Control Model was also common to all FGDs as indicated by the following responses:

> "At times husband's money may not be enough. Women are nowadays busy with small and medium-term businesses and do not necessarily depend on their husbands. Women even join *chamas* (small organizations where they contribute money and engage themselves in income generating activities). Some sell firewood, farm produce, join merry-go-rounds[2] and take care of their families. Where the husband may be unable to contribute or is jobless; the woman takes responsibility to help the family". [FGD 1: CHVs].

> "If the husband may be unable to contribute or is jobless or incapacitated; it is the women to take responsibility and help their families. If women get even a small piece of land they plant vegetables, even rear chicken for eggs and or sell to get money to take care of everyone in their households" [FGD 2: Caregivers group 1].

> "Women really know how to use their money. If they get any small amount of money, they first think about buying food for their families and because they are more child-oriented than men, then they ensure their children eat enough food" [FGD 3: Caregivers group 2].

The impact of women's "*control over resources*" and "*income*" was expressed in all the discussions, the basic reasons being they are "*busy with small businesses and no longer depend on husbands*", "*if they get land, they plant vegetables, rear chicken and take care of everyone in their households*" and "*ensure their children eat enough food*".

[2] Money is collected periodically by a group and members take turns to receive the amount collected

4.1.1.1.3 Bargaining Model

Bargaining Model was expressed in FGD 2 and 3 as indicated by the following responses:

> "Where there is respect, father and mother consult and no one forces the other on household matters including sharing food. Older children can also be involved in decision making especially on household issues that do not require secrecy such as giving instructions on farming issues, washing up, cooking and serving food" [FGD 2: Caregivers group 1].

> "We always do things together. For example in times of food shortage one person cannot work alone to bring food to the household. We discuss and agree. Both of us go out to work; we both bring home food and prepare and eat. In many occasions, the two of us sit and discuss about what to buy and eat because we know what is needed in the household. If the husband is away, then the mother can decide with elder children who are of age particularly an elder girl or boy" [FGD 3: Caregivers group 2].

The decision makers "*discussing on bringing, preparing and eating food*" was expressed repeatedly in the discussions 2 and 3 the basic reasons given being "*they consult without forcing each other*", "*there is respect for each other's decision* " and "*there is agreement in the family*".

4.1.1.2 Patterns that Do Not Favour the Child

Patterns that do not favour the child, as depicted from responses generated from FGDs including Cultural Rule, Functional Model and Contributions Rule, are indicated below:

4.1.1.2.1 Cultural Rule

Cultural Rule was common to all FGDs as indicated by the following responses:

"A household with a man as the head is the one that grows well and thus he is served first and more food before other members as a sign of respect" [FGD 1: CHVs].

"The man is served first and given more food than others because of respect and appreciation, being the owner of the home and because it is part of our culture" [FGD 2: Caregivers group 1].

"The man is served first an amount of food enough for him; he is given first consideration because the wife may not want him to sleep hungry as a hungry man is an angry man. Because some children are young and others older, the man cannot be at ease fighting over food and some young boys are already eating a lot and are pretty fast, and the man may not get sufficient food, hence the mother takes care of this early enough. In case the father is not there, then the elder son is served in the same way as the father that is he is served first and enough food and if he has his friends around he can eat with them. If he is of age he becomes the decision maker of the household" [FGD 3: Caregivers group 2].

The man being "*served first*" and "*more food*" was expressed repeatedly in all the discussions the basic reasons given being "*as a sign of respect and appreciation* ", "*it is part of culture*", and "*they are the owners of the home"*.

4.1.1.2.2 Functional Model

Functional Model was expressed in FGD 2 and 3 as indicated by the following responses:

"Working people often use a lot of energy in working to maintain the survival of household by producing food for the family and so are served more food to replace the energy they lose" [FGD 2: Caregivers group 1].

> "Adults, older boys and girls who are able to work generally are required to fend for the younger ones, work harder and support the household by bringing food home and to help the young" [FGD 3: Caregivers group 2].

Productive members of the household's need for "*more food*" was expressed in FGD 2 and 3 the basic reasons given being the need to "*replace the energy they lose from hard work*", " *produce food to maintain household survival and help the young".*

4.1.1.2.3 Contributions Rule

Contributions Rule was expressed in FGD 1 and 2 as indicated by the following responses:

> "Those who contribute more money to the family must not miss food and are served larger portions of food because that means that they take care of the family and do not misuse money elsewhere as using it to take drugs. They eat to their fill and whatever they want to eat as an encouragement so that they can bring home more money" [FGD 1: CHVs].

> "Household members who contribute to the family in terms of providing workforce such as ploughing with oxen, sowing crops, weeding and even preparing food are served slightly larger portions of food in order to enhance their capacity to work and continue helping the family. Some women who contribute a lot to the household in terms of their money and even in domestic work as in food preparation are served more food. Some women who contribute a lot to the household accept larger shares of food and others just take enough" [FGD 2: Caregivers group 1].

Household members who contribute more to the family being served "*larger portions of food*" was expressed in FGD 1 and 2 the basic reasons given being they "*care for family and do not* *misuse money*", "*as encouragement to bring more money*", "*enhancing their capacity to work and help the family".*

4.1.2 Intra-household Food Distribution Patterns in Households of Kanyawegi Sub-location

To determine the intra-household food distribution pattern practiced at household level, the intra-household food distribution pattern survey questionnaire constructed based on the results from focus group discussions was administered to the caregivers in the participating households. The pattern practiced was determined as described in chapter 3. The most widely practiced food distribution patterns were Cultural Rule and Functional Model which, combined, were applied by about 42% of the households, followed by Multiple Patterns, Needs Rule, Contributions Rule, Resource Control Model and Bargaining Model. **Figure 5** shows the distribution of households by intra-household food distribution pattern.

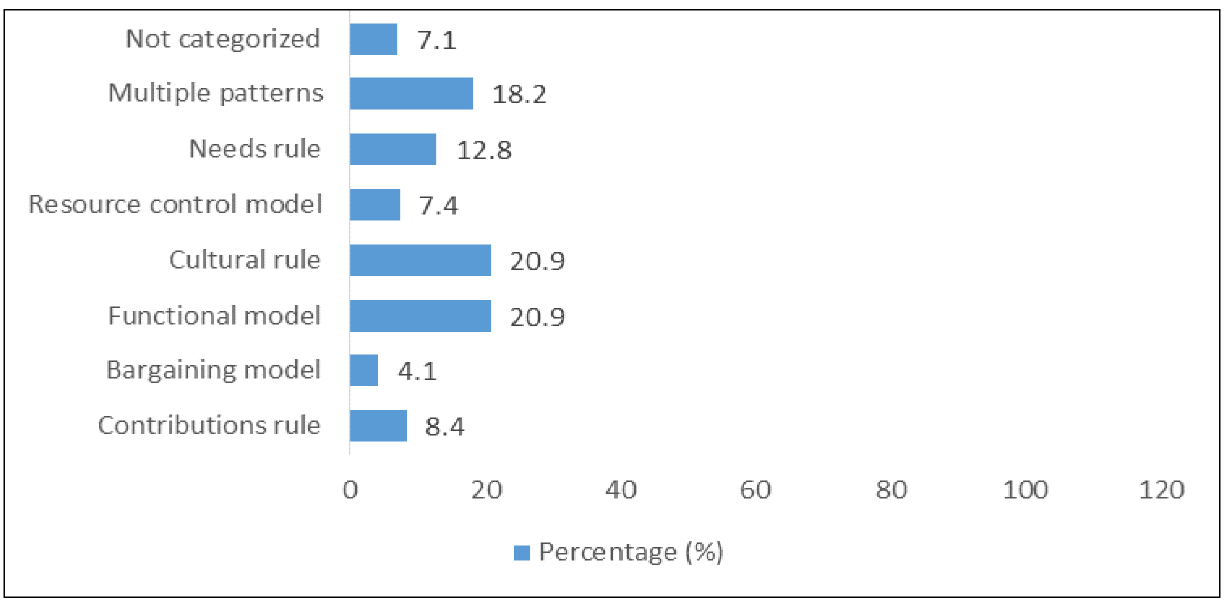


Figure 5: Distribution of households by intra-household food distribution patterns

A Z-test was conducted to identify the most dominant food distribution patterns. In all the food distribution patterns, an expected frequency of 12.5 was appropriate in the sampled households.

The Functional Model, Cultural Rule and Multiple Patterns were significantly higher than the expected frequency ($p<0.001$). Needs Rule was not significantly higher than the expected frequency ($p>0.05$). However, Contributions Rule, Resource Control Model and Bargaining Model were significantly lower than the expected frequency ($p<0.001$). The uncategorized food distribution patterns were significantly lower than the expected frequency ($p<0.0001$). These results confirm that the functional model and cultural rule appeared to be the most dominant food distribution patterns; and that multiple patterns were identified in a significant proportion of households. The other patterns (Resource Control Model, Bargaining Model and Contributions Rule) were not frequently applied (**Table 4.2**).

Table 4.2: Significant proportions of intra-household food distribution patterns

Pattern of food distribution	Proportion Expected Frequency = 12.5	Z-test	95% CI	P value
Contributions Rule	8.4	37.1957	0.08-0.16	0.0001
Bargaining Model	4.1	14.8263	0.08-0.16	0.0001
Functional Model	20.9	4.3698	0.08-0.16	0.0001
Cultural Rule	20.9	4.3698	0.08-0.16	0.0001
Resource Control Model	7.4	31.9935	0.08-0.16	0.0001
Needs Rule	12.8	0.1581	0.08-0.16	0.876
Multiple Patterns	18.2	2.9653	0.08-0.16	0.003
Not categorized*	7.1	30.4329	0.08-0.16	0.0001

*Scores below 3.5 the minimum for establishing a pattern

4.2 Potential Iron Intake from Iron-fortified Flour

The second objective sought to assess the potential amount of iron consumed by school age children in the study area. The children were grouped as either falling in food distribution patterns that favour the child or food distribution patterns that do not favour the child. First, assessment of flour intake by children occurred in the third phase of the study in which the flour products intake of index children was measured using the 24-hour dietary recall. Flour products intakes were then assessed in index children based on the two groups of food distribution patterns. The potential iron intake of school age children was assessed first by calculating the amount of flour a child consumed; and then calculating the potential amount of iron that would be consumed by the child if the flour were fortified with iron. The calculated potential iron intake was based on two iron fortification levels: the WHO recommended fortification level of 20 mg/kg flour and the maximum Kenya recommended iron fortification level of 15 mg/kg flour.

4.2.1 Assessment of Flour Intake by School Age Children

Given that the flour consumption was not normally distributed, medians were used to describe flour intake and interquartile ranges were used to describe the flour consumption distribution. The median (IQR) total flour consumed for all children falling in both the food distribution patterns that favour the child and the food distribution patterns that do not favour the child was 231.6 (153.9, 322.9) g. For children falling in the group with food distribution patterns that favour the child, the median (IQR) total flour consumed was 319.8 (224.7, 450.7) g. For children falling in the group with food distribution patterns that do not favour the child, the median (IQR) total flour consumed was 143.3 (83.0, 195.1) g. Children 3 to 8 years were found to consume 82-469 g flour in a day. The data is indicated in **Table 4.3** aggregated by food distribution pattern, and for all children.

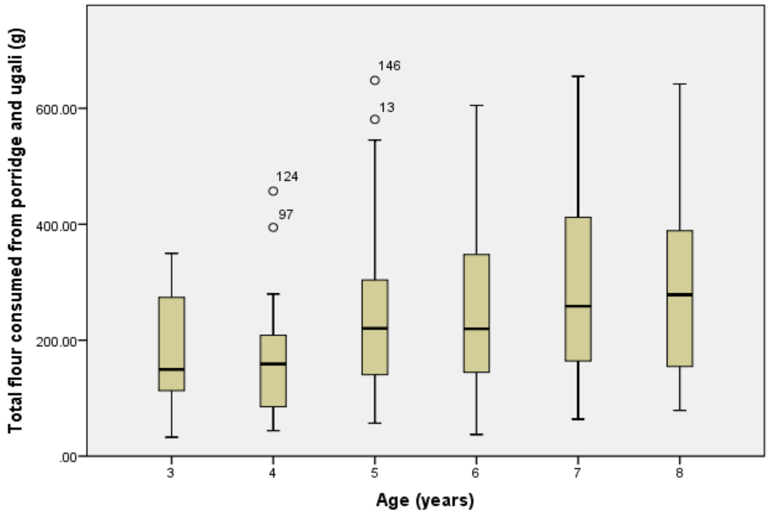
Table 4.3: Participant age, sex and flour consumption by food distribution pattern

Food distribution pattern	N	Age (Years)*	Sex (M/F) (%)	Total flour(g)**
Contributions Rule (CBR)	9	4.8±1.3	66.7/33.3	143.3 (123.7, 181.6)
Bargaining Model (BM)	12	5.8±1.0	41.7/58.3	327.9 (330.9, 469.1)
Functional Model (FM)	29	4.9±1.5	48.3/51.7	158.3 (79.7, 222.1)
Cultural Rule (CR)	39	5.3±1.5	53.8/46.2	133.5 (82.0, 187.6)
Resource Control Model (RC)	23	5.9±1.5	47.8/52.2	324.8 (191.8, 419.1)
Needs Rule (NR)	37	6.4±1.4	54.1/45.9	297.8 (221.3, 458.8)
Patterns that favour the child	77	6.1±1.5	49.4/50.6	319.8 (224.7, 450.7)
Patterns that do not favour the child	77	5.1±1.4	53.2/46.8	143.3 (83.0, 195.1)
All children	154	5.6±1.5	51.3/48.7	231.6 (153.9, 322.9)

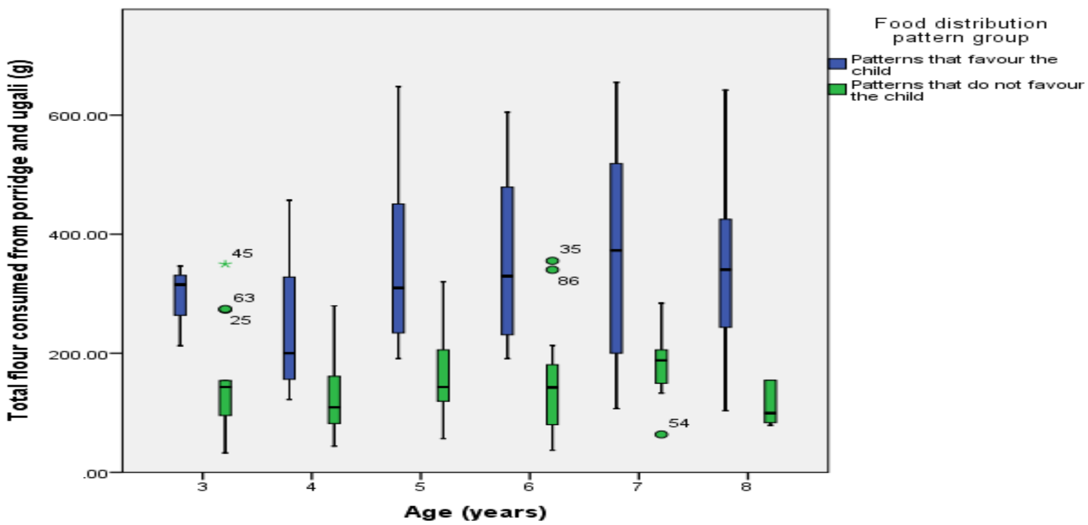
* Mean ±SD **Median (IQR); Sex (M-Male, F-Female)

4.2.1.1 Distribution of Flour Consumption by Age of Child

To determine whether participant characteristics may influence flour intake, hence potential iron intake, box plots were used to visually assess the distribution of flour consumption by age, sex and village of residence of the children; followed by confirmatory statistical tests. The mean age for all children in both food distribution patterns that favour the child and food distribution patterns that do not favour the child was 5.6±1.5. The mean age of children whose food distribution patterns favour the child was 6.1±1.5 and that for children whose food distribution patterns do not favour the child was 5.1±1.4. Children of all age groups whose food distribution patterns favour the child appeared to consume more flour compared to children whose food distribution patterns do not favour the child (**Figure 6**).



Panel a

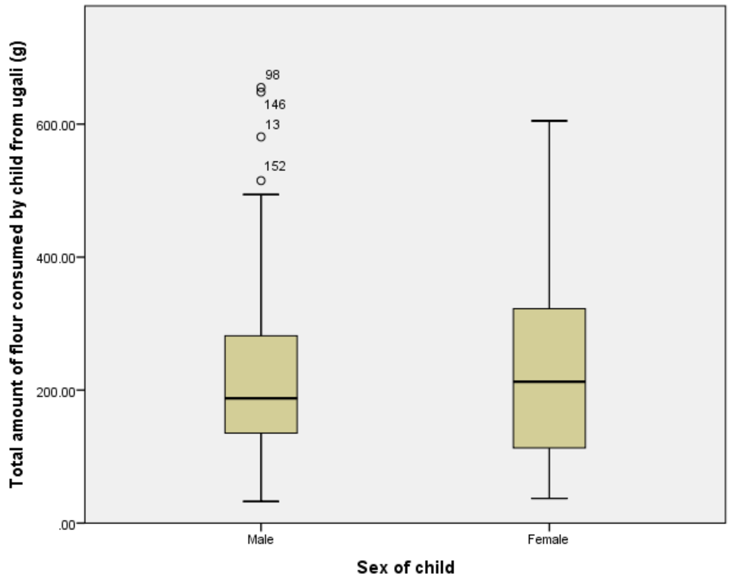


Panel b

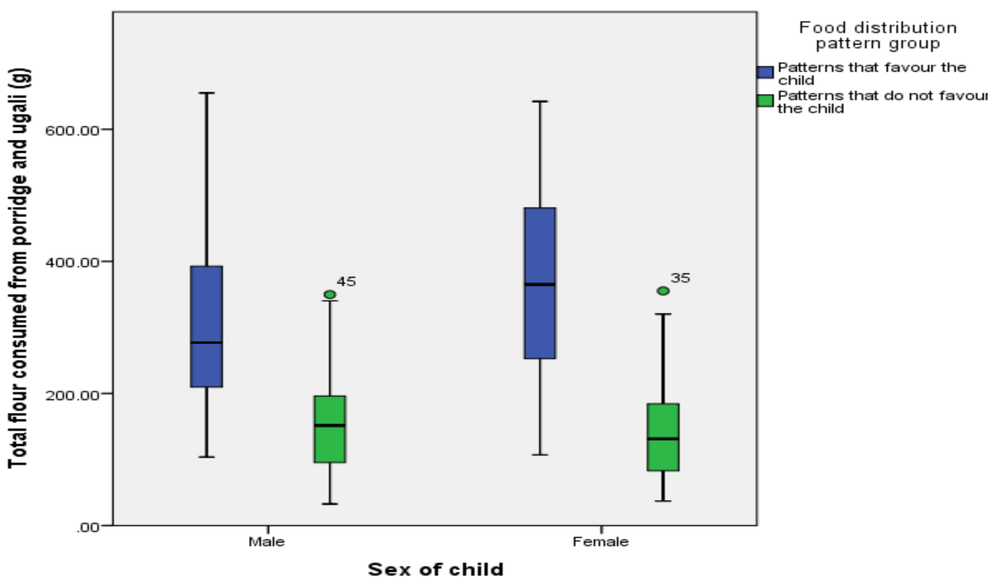
Figure 6: Box plots showing the distribution of total flour consumption by age of child: Panel a: all the children; panel b: aggregated by food distribution pattern group.

4.2.1.2 Distribution of Flour Consumption by Sex of Child

Flour consumption appears to be similar in males and females in general (**Figure 7 panel a**). However, intakes appear to be higher in general in the group of children from households that practice patterns that favour the child than in those from households practicing patterns that do not favour the child (**Figure 7 panel b**).



Panel a

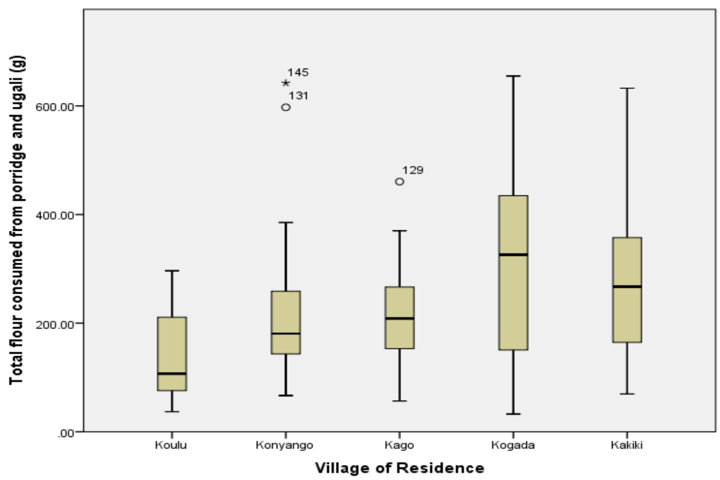


Panel b

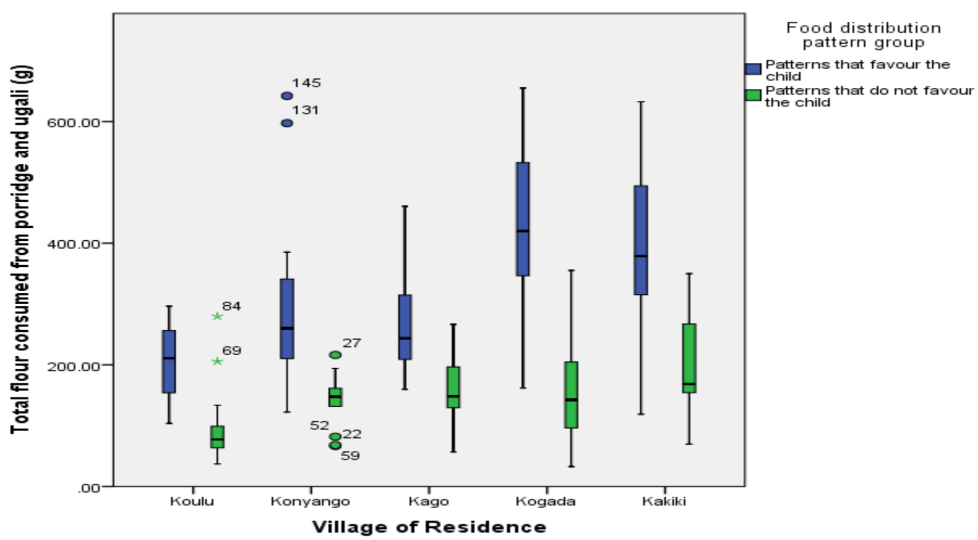
Figure 7: Box plots showing the distribution of total flour consumption by sex of children: Panel a: sex of the child; panel b: aggregated by food distribution pattern group

4.2.1.3 Distribution of Total Flour Consumption by Village of Residence of the Child

More children across all the villages appeared to consume a higher proportion of flour in food distribution patterns that favour the child and a smaller proportion of flour in food distribution patterns that do not favour the child (**Figure 8**).



Panel a



Panel b

Figure 8: Box plots showing the distribution of total flour consumption by village of residence of child: Panel a: village of residence of the child: panel b: aggregated by food distribution pattern group.

Independent samples Mann-Whitney U test was conducted to assess whether there were differences in flour consumption between male and female children. The test indicated that there were no differences (p=0.395).

An independent samples Kruskal-Wallis test to assess whether the distribution of total flour consumed was the same across all age categories of children indicated that it was not the same (p=0.034). An independent samples Kruskal-Wallis test to assess whether the distribution of total flour consumed was the same across categories of village of residence of children indicated that it was not the same (p=0.000). This could suggest that age and village may influence flour intake hence iron intake.

Chi-square (χ^2) test was performed to confirm whether or not there were differences in the distribution of sex, age and village of residence in the two food distribution pattern groups. There were no differences in the distribution of sex (χ^2 = 0.104; degrees of freedom, df =1; p=0.747) or village of residence (χ^2 = 1.518; df = 4; p=0.823) of children, in food distribution pattern groups that favour and those that do not favour the child. There were differences in the distribution of age of children in food distribution pattern groups that favour and those that do not favour the child (χ^2 = 17.078; df = 5; p=0.004). Therefore, age could influence flour intake hence iron intake, therefore should be adjusted for in subsequent analyses.

4.2.2 Assessment of Potential Iron Intake from Iron-fortified Flour

The potential amount of iron from iron-fortified flour that was consumed by school age children was calculated based on the fortification level recommended by the World Health Organization of 20 mg iron/kg flour and that of the Kenya Government of 15 mg iron/kg flour. Potential iron intakes were not normally distributed and thus medians and interquartile ranges were used to describe the data. The median (IQR) potential iron intake (mg) assuming WHO fortification level of 20 mg iron/kg flour for all children was 4.7 (3.1, 6.5) mg and the median (IQR) potential iron intake (mg) assuming Kenya fortification level of 15 mg iron/kg flour for all children was 3.5 (2.3, 4.8) mg. For children falling in the group with food distribution patterns that favour the child, the potential iron (mg) assuming WHO fortification level of 20 mg iron/kg flour was 6.4 (4.5, 9.0) mg. For children falling in the group with food distribution patterns that do not favour the child, the median potential iron (mg) assuming WHO fortification level of 20 mg iron/kg flour was 2.9 (1.7, 3.9) mg. For children falling in the group of food distribution patterns that favour the child, the median (IQR) potential intake of iron (mg) assuming Kenya fortification level of 15 mg iron/kg flour was 4.8 (3.2, 6.7) mg and for children falling in the group with food distribution patterns that do not favour the child the median iron intake was 2.2 (1.4, 2.9) mg. **Table 4.4** shows participant age, sex and potential iron intake by food distribution pattern.

Table 4.4: Participant age, sex and potential iron intake by food distribution pattern

Food distribution pattern	**N**	**Age (Years)***	**Sex (M/F) (%)**	**Fe WHO (mg)****	**Fe Kenya (mg)****
Contributions Rule (CBR)	9	4.8±1.3	66.7/33.3	2.9 (2.5, 3.6)	2.1 (1.9, 2.7)
Bargaining Model (BM)	12	5.8±1.0	41.7/58.3	6.6 (4.6, 9.4)	4.9 (3.3,7.0)
Functional Model (FM)	29	4.9±1.5	48.3/51.7	3.2 (1.6, 4.4)	2.4 (1.2, 3.3)
Cultural Rule (CR)	39	5.3±1.5	53.8/46.2	2.7 (1.6, 3.8)	2.0 (1.2, 2.8)
Resource Control Model (RC)	23	5.9±1.5	47.8/52.2	6.5 (3.8, 8.4)	4.9 (2.9, 6.3)
Needs Rule (NR)	37	6.4±1.4	54.1/45.9	5.9 (4.4, 9.2)	4.5 (3.3, 6.9)
Patterns that favour child	77	6.1±1.5	49.4/50.6	6.4 (4.5, 9.0)	4.8 (3.2, 6.7)
Patterns that do not favour child	77	5.1±1.4	53.2/46.8	2.9 (1.7, 3.9)	2.2 (1.4, 2.9)
All children	154	5.6±1.5	51.3/48.7	4.7 (3.1, 6.5)	3.5 (2.3, 4.8)

* Mean ±SD **Median (IQR); Sex (M-Male, F-Female)

4.3 Relationship between Intra-household Food Distribution Pattern and Potential Iron Intake

Iron intake data was log-transformed to normalize the data and allow for adjustment for factors that were identified as influencing flour consumption. This was done by transforming the data to log base 10. To determine whether there were differences in log iron intake in the two food distribution pattern groups, a crude analysis was performed followed by an adjusted analysis to account for any differences that may be attributed to factors other than food distribution pattern group. It was decided *a priori* that adjusted estimates could be more relevant than crude estimates because even small differences in iron intake of children could lead to confounding and therefore it was important to perform a log transformation. In the crude analysis, a t-test was used to compare iron intake between the two groups of food distribution patterns: those that favour and those that do not favour the child for both WHO and Kenya recommended fortification levels. Food distribution patterns that favour the child were used as the comparison group. For both WHO and Kenya fortification levels, the crude log iron difference was -0.37 (95% CI: 0.44-0.29 mg; p=0.000). Mean difference in log iron intake generated were exponentiated to obtain the geometric mean. The crude value was 0.43 (95% CI: 0.36, 0.50; p=0.000) mg based on WHO and Kenya recommended fortification levels (**Table 4.5**).

In the adjusted analysis age, village of residence of the child, and sex were also included in addition to food distribution pattern groups, in a multiple linear regression analysis. Sex was included because although it did not seem to influence intake in this study, it is a known influencing factor of food intake and its influence may have been too small to detect in this study. For both WHO and Kenya fortification levels, the adjusted log iron intake was -0.35 (-

0.43-0.29 mg CI, p=0.000). Regression coefficients were exponentiated to obtain geometric mean differences in iron intake. The geometric mean for adjusted log-transformed iron intake for the WHO and the Kenya fortification levels was 0.44 (0.38, 0.50) mg. This mean was based on iron intake from the two groups of food distribution patterns. These results were expressed as percent difference in iron intake[3] in food distribution patterns that favour and those that do not favour the child in iron intake (**Table 4.5**).

Table 4.5: Difference in iron intake between food distribution patterns that favour and those that do not favour the child

	Difference in iron intake (mg)			
	Log iron (95% CI)	**Geometric mean (95%CI)**	**Percent mean difference (95%CI)**	**p-value**
WHO levels‡				
Crude analysis	-0.37 (-0.44, -0.29)	0.43 (0.36, 0.50)	-57.2 (-63.6, -49.8)	0.000
Adjusted* analysis	-0.35 (-0.42, -0.29)	0.44 (0.38, 0.50)	-55.5 (-61.9, -48.2)	0.000
Kenya levels‡				
Crude analysis	-0.37 (-0.44, -0.29)	0.43 (0.36, 0.50)	-57.2 (-63.6, -49.8)	0.000
Adjusted* analysis	-0.35 (-0.42, -0.29)	0.44 (0.38, 0.50)	-55.6 (-61.9, -48.2)	0.000

Results are indicated as difference in the group of children from households with food distribution patterns that do not favour the child relative to children from households with food distribution patterns that favour the child; *Adjusted for age, village of residence and sex; ‡Recommended iron fortification levels by WHO and Kenya, respectively.

[3] Percent difference = (Geometric mean – 1)*100

CHAPTER 5: DISCUSSION

5.1 Intra-household Food Distribution Patterns

This study aimed at identifying the intra-household food distribution patterns in households in Kanyawegi Sub-location which were then grouped based on whether they favour or do not favour the child with regard to food intake. The food distribution patterns were identified using a descriptive framework consisting of six food distribution patterns drawn from literature. Based on this approach, all the six food distribution patterns were identified in this population. Of the six food distribution patterns, three favour the child and the other three do not favour the child. The most prominent food distribution patterns identified in this community were Cultural Rule and Functional Model, both of which do not favour the child. It was observed that three quarters (75%) of the households practice food distribution patterns that do not favour the child. This implies that food distribution patterns practiced in this population mainly do not favour the child.

Although some households were found to use multiple food distribution patterns most of these, though not possible to categorize into individual patterns, could still be either categorized as favouring or not favouring the child therefore could be included in the study. Multiple Patterns that remained uncategorized because they were not consistent with a clear pattern of food distribution were omitted from the analyses. It is acknowledged that inability to clearly categorize some food distribution patterns could have resulted from potential existence of additional patterns that may not be captured in the framework used. Alternatively, more questions than the number used in this study may be required to clearly categorize these households. It could also mean that households may practice mixed patterns on the basis of this framework as observed. However, this did not compromise identification of intra-household food distribution patterns in the study area within the two groupings of interest to the study. The possibility that some households may practice more than one pattern needs to be confirmed.

The findings from the current study confirm our interpretation that the Needs Rule (Cassidy 1987, Peter *et al*., 1997), Bargaining Model (Maluccio and Quisumbing, 2003; Kishor, 2000) and Resource Control Model (Doss, 1997) are intra-household food distribution patterns that benefit children. On the other hand, Cultural Rule (Esterik, 1985; Gittelsohn, 1991), Functional Model (Wheeler, 1988) and Contributions Rule (Leventhal, 1980), do not favour children in households. This is confirmed by higher intakes of flour based products observed in children from households practicing the first three intra-household food distribution patterns and low intakes observed in children from households practicing the latter three intra-household distribution patterns.

The potential advantage experienced by children in households that practice intra-household food distribution patterns that favour the child are explained by preference in food allocation to children as needy members (Cassidy, 1987); female bargaining power, which is likely to lead to better child nutrition and health outcomes (Maluccio and Quisumbing, 2003) and women's autonomy being associated with improved child health (Kishor, 2000); and the observation by Doss (1997) that females' income is likely to have greater positive effect than males' income on infant, pre-schooler nutrition and education of children. These explanations apply to the Needs Rule, Bargaining Model and Resource Control Model, respectively. Greater benefit to children in households that practice these patterns could mean that such children would in turn receive more iron than children in households that practice patterns that do not favour children.

Potential disadvantage for children in households that practice intra-household food distribution patterns that do not favour children are explained by people with high status being served larger portions at the expense of the vulnerable individuals such as school age children (Esterik, 1985; Gittelsohn, 1991); food allocation being based on an individual's productivity to the household (Wheeler 1988), rendering children vulnerable; and food seen as a reward for the recipient's inputs and contribution, implying equal pay for equal work hence is distributed based on household members' input, with children making the least contribution (Leventhal, 1980). These explanations apply to the Cultural Rule, Functional Model and Contributions Rule, respectively. Children from such households are therefore likely to receive less food than other household members and in our study children from these households consumed less flour-based products than children from households that practice intra-household food distribution patterns that favour children.

5.2 Potential Iron Intake from fortifiable Flour by School Age Children

The Estimated Average Requirements (EAR) of school age children 3 years old is 3.0 mg/d and for children 4-8 years it is 4.0 mg/d (IOM, 2001). This falls within the range suggested from the review of literature, 2.5 – 5.6 mg of iron per day that have been found to be efficacious in children of similar ages, in efficacy studies (Andang'o *et al*., 2007; Zlotkin and Tondeur, 2007; Macharia-Mutie *et al*., 2010). The median (IQR) for potential iron intakes of all children in this population based on WHO recommendation (20 mg) iron per kg flour, would be 4.7 (3.1, 6.5) mg and for Kenya it would be 3.5 (2.3, 4.8) mg. This implies that overall, in this population, the iron intake of children, from fortified flour, based on WHO recommendations is sufficient for both children aged 3 years and those aged 4-8 years because the upper intake limit (6.5 mg) of iron in this group of children (indicated by intake of all children) is above the EAR. If the Kenya fortification levels of 15mg iron per kg flour were adopted, the iron intake of children aged 3 years and 4-8 years from fortified products would be sufficient because the upper intake limit (4.8 mg iron) is above the EAR.

However, in the three efficacy studies mentioned the authors used porridge as the fortification vehicle, with intakes of the fortified product separated from other meals, to estimate iron intake of children. In contrast, the fortifiable flour in the current study would be consumed with other meals implying that if the flour consumed were fortified, there may be other factors in the diet that could potentially influence iron bioavailability. In children from households with food distribution patterns that do not favour the child, the iron intake based on the WHO fortification levels could still meet their requirements as confirmed by median (IQR) potential iron intakes of 2.9 (1.7, 3.9) mg, however, the iron intake based on Kenya fortification levels may not meet their requirements with respect to the EAR as confirmed by median (IQR) potential iron intakes of 2.2 (1.4, 2.9) mg. This implies that for these children fortification at the maximum fortification level could be inadequate to meet their needs if additional iron from the diet is insufficient.

It should be noted that considering the overall intake of children in this group, which reflects the average intake of children both from households practicing food distribution patterns that favour the child and those practicing food distribution patterns that do not favour the child, masks the difference in iron intakes of children from the two groups because the higher intakes in the former group of children compensates for the low intakes of the children in the latter group making the overall intake appear sufficient when compared with the EAR for children in the age groups included in this study. It is therefore necessary to consider these groups separately when addressing issues of food and nutrient intakes.

In this population, the fortified iron product is mainly consumed with other meals. Therefore, although the data from the current study shows that fortification alone may not meet some children's iron requirement, the potential iron intake of this age group may still be rendered sufficient from fortified products, because EDTA, a component of the recommended iron fortificant, has the ability to mobilize iron from other sources (Hurrel, 1997). The EDTA chelates iron, and may prevent it from binding to the ligands or inhibitors of iron absorption, such as phytates (Bothwel and Macphail, 2004). Improved iron bioavailability may result in higher absorption of iron than is expected, hence increasing the possibility of most children in this group meeting their iron requirement. However, this cannot be established in the current study, and it can only be assumed that some children may not meet their requirement, from the data shown especially if their intakes are based on fortification level recommended by Kenya and are from households applying intra-household food distribution patterns that do not favour the child.

Improved iron bioavailability does not increase the possibility of iron overload because iron absorption is regulated according to the body's needs; increasing in iron deficiency and decreasing where iron status is normal (Ganz, 2013). On the other hand, a study by Hurrell and Egli (2010) has shown that vehicles such as sorghum have a strong inhibitory effect and may lower bioavailability of iron even from NaFeEDTA. In the current research setting, most families consume flour products prepared from mixtures of maize with other grains such as sorghum or millet indicating that there is a possibility of lower bioavailability of iron than in the Andang'o *et* *al*., 2007; Macharia-Mutie *et al*., 2010 and Zlotkin and Tondeur, 2007 studies. This implies that less iron than expected may be absorbed, and iron intake may be insufficient, especially at the Kenya fortification levels. The question of whether NaFeEDTA may increase iron absorption from the diet enabling all children in this population; or whether iron absorption inhibitors in the diet may inhibit iron absorption thereby reducing the ability of some children in this population to meet their iron requirements therefore remains unanswered.

5.3 Relationship between Intra-household Food Distribution Pattern and Iron Intake by School Age Children

The findings of this study indicate an association between intra-household food distribution pattern and potential iron intake of this group of school age children. The potential iron intake of children in households that practice food distribution patterns that do not favour the child is 55% lower than that of their peers in households that practice food distribution patterns that favour the child. This implies that children in households that practice food distribution patterns that do not favour the child would benefit less than half as much from iron fortification interventions. This confirms that intra-household food distribution patterns influence the iron intake of children through fortification.

Although the children in households with food distribution patterns that do not favour the child would receive less than half of the iron from fortification adding NaFeEDTA to their meals including their flour based food product, would result in a reciprocal or equal exchange between food iron and iron from the NaFeEDTA and this could enhance absorption of intrinsic non-heme iron from foods consumed (Hurrel, 1997). However, infections such as malaria and helminthes are likely to reduce potential iron intake of school age children both in households that apply intra-household food distribution patterns that favour the child and those that do not favour the child. The effect of such reductions could be felt more in children in households applying food distribution patterns that do not favour the child, even potentially causing their intake to be insufficient. This is because infections are likely to reduce the utilization of iron for haemoglobin synthesis (Oppenheimer, 2001). Malaria has been shown to reduce the absorption of iron due to inflammation (Ganz 2002; Nemeth, Ganz, 2006). If malaria reduces iron absorption, then iron interventions such as fortifiying flour with NaFeEDTA are likely to improve iron intakes more in populations without malaria, and be less effective in populations with high endemic malaria such as in Kenya. In populations which are not exposed to malaria, the benefits of NaFeEDTA for example in increasing iron bioavailability could be more pronounced. The potential positive effects of EDTA and the potential negative effects of infections and nature of flours used on sufficiency of intake should be established in appropriately designed studies.

CHAPTER 6: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Findings

Six intra-household food distribution patterns were identified using a descriptive framework. Among the food distribution patterns identified Needs Rule, Resource Control Model and Bargaining Model favour the child in iron intake while the Cultural Rule, Functional Model and Contributions Rule do not favour the child in iron intake. This population predominantly practices intra-household food distribution patterns that do not favour the child, of which the Cultural Rule and Functional Model are the most prominent. The potential iron intake of school age children in this study appears sufficient to meet the requirements of the general population of this age group, and particularly in children from households that practice food distribution patterns that favour the child. However, it may not be sufficient for children 3 to 8 years in households that practice food distribution patterns that do not favour the child. The potential iron intake of children in households that practice food distribution patterns that do not favour the child is 55% lower than their peers in households that practice food distribution patterns that favour the child. This implies that children in households with food distribution patterns that do not favour the child are likely to benefit less from iron fortification intervention than those in households with food distribution patterns that favour the child.

6.2 Conclusions

Six intra-household food distribution patterns: Needs Rule, Resource Control Model, Bargaining Model, Cultural Rule, Functional Model and Contributions Rule are applied in this community with the most prominent ones being Cultural Rule and Functional Model both of which do not favour the child with regards to food intake. In this community, most households practice intra-household food distribution patterns that do not favour the child.

The potential iron intake of school age children in Kanyawegi Sub-location, from fortifiable flour, were it fortified, is sufficient to meet their iron requirements based on both WHO and Kenya recommended fortification levels in households with food distribution patterns that favour the child. Children in households with food distribution patterns that do not favour the child may; however, not have their iron requirements met by fortification alone, if their intakes are based on Kenya recommended fortification levels because their intakes fall below the EAR. However this would be dependent on iron intake from other sources. Therefore, although the iron intake of children in the current study, from fortifiable flour may appear adequate, their requirements are still likely to be compromised if bioavailability is low and iron from other sources is inadequate.

Children in households with food distribution patterns that do not favour the child would benefit less than half as much from iron fortification of flour as children in households that favour the child if fortification at both WHO and Kenya recommended levels are applied. Therefore IHFD pattern influences the potential amount of iron a child would obtain from iron fortified flours.

6.3 Recommendations

1. Because a simple descriptive tool such as the one used in the current study was able to identify food distribution patterns, it can also be used to identify food distribution patterns in similar settings, to facilitate determination of how these patterns may affect the benefits of nutrition intervention.

2. Iron fortification of flour should be implemented because it is beneficial in the general population of children 3 to 8 years old especially for children from households that practice food distribution patterns that favour the child. However, those from households

that practice food distribution patterns that do not favour the child may not meet their iron requirements from this source alone based on the Estimated Average Requirements.

3. Because the actual benefit of iron fortified flour is less in children from households that do not favour the child, it would be necessary to identify such households so that additional targeted iron interventions can be recommended for them.

6.4 Suggestions for Further Research

1. Further work needs to be done to identify intra-household food distribution patterns in the small percentage of households that may not be categorized using the tool applied in the current study and to determine whether multiple patterns may exist in some households.

2. The fortifiable flour product for this population was consumed in meals comprising of other foods. Actual iron bioavailability should be assessed for the range of flours used to determine actual benefit from iron-fortified flours; considering both WHO and Kenya recommended fortification levels and confirm the necessity of additional targeted interventions recommended in this study.

3. Research is needed to establish the effect of food distribution pattern on iron intake from iron-fortified flour by school age children taking into account the nature of flour consumed (refined and unrefined, mixture of grains) as these influence bioavailability of flour hence overall benefit from iron fortification interventions.

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APPENDICES

Appendix 1: Kenyan Map Showing the Study Area

Position of Kanyawegi Sub-location relative to other Sub-locations: Ojolla, Osiri, Bar ‘A’, Bar ‘B’ Korando ‘A’, Korando ‘B’, Nyahera, Dago and Kanyakwar.

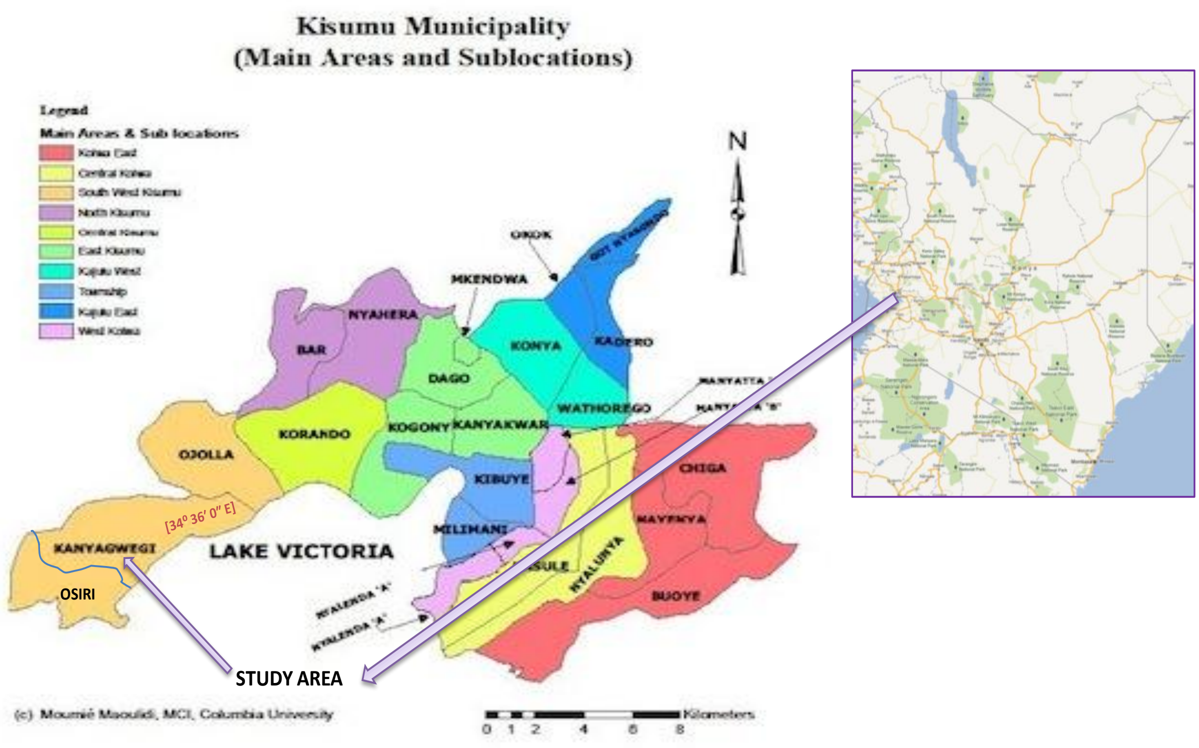

Figure 9: Location of the study area in Kenya

Appendix 2: Letter of Proposal Approval

MASENO UNIVERSITY
SCHOOL OF GRADUATE STUDIES
Office of the Dean

Our Ref: PG/MSC/0115/2011

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 3rd October, 2013

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR NYAMBANE ALBERT— PG/MSC/0115/2011

The above named is registered in the Master of Science in Community Nutrition and Development Programme of the School of Public Health and Community Development, Maseno University. This is to confirm that his research proposal titled "Influence of Intra-Household Food Distribution Pattern on Potential Iron Intake from Iron-Fortified Flour by School Age Children in Kisumu North District" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

MASENO UNIVERSITY DIRECTOR 03 OCT 2013 SCHOOL OF GRADUATE STUDIES

Dr. Pauline Andang'o
ASSOCIATE DEAN, SCHOOL OF GRADUATE STUDIES

Maseno University *ISO 9001:2008 Certified*

Appendix 3: Permission from Maseno University Ethics Review Committee

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221

Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: SECRETARY - MUERC

DATE: 18th November, 2013

TO: Albert Nyangetiria Nyambane
PG/MSc./0015/2011,
School of Public Health and Community Development
Maseno University

REF: MSU/DRPC/MUERC/000045/13

PROPOSAL REFERENCE NO.: MSU/DRPC/MUERC/00045/13 – INFLUENCE OF INTRA-HOUSEHOLD FOOD DISTRIBUTION PATTERN ON POTENTIAL IRON INTAKE FROM IRON-FORTIFIED FLOUR BY SCHOOL AGE CHILDREN IN KISUMU NORTH DISTRICT, KENYA

This is to inform you that Maseno University Ethics Committee (MUERC) determined that the ethics issues were adequately addressed in the proposal presented.

Consequently, the study is granted approval for implementation effective this 18th day of November 2013 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 19th November 2014. If you plan to continue with the study beyond this date, please submit an application for continuation approval to the MUERC Secretariat by 18th October 2014.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach the MUERC Secretariat by 18th October 2014.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

Yours faithfully,

for **Dr. Bonuke Anyona,**
SECRETARY,
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED

Appendix 4: Household Listing Form

Name of father

First…………………………..Middle…………………………..Last……………………………

CONTACT/CELL PHONE NUMBER………………………………………………………...

Name of mother

First…………………………..Middle…………………………..Last……………………………

CONTACT/CELL PHONE NUMBER……….………………………………………………...

Name of index child

First…………………………..Middle…………………………..Last…………………………….

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Village…………………………………………………………………………………………

Land mark……………………………………………………………………………………..

Appendix 5: Consent to Participate in Research

Maseno University

Caregivers' Consent Form

(*To be translated into Dholuo (local language of the people); to be administered verbally to those not able to read*)

Consent Form Section A: Study Information

Study Title: Influence of Intra-household Food Distribution Pattern on Potential Iron Intake from Iron-fortified Flour by School Age Children in Kisumu North District, Kenya.

Statement of the Researcher

We request you to participate in a research study. The information in this form explains what participation in the study entails. Please, listen carefully as I read this form. You are free to ask questions about what we will ask you to do, the risks involved, the benefits, your rights as a volunteer or anything in this form that may not be clear to you. In a process known as informed consent you decide whether or not you would like to participate in the study. If you agree to take part in the study after we have described it to you and having answered any questions you have to your satisfaction, we will give you a signed copy of this form for your records.

Purpose of the Study

The purpose of this study is to determine the influence of intra-household food distribution pattern on potential iron intake from iron-fortified flour by school age children (3 to 8 years). This information is useful in determining whether a food distribution pattern has influence on iron intake of school age children and hence will give direction on whether flour fortification alone may provide sufficient additional iron to these children; hence whether or not additional targeted iron interventions are required for this age-group.

Study Procedure

The study will be carried out in Kanyawegi sub-location, Kisumu North District. We shall engage trained research assistants to work with you so as to identify the common food distribution practice in your household and later to determine the potential amount of iron school age children are likely to obtain from iron-fortified flour by calculating their iron intake based on amount of iron-fortified flour product they would consume within a 24 hour period. If you agree to participate in the study, we may visit your home twice. First to collect data on type of food distribution pattern, using an intra-household food distribution pattern survey questionnaire. Second to collect data on flour consumption using the 24-hour dietary recall and this will yield information on the child's current food intake. Both interviews will take about 20 to 30 minutes in the privacy of your home.

Risks, Stress and Discomforts

This study does not put you at any risk. However, answering the questionnaire will take about 20 to 30 minutes.

Benefits of Participating in the Study

Your participation will help us identify intra-household food distribution patterns and to quantify the amount of iron school age children could potentially obtain from iron-fortified flour in Kisumu North District.

Volunteerism and other Information

Your participation in this study is absolutely voluntary and you may decide to withdraw your participation before or during the interview without any consequences. It is still possible to decline to participate even after signing this consent form. Information generated from this study will be used for the purpose described in this consent form. We would like to reassure you that the data and any publication from this study will not contain information that will reveal your identity as a participant. Only the investigator and study staff will have access to information that link your name on the consent form you have signed or put your mark on and your study number. We will keep information you give confidential. Should you have any question about the study, please feel free to get in touch with

ALBERT NYAMBANE

______________________ __________ _______________

Name of Researcher Signature Date

Consent Form Section B: Statement of the Participant

The purpose of the study has been clearly explained to me. I consent to participate in this study. I have been accorded the opportunity to ask questions. I understand that my participation in this research will expose me to no risk. I understand that my identity will be kept confidential. Data will be coded such that my identity will not be compromised at any time nor will any key with participant names be available to anyone other than the investigator of this research and the academic supervisors. I understand that if I need additional information or have further questions, I will reach the investigator of this research study, Albert Nyambane, Master of Science (MSC) Community Nutrition and Development candidate, Department of Nutrition and Health, School of Public Health and Community Development, Maseno University, Kenya, at the following address:

Maseno University

School of Public Health and Community Development

Private Bag, Maseno.

________________________ ____________________ ______________

Name of Participant Signature Date

Or (for those unable to sign)

Thumbprint (right hand)

Date______________
(To be filled by the recruiting staff)

____________________ _____________ ________________

Name of witness (if necessary) Signature Date

Appendix 6: Attributes of Intra-household Food Distribution Patterns

Intra-household food distribution Pattern	Attributes
Contributions Rule	• Anyone who contributes more money is given more food • A person who prepares food decides how it should be shared • Anyone who earns money is given more food • Girls who earn income receive more food than those who do not • Girls who provide high bride price are served more food • Fewer resources including food are directed to a child who is likely not to be a long-term contributor to the household i.e. due to characteristics such as sickliness, high birth order, twin, short inter gestational period.
Functional Model	• Working adults, working people and teenagers receive larger portions of food • Individuals who help produce family food are given more food • Working males are served more food
Cultural Rule	• The breadwinner who is mostly the husband is apportioned more food than other household members • The household head is served food first and more food before others are served • Male children are preferred in some families and this discriminates against daughters in some households • People of high social status such as elders are served more food
Bargaining Model	• Decision making on resource distribution including food occurs by bargaining and negotiation • Common decisions on who should be apportioned what quantity

Intra-household food distribution Pattern	Attributes
	of food is reached by decision makers • Decision makers discuss how food should be shared • Both parties agree on sharing food without forcing each other • One respects another person's decision because their requirements and or preferences are different
Needs Rule	• Young children are served food depending on how much they need • More of the family food is given to individuals who have greater need for food e.g. for growth • Family members are served food fairly without considering age
Resource Control Model	• Food allocation is taken to focus much on who controls the food resources and or the food budget • Household members are served adequate food portions when the mother controls the food budget • School enrolment and performance of children improves when the mother controls household income • Mother's decision making in household issues is improved when she has control over independent income

Appendix 7: Data Collection Tools

This section contains the data collection tools to be used in the study. Included in this section is the focus group discussion guide, intra-household food distribution pattern survey questionnaire and the 24-hour dietary recall form.

a)Focus Group Discussion Guide

Thank you for giving up your time to participate in this focus group discussion. We would like to find out the food distribution patterns in Kanyawegi Sub-location. Therefore, please give responses to the following questions:

1. Who is the head of the household?
2. Is it possible to be a decision maker and not be the head of the household?
3. What is the family structure (types of households) in this Sub-location? e.g. child-headed, female- headed, male-headed etc
4. Who makes decisions about food in the household?
5. Who controls the food budget in a household?
6. Who contributes more to the household? How does the level of contribution affect amount of food a member receives in a household?
7. Who prepares and serves food in the household? What is the serving order in the household?
8. How is food shared in the household after it has been prepared?
9. How are members of both sexes served in households of this Sub-location?
10. Who is served more food in the household and why?
11. How are people who work for the household served?
12. How can you tell that a child has had enough food?

b) Intra-household Food Distribution Pattern Survey Questionnaire

Identification

Location...................................... Sub-location..............................Village....................Household No............

Name of Interviewer... Date of interview.............................../.................../2013

Respondent's name... Sex...

Name of the index child... Sex...........................Age (years).................................

We would like to find out the food distribution pattern in your household. This information will help us know whether the food distribution practice used may enhance adequate intake of flour-based food by school age children who are among one of the most vulnerable groups in society.

Please not that there is no right or wrong answers. Any information given here will be kept confidential.

Beside each of the statements presented below, please score the common food distribution practice in your household on a scale of 1 to 5, to indicate whether you strongly disagree, disagree, neutral, agree or strongly agree.

Key: 1= strongly disagree, 2= disagree, 3= neutral (neither agree nor disagree), 4= agree, 5= strongly agree

Statement	**Score**					**Additional information** (probe for reasons for the choice of a score)
	1	2	3	4	5	
a) In this household, anyone who earns more money is given more food (*Contributions Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
b) In this household, decision makers discuss how food should be shared (*Bargaining Model*).						If 4 and 5, how often and why? If 1 and 2, why? How is the common decision agreement reached?
c) In this household, working adults and teenagers receive larger portions of food (*Functional Model*).						If 4 and 5, how often and why? If 1 and 2, why?
d) In this household, the breadwinner is served first and is apportioned more food than others (*Cultural Rule*).						If 4 and 5, how often and why? If 1 and 2, why? Who is the breadwinner?

Statement	Score					Additional information (probe for reasons for the choice of a score)
e) In this household, members including young children are served food depending on how much they need (*Needs Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
f) In this household, the person who prepares the food decides how the food should be shared (*Contributions Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
g) In this household, all household members are served adequate portions of food when mother controls food budget (*Resource Control Model*).						If 4 and 5, how often and why? If 1 and 2,
h) In this household, some members are served first and are apportioned more food than others (*Cultural Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
i) In this household, children are provided enough food when the mother controls the use of household income (*Resource Control Model*).						If 4 and 5, how often and why? If 1 and 2, why?

Statement	Score					Additional information (probe for reasons for the choice of a score)
j). In this household, individuals who help produce family food e.g. in the *shamba* are given more to eat (*Functional Model*).						If 4 and 5, ask why he/she is given more to eat and how often this happens? If 1 and 2, why?
k).In this household, common decision on who should be apportioned what quantity of food is reached by decision makers (*Bargaining Model*)						If 4 and 5, how often and why? If 1 and 2, why?
l) In this household, the household head is served food first before other members are served (*Cultural Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
m). In this household, males who work are served more food to eat (*Functional Model*).						If 4 and 5, how often and why? If 1 and 2, why?

Statement	Score					Additional information (probe for reasons for the choice of a score)
n). In this household, more of the family food is given to individuals who have greater need for food e.g. for growth (*Needs Rule*).						If 4 and 5, ask who is vulnerable and is given more food on the basis of vulnerability, how often this happen and why? If 1 and 2, why?
o). In this household, anyone who contributes money is given more food to eat (*Contributions Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
p). In this household, family members are served food fairly without considering age (*Needs Rule*).						If 4 and 5, how often and why? If 1 and 2, why?
q).School enrolment and performance of children improves when the mother controls the use of household income (*Resource Control Model*).						If 4 and 5, how often and why? If 1 and 2, why?

Statement	**Score**					**Additional information** (probe for reasons for the choice of a score)
r). In this household, husband and wife do not have a common housekeeping or child rearing budget, but decisions are made by bargaining and negotiation (*Bargaining Model*).						If 4 and 5, how often and why? If 1 and 2, why?

c) The 24-hour Dietary Recall Form

Thank you for giving up your time to participate in this recall. We would like to find the amount of food items made from flour a school age child consumes in this household. Please, think carefully about the food items made from flour which the child consumed in the previous 24 hours and provide the relevant information that is required in the recall form. We will start with the most recent meal the child has consumed just before this session and work backwards to cover all the foods made from flour that were consumed in the last 24 hours. The form has a section about the time, name of flour item cooked, description of the item, volume of flour item cooked, volume of flour item served to the child, volume the child ate and the volume the child left. It also has three last columns that contain information on weight of food served to child, weight of food left by the child and weight consumed by the child. This section will be filled by the researcher. Information obtained from the recall was useful in helping us assess whether the food intake of school age children was adequate in order to improve their health and nutrition status.

THE 24-HOUR DIETARY RECALL FORM

Household Name ______________________________ Village Name ______________________________

ID of index child ______________________________ Date ______________________________

Name of index child ______________________________ Time of interview ______________________________

Age of index child ______________________________ Name of respondent ______________________________

Time	Dish name	Dish description		Total volume of dish cooked	Total volume served to child	Total volume left by child	Total volume consumed by child	FOR RESEARCHER'S USE		
		Ingredients (One line per ingredient)	Amount of ingredients					Weight of food served to child	Weight of food left by child	Weight of food consumed by child

Name of interviewer ______________________________

Appendix 8: Intra-household Food Distribution Patterns and Responses to the Statements Identifying them

Type of pattern	**Responses**
Contributions Rule (CBR)	a+f+o
Bargaining Model (BM)	b+k+r
Functional Model (FM)	c+j+m
Cultural Rule (CR)	d+h+l
Resource Control Model (RC)	g+i+q
Needs Rule (NR)	e+n+p
Multiple Pattern (MP)	g+i+q and e+n+p

[a] Letters are responses to statements indicating the characteristics of a reference pattern

Appendix 9: Assessment of Influence of Water: Flour for *Ugali* Preparation on Weight of *Ugali*

To determine whether the ratio of the weight of water to flour used for *Ugali* preparation substantially influenced the amount of flour a child consumes, the weight of similar volumes of *Ugali* prepared from 3 different ratios of *Ugali* to flour was measured in data obtained from 10 households during the pilot study.

Weight of *Ugali* of similar volumes with different flour to water ratios used in *Ugali* preparation

Volume of *Ugali* (cm^3)	Weight of *Ugali* (g) for different ratios of flour to water used in its preparation		
	1:1.1	1:1.5	1:2
28.8	40	42	39
28.8	40	42	39
28.8	40	42	39
23.1	28	30	27
23.1	28	30	27
23.1	28	30	27
12.1	16	18	16
12.1	16	18	16
12.1	16	18	16

Differences in *Ugali* Weight Resulting from Flour to Water Ratio

The 3 different ratios of *Ugali* in terms of four to water were (1:1.1, 1:1.5 and 1:2) were the most common ratios used in households that participated in the pilot study. The ratio 1:1.5 had the highest weight while that of 1:2 had the lowest. However, there was no much difference between them and hence the ratio of flour to water did not substantially influence the amount of flour a child was likely to consume. The difference in weight of the *Ugali* from the 3 different ratios was about 1 to 3 grammes.

Appendix 10: Focus Group Discussions (FGDs) Results

Themes **(food distribution patterns)**	**Quotes/features**	**FGD Number**
Contributions Rule	One **who contributes more to household must not miss food. They eat to their fill and whatever they would want to eat** e.g. prime cuts of meat.	FGD 1 and 2
	Women contribute a lot to the household in terms of their money and even in domestic work as in food preparation. At times when women contribute more to the house and especially in terms of money, some of them climb to assume household headship. She may start to dictate that nothing should leave the house before she consents to it. The husband has to obey her rules in order to avoid quarrels. **Sometimes where women contribute more to the household even their homes are known by their names e.g. '*Ka-Mama Mary'*, at Mary's home**. **This is either because she is influential or very well known by all people in that locality** including the children or may be the man lives out in town, people rarely see him and he comes home occasionally.	FGD 1 and 2
	In other cases **people who contribute more money may mean they are either able or working**. However, this does not allow them to be served larger shares of food. Food will be served depending on individual's requirements.	FGD 2
	If there is a bigger boy or girl in a household **who provides food for the household, he/she is served separately and if absent then his/her food is kept till he/she comes back**.	FGD 1 and 2
	A household head is one who ensures that food gets to the house. That is why he/she is head. He/she knows the household size and the amount of food enough for them.	FGD 1 and FGD 2.

Themes **(food distribution patterns)**	**Quotes/features**	**FGD Number**
Needs Rule	Children are **grouped according to age and served each with his/her plate of *Ugali* and vegetables or '*omena*' (sardines) because others eat faster than others and is also hygienic to serve them in their own plates**. When food is little the mother takes very little and in case of a guest she gives out her share. **We serve girls separately because they eat slowly. Younger children are seated near the mother.** Girls don't eat with the father; no girl can eat with the father.	FGD 1 and 2.
	Mothers take care of children needs first. Sometimes mothers provide food to household but get very little or no food at all because they take care of a family's needs first. **It is important that mothers sit with children so that would get to know their eating habits, quantities and whether they have eaten enough**. May be the child is sick, and if he/she eats away from home you may not know whether he or she has eaten or not and whether the food was enough or not. So food is served at table and whoever wants more goes ahead. Other children particularly girls are never served together with the boys because they eat slowly; they sit with the mother and eat with her. **Once the children have been serve enough food, they can sit anywhere with their plates and eat alone. If any child wants more food he/she can back to the table and is added.** It is important that one eats near the children especially at table so that they can get to know their eating habits, quantities and whether they have eaten enough. **Some husbands are feel that it is important that the children are given enough food to eat in order to**	FGD 1, 2 and 3

Themes (food distribution patterns)	Quotes/features	FGD Number
	grow.	
	Children eat a lot of food. They eat regularly and play more. At times they eat, leave the food for some time. Play a bit and again come back to continue eating**. Before they go to school they can take even a big mug of porridge and after they come home before they start playing they take another mug. So as this must recorded and some food kept for them**.	FGD 2 and 3

Themes (food distribution patterns)	Quotes/features	FGD Number
Cultural Rule	**The husband is first served then the youngest children as they get anxious and impatient and the mother serves last.** **In case of polygamy, all women prepare food and bring it to the man's office or to first wife's house where he eats it with male children**. Every woman brings enough food for her husband and her male children or child who is going to eat with the father. In other polygamous families and if there is peace and harmony let us say there are two women, these women take turns to cook enough food for the husband. If one cooks breakfast another cooks lunch and they bring to the husband. Some polygamous men have shades built between the houses of the wives. So each woman struggles to bring her food here first. Depending on what is prepared and how it is prepared will determine whose food will be eaten more and this could be a source of conflict.	FGD 1, 2 and FGD 3
	In case the father is not there, then the elder son is served in the same way as the father that is he is served first and enough food and if he has his friends around he can eat with them. If he is of age he becomes the decision maker of the household. **Children especially elder sons have privileges. They can eat with the 'Baba'-father and you know fathers are normally served big portions of food because in our culture this is a sign of respect and appreciation**. **Where there are both male and female children we first serve the father first a large share of food, then the eldest son may sit and eat with the father**. At times father eats alone. He cannot eat with the younger boys because they are already eating a lot and are pretty fast so they will disorganize him. He won't eat enough if he eats	FGD 2 and 3

Themes (food distribution patterns)	Quotes/features	FGD Number
	with these boys. When the mother has served everybody else and particularly if there is no old enough son to eat with the father, she can sit with the father and eat with him. Ugali is in one tray and vegetables in a hot pot. So we just	

Themes (food distribution patterns)	Quotes/features	FGD Number
	serve from there. Mothers serve food because they serve because know how to serve, what amount to serve the husband and the children. Because mothers are mostly responsible for preparing food, they know the amounts to serve each one because they keep each individual food preferences in mind. Mother serves food because know how to serve, what amount to serve the husband and the children. Then she can sit and eat with the husband particularly if there is no old enough son to eat with him. **In case the father is not there, then the elder son is served in the same way as the father** that is he is served first and enough food and if he has his friends around he can eat with them. If he is of age he becomes the decision maker of the household. **The husband is served first and more food as a sign of respect being the owner of the home**. Even if he is jobless, incapacitated or unable to support the household he still remains the head no matter what happens. Mother may support the household in this case but the father as household head still is served first and enough food to eat. **The wife serves him (the household head, the husband) an amount that is enough for him to eat until it remains because once it is finished and he wants more, he may feel shy to ask for more or it may not be there. So she first serves the husband**, the youngest children, and then the older children starting with the boys then the girls and she serves herself last. **The wife first serves the husband an amount enough for him; she first organizes him because she does not want him to sleep hungry as a hungry man is an angry man**. Then serve each and every child in their plates and add in the vegetables.	FGD 1, 2 and 3

Themes (food distribution patterns)	Quotes/features	FGD Number
	The father does not eat together with children. You see some children are older and others younger and father will not be at ease fighting over food with them. Therefore, the mothers take care of this early by serving the fathers food before everyone else. **Mother ensures that the man is satisfied with food first so that when out there he can speak with confidence with his fellow men**. So the mother takes care not to embarrass him. Otherwise, there will be no peace in the house.	FGD 2 and 3
Bargaining Model	**Father and mother consult one another and negotiate as regards amounts of food to be allocated to each member in the household**. Sometimes elder children especially elder son who is of age can be called to participate in decision making. Grandmother and mother-in-law can also be consulted for decision making.	FGD 2 and 3
	Husband and wife sit together and make decisions on food service together; no one forces the other. **If a mother wants cook some food, she cannot decide alone. She calls the husband and tells him what she wants to cook and serve for example and if he agrees then she does it because she may** cook something the husband and or children may not want to eat. This also helps us to avoid domestic quarrels. If he is away, then the mother can decide with elder children who are of age particularly an elder girl or boy. Sometimes the husband asks the wife, 'what can we eat today?' The wife can mention some food and if the husband does not want to take it then he can give another suggestion. This can go on until they settle on one.	FGD 2 and 3

Themes **(food distribution patterns)**	**Quotes/features**	**FGD Number**
	We always do things together. For example in times of food shortages the husband or wife cannot work alone to bring food to the household. They agree and both go out to work, bring home food, prepare and eat. They try very much to maintain the size of *Ugali* they eat in the household even during times of food shortages. **In some households decisions are not made by force. No, no. If one manages to convince the other then that is decision agreed on. People (both parties) have to agree including older children**. Where the husband respects the wife, **he recognizes decisions she makes**, **they discuss** them out and things will run smoothly.	FGD 2 and 3
Resource Control Model	At times men misuse their money. Some take alcohol with it. Husband's money may not be enough. But women know how to budget for their money. **So women are busy with small and medium-term businesses and do not necessarily depend on their husbands.** Women even join 'chamas' (*small organizations where they contribute money and engage themselves in income generating activities*). **Some sell firewood, farm produce, join merry-go-rounds and take care of their families**. Where the husband may be unable to contribute or is jobless; it is the woman to take responsibility and help the family".	FGD 2 and 3

Themes **(food distribution patterns)**	**Quotes/features**	**FGD Number**
	If we women get **even a small piece of land we plant vegetables, even rear chicken for eggs and or sell to get money to take care of everyone in our households**. Women really know how to use their money. **If they get any small amount of money, they first think about buying food for their families and because they are more child-oriented than men then they ensure their children eat enough food.**	FGD 1, 2 and 3
Functional Model	Sons are given **more food actually because they work a lot are served more food** always to increase their energy. **Older boys and girls who are able to work generally are required to fend for the younger ones, work harder and support the household** by bringing food home and to help the young. **Women work very hard to bring food home** because they feel the members of the household will be hungry if they do not bring food home.	FGD 2 and 3
	A **household head is important in organizing for the production, purchase availing food to household** which will ensure that life of the household continues. A **good husband is one who knows about his family, goes out works and brings food home**. He can as well farm and produce food from the farm. But bad ones are lost in alcohol and so misuse money leaving the family hungry. **Even mothers work hard, plough with oxen, care for chicken and animals in order to provide for the continuity of the family.**	FGD 1, 2 and 3

[b] Bolded sections of the focus group discussions indicate the main quotes/features that helped to identify the intra-household food distribution pattern

Appendix 11: Volumes of *Ugali* from Equivalent Plasticine Volumes and Weights of *Ugali* and Porridge

Flour Ugali Mls	Flour Ugali g	Water Ugali	Flour Porridge mls	Flour Porr g	Water porr	Totalvol Porr cooked mls	Volporr Cons Child mls	Totalvol ugali cooked mls	Sufuria height ugali (cm)	Ugalivol cm3	Ugali vol 1 cm	Ugali vol 2 cm	Ugali vol 3 cm	Aveg ugali Vol	Total flour porr	Total flour ugali	Total Flour Cons
2500	2308	2900	0	0	0	0	0	6200	23.7	5646.66	585.78	573.77	585	581.52	0	237.69	237.69
1700	1095	1900	0	0	0	0	0	3900	41.7	3200.29	478.8	474.84	470.76	474.8	0	162.46	162.46
1800	1157	2600	0	0	0	0	0	3000	18.4	2477.15	483.34	502.44	495.6	493.79	0	230.64	230.64
2600	2260	3800	0	0	0	0	0	4800	16.1	3800.34	458.11	513.59	523.64	498.45	0	296.42	296.42
1400	872	1900	0	0	0	0	0	3500	20.8	2938.73	352.83	358	336.69	349.17	0	103.61	103.61
1700	1097	2450	0	0	0	0	0	3150	17.4	2677.16	499	523.78	520.46	514.41	0	210.79	210.79
2800	2370	3800	0	0	0	0	0	7400	19.5	6415.96	392.52	395.01	395.76	394.43	0	145.7	145.7
1400	873	1900	0	0	0	0	0	3500	17.8	2938.73	363	357.93	359.68	360.2	0	107	107
2000	1847	1900	0	0	0	0	0	3800	17.1	3123.36	414.21	481.78	497.74	464.58	0	274.73	274.73
5700	4789	6000	0	0	0	0	0	9800	19.5	8216.12	427.21	492.88	512.82	477.64	0	278.4	278.4
2100	1920	2800	0	0	0	0	0	4000	18.4	3307.99	344.69	326	341.93	337.54	0	195.91	195.91
1800	1157	2400	0	0	0	0	0	3000	36.7	2477.15	512.68	516.53	455.11	494.77	0	231.09	231.09
6000	3703	6600	0	0	0	0	0	7600	13.8	6569.82	567.13	527.04	476.53	523.56	0	295.1	295.1
3000	2776	3400	0	0	0	0	0	3800	17.8	3123.36	298	312.48	272.25	294.24	0	261.52	261.52
1250	809	1600	0	0	0	0	0	2200	24.7	1692.46	258.12	262	248.5	256.21	0	122.47	122.47
4400	3989	6000	0	0	0	0	0	7200	19.1	6262.1	380.25	430	407.88	406.04	0	258.65	258.65
3000	2777	4400	500	407	1000	1500	900	5400	14.5	4985.06	644.73	649.13	608.04	633.97	244.2	353.16	597.36
1200	774	1600	0	0	0	0	0	1800	20.3	1307.81	475.53	525.13	502.05	500.9	0	296.45	296.45
1500	925	2400	500	407	1500	2600	700	3500	44.7	2938.73	382.47	391.4	372.68	382.18	109.58	120.3	229.87
3000	2775	4000	0	0	0	0	0	5000	42.7	3984.97	527.04	565.53	567.13	553.23	0	385.25	385.25
2600	2260	3000	0	0	0	0	0	6000	25.9	5462.03	373	361.57	356.93	363.83	0	150.54	150.54
1500	925	1800	0	0	0	0	0	2950	19.1	2415.6	456.13	374.68	666.43	499.08	0	191.11	191.11
9000	8022	9800	1500	982	3000	6000	600	10800	16.1	9600.86	623.04	664.73	665.13	650.97	98.2	543.91	642.11
2100	1926	2500	0	0	0	0	0	3450	40.7	2892.57	286	279.12	295.5	286.87	0	191.01	191.01
7500	6519	8100	0	0	0	0	0	16200	48.3	13893.56	496.31	521.29	539.83	519.14	0	243.59	243.59

Flour Ugali Mls	Flour Ugali g	Water Ugali	Flour Porridge mls	Flour Porr g	Water porr	Totalvol Porr cooked mls	Volporr Cons Child mls	Totalvol ugali cooked mls	Sufuria height ugali (cm)	Ugalivol cm3	Ugali vol 1 cm	Ugali vol 2 cm	Ugali vol 3 cm	Aveg ugali Vol	Total flour porr	Total flour ugali	Total Flour Cons
900	599	1050	0	0	0	0	0	1100	11	769.3	232	258.4	248.48	246.29	0	191.77	191.77
1200	729	1300	0	0	0	0	0	1550	8.5	1061.63	341.66	276.38	292.94	303.66	0	208.52	208.52
3200	2943	4300	0	0	0	0	0	5000	13.2	3984.97	361.57	379	356.93	365.83	0	270.18	270.18
2400	2142	2800	350	296	1025	1560	500	3600	35.5	3000.27	471.11	535.72	529.69	512.17	94.87	365.66	460.53
1700	1098	2000	0	0	0	0	0	2500	13	2030.95	396.4	377.58	389.45	387.81	0	209.66	209.66
2100	1922	2700	0	0	0	0	0	3600	18.8	3000.27	581	571.88	580.89	577.92	0	370.22	370.22
2000	1848	2400	300	266	700	1100	450	4800	8.5	3800.34	251.04	266.98	277.98	265.33	108.82	129.02	237.84
2700	2310	3200	0	0	0	0	0	4700	20.3	3738.8	534.77	538.71	479.11	517.53	0	319.75	319.75
2900	2446	3100	0	0	0	0	0	3800	5.9	3123.36	415.5	391.44	379.57	395.5	0	309.73	309.73
2600	2263	2800	0	0	0	0	0	3800	19.5	3123.36	421.21	486.69	501.64	469.85	0	340.42	340.42
1800	1158	2200	0	0	0	0	0	2600	16.8	2123.27	527.21	544.87	565.84	545.97	0	297.77	297.77
1100	708	1600	0	0	0	0	0	2000	6.5	1461.67	348	325.58	315.83	329.8	0	159.75	159.75
2600	2260	3400	0	0	0	0	0	6400	25.9	6000.54	586.31	594.84	567.28	582.81	0	219.51	219.51
7000	6175	7500	0	0	0	0	0	9500	16.8	7954.56	755.13	743.63	746.08	748.28	0	580.88	580.88
2100	1923	2400	0	0	0	0	0	3000	9.5	2477.15	490	430.99	418.38	446.46	0	346.58	346.58
2600	2263	4000	0	0	0	0	0	8400	20.3	7185.26	475.11	536.62	529.68	513.8	0	161.82	161.82
2100	1922	2400	0	0	0	0	0	2800	13.2	2307.9	426.21	489.78	505.73	473.91	0	394.67	394.67
3600	3188	4300	0	0	0	0	0	4400	24	3554.17	717.07	746.14	727.63	730.28	0	655.04	655.04
1150	742	1550	0	0	0	0	0	1700	24.7	1230.88	348.69	281.48	299.93	310.03	0	186.9	186.9
2200	2012	2800	0	0	0	0	0	3200	19.5	2631.01	446	420.89	417.28	428.06	0	327.35	327.35
2300	2090	3000	0	0	0	0	0	4400	9.3	3554.17	511.73	496.79	439.21	482.58	0	283.78	283.78
2000	1848	2300	0	0	0	0	0	1950	17.8	1430.9	466.21	510.68	528.74	501.88	0	648.17	648.17
2200	2016	2300	0	0	0	0	0	2800	15.3	2307.9	411.21	478.69	496.64	462.18	0	403.72	403.72
2000	1845	2600	0	0	0	0	0	2800	9.3	2307.9	652.14	661.73	619.04	644.3	0	515.07	515.07
2100	1924	2900	0	0	0	0	0	3100	39	2584.85	515.21	539.79	556.93	537.31	0	399.94	399.94
1500	925	2000	0	0	0	0	0	1950	11	1430.9	498.31	519.78	540.84	519.64	0	335.92	335.92
5600	4771	6000	0	0	0	0	0	4400	51.7	3554.17	431.41	407.88	379.36	406.22	0	545.29	545.29
2000	1845	2600	0	0	0	0	0	2900	30.8	2354.06	516.21	534.96	556.83	536	0	420.09	420.09

Flour Ugali Mls	Flour Ugali g	Water Ugali	Flour Porridge mls	Flour Porr g	Water porr	Totalvol Porr cooked mls	Volporr Cons Child mls	Totalvol ugali cooked mls	Sufuria height ugali (cm)	Ugalivol cm3	Ugali vol 1 cm	Ugali vol 2 cm	Ugali vol 3 cm	Aveg ugali Vol	Total flour porr	Total flour ugali	Total Flour Cons
6000	3701	7000	700	369	2100	6100	650	8500	13.2	7216.03	877.63	889.14	842.09	869.62	39.32	446.02	485.33
3400	3070	3700	600	453	1700	2150	500	6500	15	6046.7	685.13	643.04	674.83	667.67	105.35	338.98	444.33
2050	1884	2300	650	492	1750	2700	450	2850	15	2369.44	379.48	390.4	369.79	379.89	82	302.06	384.06
2100	1922	2600	0	0	0	0	0	2900	21.1	2354.06	634.04	674.73	685.13	664.63	0	542.65	542.65
5800	4851	7600	0	0	0	0	0	8200	19.1	7016.02	669.03	711.63	712.13	697.6	0	482.33	482.33
1800	1160	2000	0	0	0	0	0	2300	19.1	1738.62	552.9	573	560.99	562.3	0	375.16	375.16
2200	2013	3000	0	0	0	0	0	3300	17.8	2738.71	725.53	745.14	702.06	724.24	0	532.33	532.33
4200	3862	4600	700	519	2100	6100	950	7500	19.1	6415.96	549.21	568.98	567.93	562.04	80.83	338.31	419.14
4200	3865	6000	0	0	0	0	0	7000	15.7	6154.4	479.11	539.72	532.79	517.21	0	324.81	324.81
1700	1095	1900	700	519	1200	1700	600	2400	23.7	2000.18	665.13	623.03	664.83	651	183.18	356.39	539.56
5000	4328	5200	950	683	2600	5600	900	7200	62.4	6262.1	462.11	523.72	521.79	502.54	109.77	347.33	457.09
3900	3774	4100	0	0	0	0	0	5800	7.5	5215.85	594.21	596.93	571.38	587.51	0	425.1	425.1
2400	2145	2500	0	0	0	0	0	2800	20.8	2307.9	623.03	664.63	665.13	650.93	0	604.98	604.98
1900	1233	2500	0	0	0	0	0	2800	19.1	2307.9	365.42	373.69	455.13	398.08	0	212.67	212.67
2200	2011	2700	0	0	0	0	0	3000	7.4	2477.15	512.82	499.88	438.21	483.64	0	392.63	392.63
3000	2778	3500	0	0	0	0	0	4300	11	3477.24	619.13	620.13	616.4	618.55	0	494.17	494.17
3000	2781	4000	0	0	0	0	0	5200	13.1	4738.89	559.21	576.98	599.92	578.7	0	339.61	339.61
3000	2772	4600	0	0	0	0	0	5900	11.3	5308.17	485	422.88	418.29	442.06	0	230.85	230.85
3100	1925	3300	500	430	1350	5200	550	7700	23.7	6600.59	252.47	239	263.39	251.62	45.48	73.38	118.86
3000	2775	4000	0	0	0	0	0	5000	22.6	3984.97	727.53	746.14	702.08	725.25	0	505.04	505.04
6000	3705	7000	1500	982	3000	6000	600	8400	46.9	7185.26	477.11	539.81	535.78	517.57	98.2	266.88	365.08
3000	2780	4600	700	498	1100	2000	850	5600	14.5	4985.06	511.91	488.89	438.21	479.67	211.65	267.5	479.15
2000	1844	2400	600	369	1000	1500	450	3000	63.2	2477.15	278.38	273.99	272	274.79	110.7	204.55	315.25
1800	1155	2200	400	583	1000	1400	800	2600	90.3	2123.27	532.29	548.98	569.83	550.37	333.14	299.38	632.53
1400	872	1700	0	0	0	0	0	3300	25.1	2738.71	232	252.45	259.49	247.98	0	78.96	78.96
1500	927	1900	0	0	0	0	0	3600	39	3000.27	244.61	266.86	268.69	260.05	0	80.35	80.35
1400	871	1900	0	0	0	0	0	3500	19.5	2938.73	147.25	146.7	151.92	148.62	0	44.05	44.05
1300	825	1500	0	0	0	0	0	3600	16.1	3000.27	278.46	275	274.11	275.86	0	75.85	75.85

Flour Ugali Mls	Flour Ugali g	Water Ugali	Flour Porridge mls	Flour Porr g	Water porr	Totalvol Porr cooked mls	Volporr Cons Child mls	Totalvol ugali cooked mls	Sufuria height ugali (cm)	Ugalivol cm3	Ugali vol 1 cm	Ugali vol 2 cm	Ugali vol 3 cm	Aveg ugali Vol	Total flour porr	Total flour ugali	Total Flour Cons
2400	2140	2000	0	0	0	0	0	4700	9.3	3738.8	229.49	231.93	238.29	233.24	0	133.5	133.5
2000	1845	2000	0	0	0	0	0	2600	41.7	2123.27	236.93	239.29	234.05	236.76	0	205.73	205.73
3300	2093	3300	0	0	0	0	0	3500	15.3	2938.73	389.44	377.57	411.4	392.8	0	279.76	279.76
1500	925	1900	0	0	0	0	0	4500	33.9	3646.48	144.25	145.6	149.82	146.56	0	37.18	37.18
1300	829	1700	0	0	0	0	0	3200	39.3	2631.01	153.07	157.79	143.5	151.45	0	47.72	47.72
1300	832	1700	0	0	0	0	0	3300	40.7	2738.71	246.46	256.4	224	242.29	0	73.6	73.6
1800	1157	2000	0	0	0	0	0	4000	9.7	3307.99	201.04	196.07	212.48	203.2	0	71.07	71.07
1300	829	1900	0	0	0	0	0	3400	23.1	2831.02	220.22	221.76	210.7	217.56	0	63.71	63.71
1400	870	1700	0	0	0	0	0	3400	23.1	2831.02	304.92	323.57	338	322.16	0	99	99
1400	873	1700	0	0	0	0	0	3300	16.8	2738.71	247.5	256.12	250	251.21	0	80.08	80.08
4000	3694	5600	0	0	0	0	0	8700	15	7431.44	293.5	279.12	292	288.21	0	143.26	143.26
2000	1847	3000	0	0	0	0	0	3500	22.4	2938.73	247.5	256.12	252	251.87	0	158.3	158.3
6000	3700	7000	0	0	0	0	0	8000	11.3	6877.54	418	380.25	407.88	402.04	0	216.29	216.29
3000	2776	3900	0	0	0	0	0	4500	8	3646.48	231.49	201.06	203.06	211.87	0	161.29	161.29
900	596	1150	600	453	1350	2650	300	1650	5.9	1153.95	272	280.34	276.88	276.41	51.28	142.76	194.04
700	461	900	0	0	0	0	0	1200	34.5	907.77	292.9	297	305.34	298.41	0	151.54	151.54
1500	925	2000	0	0	0	0	0	2700	8	2230.97	207.48	195.04	191.05	197.86	0	82.03	82.03
1100	706	1500	0	0	0	0	0	2000	15	1430.9	136.28	138.91	139.6	138.26	0	68.22	68.22
1100	710	1300	0	0	0	0	0	1700	13.8	1230.88	222	244.38	255.39	240.59	0	138.78	138.78
1500	925	2000	600	453	1500	2300	500	2700	21.5	2230.97	116.25	117.9	121.84	118.66	98.48	49.2	147.68
1500	930	2000	0	0	0	0	0	2500	24.3	2030.95	145.6	147.82	143.29	145.57	0	66.66	66.66
900	600	1100	300	266	900	1300	300	1300	13	923.16	174.07	184.06	192.48	183.54	61.38	119.29	180.67
1600	1047	2000	0	0	0	0	0	3000	22.6	2477.15	299.93	351.56	283.29	311.59	0	131.7	131.7
2600	2261	2700	0	0	0	0	0	4800	17.1	3800.34	361.58	368	356.83	362.14	0	215.45	215.45
3200	2018	3900	0	0	0	0	0	7500	46.7	6415.96	416.28	420.89	482	439.72	0	138.31	138.31
2200	2015	2600	0	0	0	0	0	3100	44.5	2584.85	247.5	253	256.13	252.21	0	196.61	196.61
800	523	1050	0	0	0	0	0	1200	25.9	907.77	401.6	389.45	377.58	389.54	0	224.43	224.43
1700	1095	1800	0	0	0	0	0	3100	21.5	2584.85	361.58	377	356.94	365.17	0	154.7	154.7

Flour Ugali Mls	Flour Ugali g	Water Ugali	Flour Porridge mls	Flour Porr g	Water porr	Totalvol Porr cooked mls	Volporr Cons Child mls	Totalvol ugali cooked mls	Sufuria height ugali (cm)	Ugalivol cm3	Ugali vol 1 cm	Ugali vol 2 cm	Ugali vol 3 cm	Aveg ugali Vol	Total flour porr	Total flour ugali	Total Flour Cons
1000	634	1450	0	0	0	0	0	2600	20.3	2123.27	180.09	191.06	199.39	190.18	0	56.79	56.79
5400	4623	5600	0	0	0	0	0	11400	24.7	9723.95	304.83	322.68	339	322.17	0	153.17	153.17
1600	1049	1800	0	0	0	0	0	2400	13.8	2000.18	168.07	167.89	169.5	168.49	0	88.36	88.36
1200	776	1400	0	0	0	0	0	1800	15	1307.81	138.29	140.5	142.82	140.54	0	83.39	83.39
2500	2191	2200	0	0	0	0	0	4900	17.1	3861.89	287.89	291	299.34	292.74	0	166.08	166.08
2255	2072	4200	0	0	0	0	0	4600	45.6	3692.64	231.84	238.28	229.05	233.06	0	130.77	130.77
2700	2308	4100	0	0	0	0	0	6100	13	5492.8	345.76	279.38	298.94	308.03	0	129.43	129.43
850	555	1100	0	0	0	0	0	1400	15	1000.09	257.7	258.12	259.14	258.32	0	143.35	143.35
3100	1928	3700	0	0	0	0	0	4900	16.1	3861.89	514.21	532.89	554.91	534	0	266.59	266.59
1400	875	1650	0	0	0	0	0	2250	15.3	1738.62	219.21	220.89	210.8	216.97	0	109.19	109.19
2600	2264	4000	0	0	0	0	0	9000	39.9	7569.91	499.76	515.62	454.11	489.83	0	146.5	146.5
850	558	1000	0	0	0	0	0	1400	49.2	1000.09	235.93	245.91	234.05	238.63	0	133.14	133.14
1900	1234	2100	0	0	0	0	0	2450	46.7	2015.57	261.89	269.88	247.05	259.61	0	158.94	158.94
2700	2309	3800	650	492	1900	4875	900	4500	9.5	3646.48	219.33	221.96	207.9	216.4	90.83	137.03	227.86
2600	2265	3000	0	0	0	0	0	4400	35.5	3554.17	149.25	147.7	152.83	149.93	0	95.54	95.54
3000	2773	4000	0	0	0	0	0	5200	24.3	4738.89	216.49	199.03	197.06	204.19	0	119.49	119.49
1500	925	2000	0	0	0	0	0	6600	25.1	6139.01	220.23	219.67	210.8	216.9	0	32.68	32.68
1500	925	1300	0	0	0	0	0	2000	15.4	1461.67	348.65	281.39	299.84	309.96	0	196.16	196.16
1100	728	1500	0	0	0	0	0	1900	6.5	1446.28	281	285.34	282.98	283.11	0	142.5	142.5
2800	2372	3100	0	0	0	0	0	3600	23.1	3000.27	468	410.88	412.28	430.39	0	340.26	340.26
1800	1159	4400	0	0	0	0	0	6400	13.1	6000.54	469	408.99	405.45	427.81	0	82.63	82.63
2000	1847	2600	0	0	0	0	0	2900	40	2354.06	351.58	336	357.83	348.47	0	273.41	273.41
2800	2374	3000	500	430	1350	2000	550	3600	39.3	3000.27	338.77	271.39	288.43	299.53	118.25	237.01	355.26
1400	873	1550	0	0	0	0	0	2500	16.1	2030.95	206.49	195.04	193.07	198.2	0	85.2	85.2
1700	1093	2300	850	630	1150	4300	550	4300	32.4	3477.24	436	413.28	416.89	422.06	80.58	132.67	213.25
1950	1270	3000	0	0	0	0	0	3950	30.8	3246.45	391.43	379.57	415.6	395.53	0	154.73	154.73
1000	630	1300	0	0	0	0	0	2000	16.1	1692.46	279.24	269.78	272	273.67	0	101.87	101.87
2200	2015	2600	0	0	0	0	0	2800	53.4	2307.9	356.58	284.39	301.93	314.3	0	274.41	274.41

Flour Ugali Mls	Flour Ugali g	Water Ugali	Flour Porridge mls	Flour Porr g	Water porr	Totalvol Porr cooked mls	Volporr Cons Child mls	Totalvol ugali cooked mls	Sufuria height ugali (cm)	Ugalivol cm3	Ugali vol 1 cm	Ugali vol 2 cm	Ugali vol 3 cm	Aveg ugali Vol	Total flour porr	Total flour ugali	Total Flour Cons
2800	2370	3000	0	0	0	0	0	6000	35.7	5462.03	225.32	216.9	228.96	223.73	0	97.08	97.08
1200	772	1700	0	0	0	0	0	2100	41.7	1492.44	372	361.69	357.92	363.87	0	188.22	188.22
1900	1233	2100	0	0	0	0	0	4200	19.5	3446.46	225.33	228.87	216.8	223.67	0	80.02	80.02
1900	1233	3100	0	0	0	0	0	2900	5	2354.06	161.08	164.98	159.6	161.89	0	84.79	84.79
2100	1923	2500	0	0	0	0	0	3500	11.3	2938.73	409.99	434	381.35	408.45	0	267.27	267.27
4500	4038	6000	0	0	0	0	0	6500	9.4	6046.7	251.47	261.39	233	248.62	0	166.03	166.03
2800	2368	3000	1050	758	3000	4500	1000	4300	15.3	3477.24	267.88	253.05	277.87	266.27	168.44	181.33	349.77
1500	925	1750	0	0	0	0	0	2250	6.9	1692.46	132.29	131.7	136.84	133.61	0	73.02	73.02
1500	925	1900	400	346	1100	2150	400	2450	23.1	2015.57	169.25	168.9	173.84	170.66	64.37	78.32	142.69
3400	3073	3500	0	0	0	0	0	3900	39.3	3200.29	178.7	174.98	173.07	175.58	0	168.6	168.6
1150	745	1150	0	0	0	0	0	2300	13.8	1738.62	481	417.98	414.39	437.79	0	187.59	187.59
1500	925	2000	0	0	0	0	0	2400	22.6	2000.18	149.25	148.8	153.93	150.66	0	69.67	69.67
2200	2015	2400	0	0	0	0	0	3200	42.9	2631.01	449	416.88	388.29	418.06	0	320.18	320.18
1500	925	1350	0	0	0	0	0	1600	30.8	1138.56	180.08	191.05	198.47	189.87	0	154.25	154.25
3000	2775	4200	0	0	0	0	0	5200	30.8	4738.89	448	420.29	426.98	431.76	0	252.83	252.83
5200	4496	5500	0	0	0	0	0	6500	39.3	6046.7	391.3	372.69	382.46	382.15	0	284.15	284.15
4200	3860	6000	0	0	0	0	0	7900	40	6846.77	283	287.86	298.34	289.73	0	163.34	163.34

KEY

Flourugali mls – amount of flour used in preparing *Ugali* measured in millilitres
Flourugalig – weight of flour in grammes used in preparing *Ugali*
Water *Ugali* – amount of water used to prepare *Ugali*
FlourPorridge mls - amount of flour used in preparing porridge measured in millilitres
FlourPorrg - weight of flour in grammes used in preparing porridge
Waterporr - amount of water used to prepare porridge
TotalvolPorrcooked mls – Total volume of porridge cooked measured in millilitres
Volporr Cons Childmls – volume of porridge consumed by the index child
Totalvolugali cooked mls – total volume of *Ugali* cooked
Sufuria height *Ugali* (cm) – height of sufuria used to cook *Ugali*
*Ugali*vol cm^3 – total volume of Ugali cooked in cubic centimeters

Ugali vol 1, vol 2, vol 3 – Ugali volumes
Av *Ugali* Vol – average volume of *Ugali*
Total flour porr – total flour in porridge
Total flour *Ugali* – total flour in *Ugali*
Total Flour Cons – total flour consumed from porridge and *Ugali*.