ANAEMIA AND STATUS OF IRON, VITAMIN A AND ZINC IN KENYA

The 1999 National Survey Report

Study Team:

DL Mwaniki, CPHR – Kenya Medical Research Institute
AM Omwega, ANP – University of Nairobi
EM Muniu, CPHR – Kenya Medical Research Institute
JN Mutunga, CPHR – Kenya Medical Research Institute
R Akelola, National Nutrition Programme (DCH – MoH)
BR Shako, UNICEF – Kenya Country Office
MH Gotink, UNICEF – Kenya Country Office
AM Pertet, SOMANET

PREFACE

The 1994 National Plan of Action for Nutrition (NPAN) advanced numerous recommendations for action to mitigate malnutrition in Kenya. Among them was a situation analysis of key micronutrients where conclusive information about extent of sufficiency or deficiency was lacking. In the same year, with support from UNICEF, countrywide surveys of vitamin A and iodine nutrition status were carried out. To this end specific activities have been started to reduce the prevalence of iodine and vitamin A deficiencies and associated disorders. Although iron and zinc had been identified as priority micronutrients in the NPAN, they were not addressed during these surveys. These micronutrients are central in the causation of nutritional anaemias.

In 1999, the Kenya Medical Research Institute jointly with UNICEF, Division of Child Health (then Division of Primary Health Care) of the Ministry of Health, Applied Human Nutrition Unit of the University of Nairobi and Social Science and Medicine-Africa Network conducted a national survey of anaemia. Nested in this survey was an assessment of iron, vitamin A and zinc nutrition status. The survey findings presented a nation wide profile of anaemia among children, mothers and adult men.

The findings of this survey are presented in three formats, namely, Policy Briefs, Executive Summary and Overview of findings and the Full Report of the survey. The Policy Briefs is an attempt to interpret and operationalize the findings of the survey especially as they relate to the National Health Sector Strategic Plan (NHSSP) for the period 1999 to 2004. Conclusions and recommendations made in these briefs are intended to facilitate consideration of various policy imperatives and support for those that are feasible and most cost effective. Furthermore, the briefs are intended to stimulate discussion on projections made in the NPAN and the NHSSP with the aim of reviewing strategies that are in place and accelerating response to observed needs.

The Overview of the Findings, Conclusions and Recommendations will facilitate cross referencing of the recommendations in the Policy Briefs and detailed report of the survey. It therefore acts as a bridge between the two formats. Readers and especially planners of interventions are encouraged to refer to the detailed report for specific information for programming at sub-regional level.

Dr Richard O Muga, OGW, MBS
Director of Medical Services
Ministry of Health

Dr Davy K Koech, SS, OGW, MBS
Director
Kenya Medical Research Institute

EXECUTIVE SUMMARY

Background and Approaches: Anemia, a manifestation of nutritional deficiencies and /or a consequence of blood loss is a global problem. The detrimental effects of anemia on quality of life and survival, including negative economic consequences is reasonably well understood. A recent regional meeting acknowledged that statistics from Africa call for immediate attention. It is in this light that a situation analysis for Kenya was deemed necessary to facilitate adequate response to reduce burden of anemia and its implications.

A national survey of anemia was carried out in 12 districts drawn from ecological and altitude sub-regions that represent the country's diversity. Three to four clusters were assigned to each the sub-regions namely, the lake basin, the western highlands, the central and mid west highlands, the dry humid and semi-arid midlands and, the coastal and semi-arid lowlands in the north. Thus 21 clusters were visited between May and October 1999. In all 3229 children aged 2-72 months, and 3163 mothers and 1183 adult males whose average ages were 28 years and 36 years respectively participated in the survey. These were mainly mother-child pairs whose households had been randomly sampled at cluster level. Anemia assessments were based on hemoglobin and clinical presentation. The survey also captured status of key facets of hidden hunger namely, iron, vitamin A and zinc. Details of dietary factors, illnesses and selected socio- economic factors, and their association with anemia, iron, vitamin A and zinc nutriture were examined. Existing information was used in estimation of anemia prevalence of school-age children and the elderly. Data from 24 facilities in the survey districts and reports from public facilities were used in the assessment of incidence of clinical anemia and control activities. The following are the main findings.

Anemia, distribution and associated factors: Among children, the prevalence of mild and moderate to severe anemia were 19.2% and 54.2% respectively. Children below 30 months had the highest prevalence (76.5 %), and within this group, half were infants. Irrespective of pregnancy status half of the mothers were anemic but the likelihood of moderate and severe grades of anemia was higher among those that were pregnant. Mild anemia affected 20% and over of older children, men and the elderly.

On the basis of observed severity and public health importance of anemia, the country was stratified into three regions. In descending order these were highly significant, moderate to highly significant and moderately low significant problem regions for children and mothers. Children in the lake basin and western highlands, the coastal and semi-arid lowlands and parts of dry humid midlands were classified as being in the highly significant or moderate to highly significant problem regions. Mothers in these regions followed a similar pattern but majority were in the moderate to highly significant problem region. In the central and mid-west highlands and parts of dry humid midlands, mothers and children were mainly in the moderate to highly significant or moderately low significant problem regions. The distribution pattern of anemia for mothers and children was comparable to that inferred

from service statistics of public facilities in 60 districts during the period 1995 and 1999. Majority of men fell in the moderately low significant problem region.
From a sub-sample analysis over 40% of children and mothers were iron deficient and 30% were at high risk of becoming deficient. In addition, iron deficiency was likely to account for about half of the anemic children and two-thirds anemic mothers. Among men, iron deficiency was estimated to be 15.9% and affected about one-quarter of the anemic ones.

Factors that significantly contributed to the risk childhood anemia were consumption of staples with low bio available iron, restricted food intake during dry seasons, family size, malaria, diarrhea and maternal anemia. Spleen enlargement, mainly attributed to malaria was associated with a five-fold increase in the risk of childhood anemia. Hookworm and Schistosoma (bilharzia) infections were associated with a two-fold increase in risk of anemia among mothers and men respectively. Vitamin A deficiency (VAD) was associated with a three-fold increase in the risk of anemia in both mothers and men. Illnesses accompanied by fever were significant in all groups.

Vitamin A and zinc deficiencies: Among children, acute and moderate VAD prevalence was estimated to be 14.7 % and 61.2% respectively. The corresponding VAD prevalence among mothers were 9.1 % and 29.6%. Men had slightly lower prevalence than mothers. These findings were comparable to those from the 1994 Micronutrients Survey in some parts of the country, but others fared much worse. VAD was associated with anemia in all groups. Malaria parasitaemia, hookworm and malnutrition were each associated with a two-fold increase in the risk of maternal VAD. Recurrent fever and hookworm infection were each associated with nearly two-fold increase in the risk of VAD among men. High risk for zinc deficiency occurred in about half of children, mothers and men. The risk of zinc deficiency was associated with diarrhea and spleen enlargement among children. Among mothers and men, anemia, VAD, hookworm, respiratory tract illnesses and consumption of animal flesh were significantly associated with risk of zinc deficiency.

Illnesses: Among children, malaria parasitemia prevalence varied between 19.8% and 80.4% in the lake basin and western highlands. In the coast the parasitemia rates varied between 26.3% and 51.8 %. The parasitaemia rates among mothers varied between 19 % and 39 % in the lake basin and western highlands, and between 18 % and 30% in the coast. The rates for men were lower but closely comparable to maternal rates. Excepting humid parts of the midlands, the rates in other parts of the country were 12 % and below. Overall, 83%, 6% and 3.8% of mothers identified malaria, respiratory tract diseases and diarrhea in that order as common household illnesses. Bed net coverage was estimated to be 18.3% but treatment and re-treatment rates were below 15%. Hookworm was prevalent in the western highlands and lake basin, coast and some parts of the dry humid midlands areas. The overall hookworm rates for children, mothers and men were 9.5%, 35.7% and 33.5% in that order. Bilharzia was prevalent in lake basin; coast and some parts of the dry humid midlands areas the rates were lower. HIV infection rates were not assessed but existing evidence shows that anemia prevalence could increases by up to 10% or hemoglobin concentration could decrease by 1.29 g/L among HIV+ individuals.

Health services utilization: The first line of treatment in half of households was self-medication using drugs bought from shops. In a third of households, treatment was first obtained from public facilities. Follow-up treatments were provided mainly by public followed by private providers. In addition, three-quarters of mothers using antenatal services visited public facilities but over 60% delivered at home.

Overall, one third of mothers indicated awareness about anemia but wide inter-regional disparities were evident. Absences of consistent practice of antenatal iron and folic acid supplementation as provided in the guidelines as well as, malaria prophylaxis in endemic areas were not consistent. Stock out periods for supplements during preceding two years ranged between 4 and 6 months per year. The laboratory capacity for anemia screening was inadequate. The price paid for supplements varied but was less than KShs. 60 per prescription. Nearly half of mothers who had been on supplements associated them with nausea, bad taste and generalized weaknesses.

Conclusions: Anemia is a national public health problem of a magnitude sufficient to retard immediate and future socio-economic development of Kenya. Anemia was attributed to inadequate intake and availability of especially, iron and losses associated with malaria among children and mothers, and hookworm among mothers. The largest burden of anemia was borne by children below 3 years, pregnant and lactating mothers. Vitamin A and zinc deficiencies underline widespread multiple micronutrients deficiencies that constitute significant public health problems in Kenya. These findings conform to deteriorating health indices reported in Demographic Health Surveys in the 1990's. There is scope for improvement in capacity of the public and private health care providers to address micronutrients deficiencies, anemia and associated risk factors. A preventive initiative must be presented to all communities jointly with all other relevant players.

Recommendations: The government should formulate policies to stimulate concerted multi sectoral efforts by public and non-governmental development partners in the control of anemia and hidden hunger. Policies to facilitate expedient interventions to protect mothers and children through improved access to micronutrients supplements and parasitic diseases control are required. In order to cater for primary prevention of the general population, the agriculture, planning, food industry, education and socio-cultural sectors should jointly with the health sector adopt innovative approaches to increase the micronutrients intake and reduces loss in the country. These efforts would be in a bid to increase micronutrients content of staples, commonly used foods and condiments, and their consumption as well as modify health-seeking behaviors. National wide advocacy campaign to highlight health and socio-economic consequences of anemia and hidden hunger, and cost-effectiveness and benefits of various intervention options should be implemented without further delay.

Next Steps: To carry the findings of this survey into action, the following steps are suggested:

- **Dissemination Workshops** -- The findings should be widely disseminated among policy makers and senior program officers in the highly relevant sectors within the government and non-governmental organizations. The findings should also be disseminated to districts and specific communities who participated in the survey.
- **Senior Managers Workshop** -- Key senior managers in health and related sectors to develop feasible intervention plans for anemia and multiple micronutrients deficiency control and amplify the National Health Sector Strategic Plan.
- **Review guidelines and further mapping of deficiencies** -- Researchers and micronutrients committee should fine tune anemia and micronutrients deficiency risk maps for different regions and associated factors, and design social marketing strategies as part of operations research to strengthen various interventions.

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ABBREVIATIONS AND ACRONYMS

ACT	-	Alpha-1 Antichymotrypsin
AGP	-	Alpha-1 acid-glycoprotein
AIDS	-	Acquired Immuno Deficiency Syndrome.
CDC	-	Centers for Disease Control
DHMT	-	District Health Management Team
DHS	-	Demographic Health Survey
HbC	-	Haemoglobin concentration
HIV	-	Human Immuno-deficiency Virus
HPLC	-	High Performance Liquid Chromatograph
ID	-	Iron Deficiency
IDA	-	Iron Deficiency Anaemia
ITNs	-	Insecticide treated nets
KEDAHR	-	Kenyan Danish Health Research
KEMRI	-	Kenya Medical Research Institute
MCH	-	Maternal Child Health
MoH	-	Ministry of Health
NCHS	-	National Centre for Health Statistics
NHANES	-	National Health and Nutrition Examination survey
NMCP	-	National Malaria Control Programme
RNIs	-	Recommended Nutrient Intake
sTfR	-	Serum-Transferrin Receptor
SI	-	System International
TB	-	Tuberculosis
TM	-	Trade Mark
UNICEF	-	United Nations Children Fund
VAD	-	Vitamin A Deficiency
WHO	-	World Health Organization

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CHAPTER 1: INTRODUCTION

1.1 Context

Anaemia, a manifestation of nutritional deficiencies and or other diseases that accelerate haemolysis of red blood cells or interfere with haemoglobin (Hb) production or frank blood loss affects over two billion people globally (1). From a public health viewpoint, anaemia constitutes a statistical construct in which Hb concentration (HbC) in full blood is 2 standard deviations below the median for a healthy population of the same age, sex, race and state of pregnancy. Thus, in regions where severe anaemia is common, the distribution of HbC is shifted to the left for majority of the population. In addition, whilst iron deficiency anaemia is dominant in regions where severe anaemia is common, it is also widely believed that its deficiency is the most prevalent type of malnutrition with a toll higher than that of anaemia (2,3). Consequently, at community level, anaemia is used as proxy indicator of iron deficiency.

The contributory factors to iron deficiency anaemia (IDA) are multiple and frequently interactive, especially nutrition deficiencies and infectious diseases. At global level, infants, young children and women of childbearing ages are at greater risk of having sub-optimal HbC than the rest of the population. Inevitably, the greater burden of IDA is borne by developing Sub-Saharan African and South Asian countries where anaemia related morbidities and food inadequacies are a public health concern. For example, in majority of Eastern and Southern Africa countries, the prevalence of anaemia in the population ranges between 40 and 49% (4). A fine illustration can be drawn from recent observations in Bagamoyo in Tanzania, where 93% and 77% of under 5-year-old children and pregnant mothers respectively were anaemic. In this example, 52% of men and 65% the non-pregnant women were also anaemic. In addition, a survey conducted by Levy in 1964 (5) and subsequent studies especially in the coast and western Kenya attest the consensus about prevalence and vulnerability in different population groups in the country (Table 1.1). From outpatients' morbidity perspectives, anaemia is among the top 5 diagnoses at national level and leading 10 diagnoses in most public and non-governmental facilities (6,7).

While the overall trend of anaemia three decades post independence is not clear, it is realistic to expect that along with changes in dominant contributory factors overtime, and moreover expositions of 1993 and 1998 DHS surveys (13), its prevalence and severity will most probably have deteriorated. For example, from epidemiological consideration, it is expected that the overall increase in the burden of infectious diseases arising from emergence of the HIV/AIDS and TB epidemics and extension of malaria endemic zones to the highlands is likely to have exacerbated anaemia when compared to findings

Table 1.1: Profiles of a sample of anaemia and iron deficiency studies in Kenya.

Source/ reference	Study location and design	Population group	Main findings and conclusions
Levy (5)	Cross-sectional field studies, across the country based on selected ethnic groups (Annex 1.1)	0-14 year-olds and ≥15 year-old populations	Estimated prevalence of anaemia among <5 year-olds was >84 % in the coast, 13.4% to 38.4% in the midlands, 2.1% to 11.5% in the highlands and 44% in the lake basin and adjacent highlands. Overall population prevalence was >80% and 44% among coastal and lake basin indigents respectively. Iron deficiency anaemia was high in the coastal and lake basin populations and positively correlated with hookworm and malaria.
Foy et al (8)	Cross-sectional clinical study across the country	Adults	Classified anemias found among African patients into microcytic and macroytic and their subtypes, sickle - cell and hemolytic splenic types. Underlined role of parasitic infections, disorders in haemopoiesis and choices of treatment
Mbuthia (9)	Follow-up, clinical study in KNH, Nairobi	Infants	Observed mean birth HbC of 16.2 g/dL fall to 9.9-10.3 g/dL within 2 months. At 6 months post iron supplementation 7% were anaemic *vs* 71% from the same cohort who were not supplemented. Due to high drop out rates, conclusion was not feasible on the effectiveness of supplementation.
Murila, (10)	Cross-sectional study, Dagoreti and Kibera, (lower and middle socio-economic groups) in Nairobi	6-60 month-olds	Prevalence of anaemia was estimated at 19.4% and about two-fifths was attributed to iron deficiency. Re-analyses of the data reveals overall sub-optimal storage iron in about 60% of the sub-sample examined.
KEDAHR (11)	Longitudinal intervention nutrition and parasite control studies of a birth and a school cohort in Western Kenya	School going children (9-18 yrs) and mother-infant pairs	Prevalence of anaemia among school age estimated at 15% and profound seasonal effects on HbC was shown. Effects of micronutrients supplements are comparable to chemotherapy and significant despite seasonal effects. Birth cohort studies are ongoing.
CDC (12)	Longitudinal malaria intervention studies of a birth cohort and nutrition of adolescent girls in Western Kenya	Children, and mother-child pairs, adolescent girls	Peak anaemia prevalence (> 80%) and malaria parasite density occur among 6-11 mo-olds. Both decrease rapidly with increasing age. The impact of treated bed nets on anaemia has been demonstrated. Other studies are ongoing.

made in 1964. In addition, the rapid population growth and an accompanying *anaemic* economy that has plagued the country for over two decades along with vagaries of weather that have lead to progressive deterioration of food security, and inadequate capacity of the public health sector all favour a worse situation. Going by anecdotal evidence, the scenario is likely to be even grimmer given that food and absolute poverty indices could already be significantly worse than those estimated in the 1998 surveys (14). Finally, inadequate advocacy and dominance of vertical health sector programmes are unlikely to have contributed towards effective prevention and control of anaemia by all stakeholders. It should be interesting to characterise anaemia and micronutrients status in the country.

1.2 Significance of IDA

The significance of IDA across different age groups and populations has been widely reported (2,3). It suffices to note that, the effects of IDA are significant enough to cause long term retardation of national development through individual's failure to realize full genetic potential and to optimally exploit opportunities. This threat is borne by the fact that, iron in heme-form has a pivotal role in transport and storage of oxygen and in non-heme form as a constituent of essential proteins and enzymatic processes (15). As a consequence of its deficiency during infancy and early childhood, psychomotor and cognitive developments are hampered. Iron deficiency has been associated with delays in speech development and behaviour. The irreversible fraction of the developmental damage has been put at par with mild-to-moderate iodine deficiency (2). Among schooling children, cognitive functions are disturbed, leading to impaired active learning capacity and unfavourable educational outcomes. In pregnant mothers, the risk of unfavourable pregnancy outcomes namely maternal mortality, low birth weight and prematurity is increased. As a consequence of low birth weight and prematurity, the risk of infant poor health and survivorship is increased. Across all age groups, work capacity is reduced due to physical and mental lethargy and equally important increased susceptibility to infections arising from immunological impairment. Recently developed algorithms for calculating economic loss due to iron deficiency in countries with high burdens of anaemia estimate losses in the order of billions of US$ every year (16, 17). In recognition of these facts, control and prevention of IDA is a priority issue in the National Plan of Action for Nutrition (18). More recently, the National Health Sector Strategic Plan for the period 1999-2004 spells out specific intentions to reduce its prevalence among pregnant women by 30% (19).

1.3 Hierarchical consideration of determinants of anaemia and iron status

In conceptualizing a simplified epidemiologic model for anaemia, iron deficiency and IDA, consideration of both short and long term intervention measures necessitates adoption of nutrition related variables as proximal and, socio-cultural and economic factors as distal determinants respectively. Moreover, their interactions in the continuum are crucial in defining intervention processes and facilitating allocative efficiency. Thus at public health level, the hierarchical model illustrated in Appendix 1.1 is proposed for anaemia in a typical Kenyan situation.

1.3.1 Nutritional factors

The main determinants are intake and bio - availability factors. The former relates to iron content in food while the later relates to its absorption in which the presence of inhibiting and enhancing ingredients make significant contribution to the iron transfer from the intestines. The inhibitory moieties that are well described in literature include calcium, phytates and phenolics. In contrast, vitamin C and animal products (meat and fish) enhance absorption of iron. Other facilitatory interactions include pre-consumption hydrolysis of phytates through sprouting and fermentation (15). In addition, at tissue level vitamin A deficiency has been shown to inhibit mobilization of depot iron (20). Intake and bio - availability of other haematinics namely copper, cobalt, vitamins B12, B6, folic and nicotinic acids, and riboflavin must also be factored into the framework.

1.3.2 Infectious diseases

The effects of acute bacterial, parasitic and viral infections on erythropoiesis, haemolysis, catabolism and food appetite are widely documented. Of particular interest to the Kenyan scenario are dominant infections in the burden of morbidity and mortality matrix. The undisputable ones include malaria, diarrheal diseases, acute respiratory infections, HIV/AIDS, TB and hepatitis B and C (6,19). The epidemic dimensions assumed by malaria, HIV/AIDS (Annex 1.2) and TB underline their candidature as leading causal factors. It is noteworthy that the contention that excess iron increases susceptibility to infectious diseases including TB remains an important issue especially in developing tropical countries where very large burdens of infectious diseases remain the principle concern of the health sector.

1.3.3. Chronic diseases

Chronic diseases of infection and non-infection origin affect iron metabolism directly but at different levels. Parasitic diseases that are of public health significance in Kenya namely, helminthic, schistosomiasis, filariasis, leishmaniasis, trypanosomiasis and amoeba are known to cause and/or aggravate anaemia. Non-infection inflammatory conditions such as rheumatoid arthritis, malignant tumours and chronic renal failure are also associated with anaemia both directly and indirectly (21). Genetic conditions affecting haemoglobin, mainly sickle cell disease and trait, and thalassaemia traits are important contributory factors (21). In Kenya, the epidemiology of sickle cell disease and trait has received significant attention (22) but from preventive and promotive viewpoints their importance in relation to anaemia is yet gain the emphasis they merit.

1.3.4. Physiological factors

In view of the central role that iron plays in body functions, increased physiological demand due to pregnancy, menstrual flow and growth spurts in early childhood and adolescence is universally recognized. The interaction between risk enhancement attributed to these demands and predictors described above presents important points of inflection. Failure to address the relative deficiency created especially during adolescent spurt could constitute a missed opportunity especially for maturing girls to improve their capacity to cope with demands placed upon them during adulthood.

1.3.5. Environmental factors

Environmental pollutants such as heavy bi- and tri-valent metals, including lead, copper, aluminium and cadmium also precipitate IDA. Unlike calcium, which is likely to interfere with absorption of iron, these heavy metals are known to interfere with Hb formation through substitution of the iron in the heme molecule (15). Excepting preliminary data from pilot activities on lead exposure, the public health importance of these pollutants is poorly documented in Kenya.

1.3.6. Socio-economic and cultural factors

High prevalence of food poverty and inequitable availability, accessibility and affordability of health care services, and inadequate knowledge and skills to reduce risk of developing anaemia in the general population are fundamental issues in the anaemia discourse. In this respect, the policy of including iron/folate supplements in the MCH package mainly for pregnant mothers has been going on for many years. In this regard, the overall effectiveness of the strategy and the impact of this intervention in containing anaemia among antenatal mothers have not been clearly established. Other activities with potential to mitigate against iron deficiency and IDA include use of insecticide treated bed nets (ITNs), deworming, food fortification and health education. Coverage by these interventions is at best low and majority of the time restricted to operational experiments. At household level, while food security is probably the most closely associated factor in the nutrition matrix, food taboos, dietary and culinary practices have potential to alter the risk of developing anaemia. Their relevance in this context is however unclear. Finally, the interaction between behavioural factors such as alcohol consumption, smoking and soil eating practices (geophagy) are also of interest in delineation of risk factors.

1.4 Vitamin A status

The importance of vitamin A and the global efforts to address its deficiency are widely documented (18). In Kenya, the findings of the National Micronutrient Survey that was carried out under the auspices of UNICEF in 1994 provided a foundation for formulating policy and strategies to contain vitamin A deficiency (VAD) in the country (23). The policy guidelines in force identified the use of high dose vitamin A supplementation as a key strategy in the short - term realization of the national objective. From a public health viewpoint, supplementation is targeting both mother's post-partum, and infants during administration of measles vaccine and in the National Immunization Days. The appropriateness of the currently recommended dose and schedule are under investigation in KEMRI's Nutrition research component of the Kenyan Danish Health Research Project (KEDAHR). In addition, in view of these interventions, it is necessary to carry out periodic surveys to facilitate monitoring of progress with regard to vitamin A deficiency reduction among other micronutrients. From these observations it was considered justifiable to carry out the following:

(a) re-visit and strengthen baseline data on VAD in the country;

(b) facilitate review of performance and strategies of VAD intervention programmes especially from the stand point of amplifying multiple strategy approach and;

(c) generate more data on maternal vitamin A status, including pregnant mothers so as to strengthen maternal focused interventions especially in rationalization of the proposed low-dose vitamin A interventions during pregnancy (19);

(d) generate more data on vitamin A status of the population in view of the association between s-retinol and mobilization of depot iron (20), and furthermore the role of acute phase response in interpretation of VAD, which was not explicitly addressed during the micronutrients survey.

1.5 Zinc nutrition status

The physio-chemical essence of zinc is reasonably well documented. Besides being the 2nd to 3rd most abundant intracellular cation, the critical roles of zinc as a constituent of many metallo-enzymes, immune system, structural stabilizer of proteins, nucleic acids and ribosomes are widely published (15). It is sufficient to note that arising from these roles, zinc involvement in protein and carbohydrate metabolism, and nucleic acid synthesis renders it essential for linear growth. Zinc deficiency is thus associated with "zinc-responsive growth failure". With regard to the immune system, zinc plays a protective role against free radical damage and interacts with practically all elements of the system. Non - surgical "thymectomy" as a response to zinc deprivation is perhaps one of the most graphic illustration of its essentiality (24). Furthermore, considering the increasing evidence of nutritionally mediated biological programming, nutritional thymic dysfunction, and their association with early death (25), the role of zinc in national micronutrients policy and programmes cannot be over emphasized. In this respect, zinc deficiency is probably going to be the next priority micronutrient after iodine, iron and vitamin A to receive global effort towards its elimination. It is noteworthy that zinc is among the micronutrients scheduled for special attention in the National Nutrition Action Plan (18).

The causes of zinc deficiency include inadequate intake and or poor bioavailability due to presence of dietary inhibitors. The likelihood of concurrent zinc and iron deficiency should therefore be considered highly probable especially among vulnerable groups namely, infants, children and pregnant mothers. Thus, in addition to expected convergence between iron and zinc nutrition status at physiological level, zinc interventions could be cost-effectively twined with iron deficiency interventions as combined supplements if indicated. It is therefore beneficial to consider assessment of zinc nutrition status along with IDA. As is the case of s-ferritin, s- zinc concentration is affected by hepatic sequestration during acute phase response to infection or inflammation, alcoholic cirrhosis and protein energy malnutrition as well as oral contraceptives. Assessments of zinc status in a population should therefore consider at least both dietary roles and infections associated with infections and chronic disease response.

1.6 Problem statement

Iron deficiency with or without anaemia is believed to be the most prevalent nutritional deficiency in the world. The consequences of its deficiency described in Section 1.3 necessitate a multi-sectoral approach in its prevention and control. Whilst sub-regional variations in prevalence and severity are expected, the relative importance of the different causes or risk factors and their interactions is unclear. Moreover, the tendency has mainly been to recognize IDA along with other anemias as a consequence or manifestation of disease process rather than nutritional deficiency. The worst-case scenario is presented by the change in epidemiologic profiles of malaria, HIV and TB, which invariably increase requirements for transfusion. Paradoxically significant risk is borne by this intervention especially with respect of HIV. Efforts to obviate this risk, the economic consequences of anaemia and the potential to control and prevent anaemia provide sufficient justification for support by government and other development agencies (16). It is therefore, necessary to take stock of existing opportunities that have potential to facilitate a concerted crusade against anaemia and especially iron deficiency along with other micronutrient deficiencies scheduled for intervention in the National Nutrition Action Plan (18).

From health service view point, the on-going health sector reforms underline deliberate shift in allocation of resources from curative to preventive and promotive care (26). In this respect, although the sector strategic plan spells out the intention of the government to reduce the prevalence of presumably IDA among pregnant mothers by 30% between 1999 and 2004, details of the rationale for this target and mechanism of realizing it are not clear. An additional oversight in the plan is the silence about interventions to reduce prevalence of anaemia among young children and adolescents who could be as vulnerable to anaemia and iron deficiency as the mothers. The role of the non-governmental providers and the household in the containment of anaemia is also not explained. Moreover, concerns on efficiency and effectiveness of the public and private sectors to deliver these services remain unresolved. Thus, process issues including where? - in order of priority zones at regional or sub regional level or population groups; how? - in terms of choice of entry point and optimum package and process, and who? - with respect to role of other providers, sectors and households, and sustainability of the initiatives among others require amplification. These observations along with preceding argumentation provided sufficient justification and motivation to assess the magnitude and characteristics of anaemia and, iron, vitamin A and zinc deficiencies in the country. It was envisaged that the survey findings will make actionable the push for a reduction of anaemia as projected in the NHSSP (19) would contribute towards improved understanding of these micronutrients and pave way for delineation of the dynamics of other front line haematinics and micronutrients deficiencies in general.

1.7 Objectives

General objective

The overall objective of the survey was to conduct a situation analysis on anaemia and associated factors in Kenya with special reference to iron deficiency type. An additional objective was to review the status of vitamin A and gain insight into zinc nutrition status in Kenya.

Specific Objectives

1. To establish the magnitude and severity of anaemia among under-5-year-olds, mothers and adult males in representative areas.
2. To determine the magnitude and intensity of malaria, hookworm and schistosomiasis infections in the selected areas.
3. To establish dietary patterns of communities in the selected areas.
4. To determine the socio-cultural and socio-economic factors influencing the consumption pattern of iron rich foods, bioavailability enhancers and inhibitors in participating communities.
5. To assess the levels of utilization of MCH services with respect to antenatal use of haematinics, immunization, use of insecticide treated nets and chemoprophylaxis, deworming and relevant health education the country.
6. To characterise vitamin A and zinc nutrition status in a sample of individuals drawn from the anaemia survey.

7. Arising from 1 to 6 above, recommend strategies for preventive and promotive anaemia interventions and propose indicators for monitoring and evaluation; provide insight into progress made by ongoing Vitamin A interventions; and relevance of zinc in multiple micronutrients interventions in the country.

1.8 Interpretation of the objectives

The study purposively used the framework of anaemia in targeted populations across the country to estimate the occurrence of IDA and non-IDA (NIDA) and iron deficiency (ID) without anaemia. The latter was assessed using biochemical indicator on a sub-sample of participants. Other classifications of anaemia namely, anaemia due to chronic disease and anaemia due to acute disease or anaemia due to direct combination of micronutrient deficiencies and disease were inferred. In addition, since the survey was to last several months, the tools used in the households attempted to capture food security situation in dry and wet seasons. Finally, in order to facilitate generalization, the bulk of the effort was posted to the rural areas where majority of the population resides.

1.9 A guide to the report

The report begins with a description of approaches adopted in the implementation of the study. The findings are grouped in five chapters and presented around three population groups namely children, mothers and adult males. Reviews of anaemia among older children and the elderly are captured in appendices. Subsequently, anaemia and related concerns are viewed from household perspectives. The last chapter on findings provides retrospective and cross-sectional details of anaemia from a health services viewpoint. A discussion of these findings presented in chapter eight leads to conclusions, recommendations and proposals for their implementation in the last chapter.

CHAPTER 2: APPROACHES

2.1 Conceptualization

Arising from the expected excessive risk of developing IDA that is borne by young children and women of reproductive age, this survey was conceptualized and implemented within the context of maternal and child health care. Assessment of the situation among school age children and the elderly was limited to review of available reports.

2.1.1 Development and indicators of IDA

Half of the iron (50%) in the body is present in red cells in form of Hb (21). In the absence of acute hemolysis and frank blood loses, development of iron deficiency anemia takes an insidious stage-wise progression (Appendix 2.1). In the early stages (pre-latent phase), depletion of iron stores takes place and serum-ferritin is a reliable marker of depleted depot iron as well as iron overloads (3,21,25). Unfortunately, s-ferritin increases in infections and other inflammatory conditions (in a manner similar to that of acute phase proteins), toxically caused liver cell damage and iron treatment. An intermediate phase that is characterized by diminished transport iron, unsaturated transferrin and iron-deficient erythopoeisis (latent phase) follows the transport system. During this stage, intra cellular transfer mediating ferric transferrin receptors are shed by cells and appear as soluble transferrin receptors (sTfR) in serum (25). Thus the second phase of IDA development is characterized by changes in three markers: namely, protopophyrin, transferrin and sTfR. sTfR is considered a particularly useful marker because it is relatively unaffected by the Amucosal block effect which interferes with s-ferritin release from body stores. However, sTfR levels could be affected by hemolytic anemia, polycythemia, hemoglobinopathies, aplastic anemia and chronic renal failure (26). The late stage of IDA is characterized by decreased hemoglobin production and mean corpuscular volume (MCV) that manifest in microcytic and hypochromic red cells. It is for these reasons that IDA is conventionally diagnosed using a combination of two or three indicators, majority of the time based on early and late stages through s-ferritin - MCV or HbC or intermediate stage and late stage through any of the three indicators and HbC or MCV. Since low HbC characterizes the final stage, it is realistic to base large-scale surveys on HbC measurements and apply the hemoglobin shift model in interpretation. In this survey, biochemical and clinical assessments of anemia and iron status were based on a combination of HbC shift model and sub sample s-ferritin determinations as indicators of absolute (storage) depletion and functional depletion respectively. The clinical aspects were based on palmar and nail bed pallor, koilonynchia, angular stomatitis and pertinent clinical history.

2.2 Study design and methods

2.2.1 Study site selection

This was a cross-sectional survey in which predominantly quantitative data was collected. The sampling frame consisted of sub-regions that typify the country with respect to agro-ecology, altitude and epidemiology. The sub-regions are broadly described as humid (equatorial), sub-humid, semi-arid and arid ecological/climatic zones (27). As would be expected some relatively small geographical areas share two characteristics. With regard to altitude, the following classification was adopted; areas lying between 0-500 m above sea level (*asl*) as lowlands, 600-1200 m *asl* as midlands and above 1300 m *asl* highlands. Epidemiologic zoning took account of the pattern of malaria, schistosomiasis and helminthiasis across the country. The coastal humid lowlands, semi-arid to arid low lands, dry humid to semi arid midlands, dry humid midlands, dry humid and humid central and midwest highlands, humid western highlands adjacent to the dry humid lake Victoria midlands (lake basin) sub-regions typify the country (Appendix 2.2). From each sub-region, one to three districts that typify the sub-region from agro-ecology, altitude, culture and epidemiology were purposively selected. In addition, district areas that had been sampled during VAD survey (23) were given priority in the choice of the districts. In all, 12 districts were selected (Table 2.1). At district level consensus on the survey sub - locations was reached after consultations with local MoH public health personnel and District Development Plans for the period 1997-2000 (28). For convenience these will be referred to in this text as clusters. Since two to three zones with respect to agro - ecology, expected culture and epidemiology, characterized most districts one to two clusters were selected per district. Thus, with exception of Busia, Kisumu and Nyando districts two clusters were selected in each district. Only Mombasa Municipality/district was considered among the urban areas. Supplementary data from a separate effort in one of Nairobi's lower middle socio-economic settlements was incorporated. Based on prevalence of poverty, the sampled clusters fell within the intermediate range of socio-economic categories (14) (Table 2.1).

2.2.2 Mobilization and recruitment

Mobilization of cluster residents was carried through briefing and discussing the survey protocols with the administrators (Chiefs and Assistant Chiefs) and village elders. The clusters had between 7 and 20 villages. Field assistants with adequate literacy and numeracy skills were recruited, trained and assigned to village elders and their respective villages. In 11 districts, only those with a form four certificate were recruited. Where possible general barazas were convened followed by a door-to-door campaign during which all households with an under 5 year-old were listed. In some clusters, general barazas were not convened because the targeted younger couples especially mothers seldom attended and time constraint.

2.2.3 *Sample sizes and household sampling*

The sample size estimates were based on expected prevalence of anemia as inferred from various sources (5,9-12). The findings of the survey by Levy et al (5) provided useful reference for prevalence of anemia in the midlands and highlands. Prevalence reported in more recent studies were applied in estimation of sample sizes for lake basin and coastal areas (9-12). The computation of the sample sizes was guided by the desire to estimate the true rate of anemia at 5% precision for each study cluster which typified a given ecological/climatic zone (29). In Kenya, it is common practice to base nationwide surveys on districts. To cater for this need and heterogeneity within and between clusters, design effect (*deff*) of 1.2 and 1.5 were factored in the estimates of the coastal and western regions and other clusters respectively. The latter was based on the fact that the situation in the other regions was even less certain than that in the coast and western Kenya. Thus the sample sizes, which ranged between 100 and 200 households per cluster, were adjusted upwards to between 150 and 240 respectively. In turn this yielded sample sizes ranging between 300 to 480 households per district area. The term district area denoted boundaries, as they existed during the 1994 VAD survey. In this respect both Meru and Kisumu districts, and their units of administration had been subdivided into 4 and 2 districts respectively. The sample for old Kisumu district area was therefore equally divided between Kisumu and Nyando districts. Because of envisioned logistical difficulties in Tharaka district, only Meru district was included in the districts hived from the former Meru district area. However, one cluster was selected in the border between the two districts (Appendix 2.3).

Table 2.1: Administrative details and selected characteristics of sampled clusters.

Province	District (Acronym)	Division	Sub-locations (clusters)	Altitude m	Climate (ecological potential), (27)	Prevalence of poverty# %
Coast	Kwale (Kwa)	Msambweni	Kikoneni	196	Humid	41.6
		Kinango	Kifyonzo	200	Dry sub-humid	
	Mombasa (Msa)	Changamwe	Miritini	69	Humid	31.9
		Kisauni	Utange	40		
Nyanza	Kisumu (Ksm)	Winam	Osiri	1200	Dry sub-humid to humid	47.1
	Nyando (Nyo)	Nyakach	Kadiang'a	1180	Dry sub-humid	
	Kisii (Kis)	Keumbu	Birongo	1973	Humid	32.7
		Mosocho	Mwamosioma	1770		
Western	Bungoma (Bun)	Bumula	Nakhwana	1300	Humid	54.2
		Kimilili	Misikhu	1700		
	Busia (Bus)	Bundalangi	Sisenye	1180	Dry sub-humid	56.1
Rift Valley	Baringo (Bar)	Sacho	Sirwet & Tenges	1830	Humid to semi-arid	39.1
		Kapsaraman	Ng'aratuko & Sibilo	610	Semi-arid	
Central	Nyandarua (Nya)	Ol Kalou	Rurii	2370	Humid to dry sub-humid	37.1
		Kinangop	Njabini	2700		
Eastern	Kitui (Kit)	Mutomo	Kyatume & Kanguli	800	Dry sub-humid to semi-arid	53.8
		Kitui Central	Wii & Wikiliye	1200	Dry sub-humid	
	Meru (Mer)	Abothoguchi West	Kibaranyaki	2500	Humid	30.0
		Miriga Mieru East	Kibureni/ Birikene	914	Dry sub-humid	
North Eastern	Garissa (Gar)	Central division	Korakora	152	Semi arid to arid	41.2
		Modogashe	Elan & Gurufa	305	Semi-arid to very arid	

- Based on unweighted cash poverty at Ksh. 978 (rural) and Ksh. 1490 (urban) below which households are deemed to be in total poverty (14). Densely populated districts are likely to be worse of than indicated.

From the household lists (section 2.2), proportionate allocation and random sampling of households from all villages in each cluster was carried out. Only households with mothers at the time of demography were included in the sample. The selected households were subsequently individually invited to participate in the study by attending the field clinic for physical and laboratory examinations and responding to interviews at home. At the time of invitation emphasis was made for participation of the selected index child, that is the youngest child in the household who was within the inclusion age bracket of 2 to 60 months, the mother and the father or a reference adult male who was resident in the household and ate from the same pot with the rest of the household. The age limit for adults was 50 years. In general, communities were informed that the process was in essence a mother-well and child-well clinic set up. Exclusion was based on obvious acute illness, chronic debilitation and presumed loss of blood such as through road traffic accident and surgery. All participating households were required to have been resident in the cluster during the past 6 months and over.

The clinics were based in the nearest community facilities, namely schools, churches or local dispensaries, local administration or cooperative meeting halls or empty shops as recommended and arranged by the village elders and the administrators. The proximity of the clinic to the households facilitated reminders and distribution of stool and urine bottles the evening before the clinic day as well as walking distances for the participants. In the event of non-participation or exclusion, the nearest demographed household made substitution. In sparsely populated clusters where desired sample size could not be enrolled during demography, the survey area was extended to neighbouring villages in the adjacent sub location. Because of low participation among fathers, schoolboys aged above 15 years from the same catchment were recruited into the survey to beef up adult male samples.

2.2.4. Household Interviews

The research assistants conducted the interviews and the respondent in all cases were mothers to the index children. Interviews addressed issues related to socio-economic status including demographic factors, morbidity experiences with emphasis on anemia, health seeking behavior and dietary practices (Annex 2.1). Because of time limitations, it was not possible to organize focus group discussions. Limited key informant interviews were carried out, mainly on food security and general health of the community living in the clusters.

2.2.5. Medical history and physical examinations

All participants were interviewed about their past and current medical history. The mother of the index child responded to both her interview as well as that of her child. The medical history covered febrile episodes, respiratory gastrointestinal tracts and cardiovascular illnesses, blood transfusion or donation during the preceding 3 months and hospitalization. (Annex 2.1) The history was captured using structured interviews administered by local nurses who had been oriented on the content and approach of eliciting responses. The nurses were drawn from each host district to facilitate communication in local languages whenever need arose and follow-up thereafter in the event of need. Physical examinations included child and maternal anthropometry. The lengths of children below 2 years were measured using a length board while height of older ones along with mothers were measured to the nearest 0.5 cm using either a standing board or a standiometer. All weights were measured to the nearest 0.1 kg using electronic scales (UNICEF Electronic Scale 890 Seca Ltd., Birmingham, UK). The weights were measured while in light clothing. The scales calibration was confirmed at least twice daily using standard weights.

All participants were examined for palmar and nail bed pallor. Both finger and toe nail beds were examined for koilonychia or similar deformations. The participants were also examined for oral mucosal disease including thrush and skin diseases. Axilla temperature was recorded using digital thermometers (Omron Corporation). Elevated body temperature was defined as a value >37.5 ^{O}C. The children were also examined for splenomegaly and hepatomegaly using mid clavicular, mid axilla and mid sternum reference lines. In the entire survey, two clinical officers who used a standardized protocol made clinical assessments.

2.2.6. Laboratory examinations

Blood collection was designed to permit determination of spot HbC for all participants, and subsequent assessment of s-ferritin and s-retinol in 30% of the participating households. The participants were sequentially assigned to either venepuncture or finger stick blood sampling procedure using an interval of one or two households depending on the level of participation. Where participation was low, the ratio was adjusted appropriately. Among venepuncture cases about 6 ml of blood was drawn. Children below 6 months of age were not effectively covered for venepuncture because of skill requirements and time constraints. All blood sampling procedure were carried out using sterile single use needles, syringes and lancets. A core team of laboratory personnel who had been re-oriented on entire laboratory procedures carried out Blood sampling.

2.2.6.1. HbC determinations:

The performance of the four portable haemoglobinometers (HemoCue^{TM}, Angelholm, Sweden) used in the Survey and microcuvettes were tested against a standard electronic counter (M530 - Coulter Electronics Ltd., Miami) before commencing the survey. Significantly high correlation (r = 0.99, P<0.0001, n=30) were observed between measurements by the two types of machines and a regression equation $HbC_{Coulter} = 1.12 + 0.99\ HbC_{HemoCue}$ defined. There were no significant differences between the four photometers. In addition, given frequent claims that finger stick based HemoCue determinations tend to over estimate anemia (30), concurrent venepuncture of ante-cubital vein and finger stick (capillary) samples were drawn for HbC determination. Overall, the finger stick samples tended to have a higher Hb concentration than vein samples but differences whose mean was 1.4 $\pm$ 0.04 g/dL (n =21) were not significant (P=0.1). Significantly high correlation was demonstrated (r=0.96, n=21) and a regression equation

$HbC_{Capillary}=0.197+HbC_{vein}$ was defined. Overall it was estimated that the use of HemoCue and finger stick samples could have overestimated anemia by 0.5 % to 2%. In addition, in view of the habitual tendency among technicians to wipe away the first drop of blood after a finger stick, which could necessitate subsequent finger squeezing, comparison between the first and second drop was carried out. A significant correlation was demonstrated between HbC values in the first and second drop (r=0.95, P<0.0001). The mean differences between the HbC in the first and second drops was 0.11 ± 0.013 g/dL (n=20, P=0.41). With an agreement close to unity, it was inferred that reported over-estimation of low HbC could clearly result from unnecessary squeezing (milking) of the finger stick site. Subsequently, precautions entailed performing a sufficiently deep lancet finger stick to allow free flow of blood and avoidance of finger milking. In the event of failure to read HbC especially due to trapped air bubble in the microcuvette, or unyielding finger stick site, the procedure was repeated. Finally, all microcuvettes in the factory packed bottle were used the same day after opening, where this was not possible the ones to be used were transferred in batches to a holding container so as to minimize exposure to air, heat, humidity and light.

Non-fasting blood collected by venepuncture between 12 and 17 hours was carefully transferred into acid washed aluminum foil covered glass test tubes, sealed with acid washed non-rubber caps and stored in a cool box between 4°C and 8°C. No anticoagulant was added to the blood. Separation was carried out in batches after about 2 hours. The serum was then transferred into 2 labeled zinc free cryo tubes (Nunc tubes™) one with aluminium foil cover and one without. The aluminum foil covered tube was out gassed with nitrogen gas. The cryo tubes were then stored in liquid nitrogen or at -10°C to -20°C for about one week before being transferred into liquid nitrogen and transported to Nairobi. In Nairobi the samples were stored between -20°C and -70°C for and analyzed for s-retinol and s-ferritin within 6 months after collection.

2.2.6.2. Parasitological investigations:

Thick and thin blood films were prepared for malaria and white blood cell count. The slides were dried, stained using May-Grunwald-Giemsa stain (31). The slides were examined for malaria parasites and the number of parasites per 200 white blood cells (WBCs) or 500 WBCs in case of low parasitaemia was counted.

Stool samples were collected mainly around time of blood sampling and examined quantitatively for intestinal helminths and schistosome eggs. Duplicate 50 mg fecal thick smears covered with cellophane soaked in glycerine were prepared from each stool sample (32). The smears were examined for hookworm eggs within 1 h and for eggs of S.*mansoni, T. trichiura,* and A *lumbricoides* after 24 h clearing. 10-40% of all stools received were analyzed for protozoa infections using modified Ritchie's concentration method (33). Urinalysis was carried out by filtering 10 ml of urine through a millipore membrane filter and syringe. The membrane was then examined under microscopes. The egg output was expressed as the mean number of eggs/g feces or eggs/10 mL of urine.

Tests for exposure to filarial parasites was carried out using immunochromatographic qualitative detection of *W. bancrofti* antigen (ICT Diagnostic, Brookvale, NSW, Australia) for selected villages in Kikoneni cluster in Kwale district where endemic filariasis has previously been reported. However, serum and not whole blood was used in this survey.

2.2.6.3. Biochemical analyses:

Ferritin analysis

Serum ferritin concentration measurements were based on sandwitch enzyme-linked immunosorbent assay (ELISA) technique using semiautomated ES300 analyser (Hamilton Bonaduz Ag, Suit). The reagents used were supplied by Boerrhinger Manheim (Germany). In contrast to the recommended range of concentrations used to construct a hyperbolic standard curve using 0 □g/L and 966 □g/L concentrations, appropriate dilutions were instituted and a linear plot was constructed using 0 to 300 □g/L concentration. All other manufacturers sample-processing protocols were observed. Inter laboratory check was based on a batch samples analyzed in both Nairobi and Institute of Human Nutrition of the Royal Agriculture and veterinary University in Denmark. A high correlation was obtained between the readings in both laboratories ($r=0.995$, $n=15$) but the readings made in Nairobi were consistently higher by a mean of 0.86 ± 0.47 µg/L and a range of 0.2 to 2.05 µg/L. In all 1987 samples consisting of 733 children, 1068 mother and 186 father sera were analyzed for s-ferritin.

S-retinol (vitamin A) analysis

Serum retinol concentrations were measured by HPLC (Hitachi, Ltd, Tokyo). The performance of the method used (34) had previously been confirmed with CDC laboratory (Atlanta Georgia) and reconfirmed by an analyst from the Institute of Human Nutrition Department (Royal Agriculture and Veterinary University, Denmark) together with local analysts during the setting up for this study. Before starting the extraction procedure, 5-µL retinyl acetate (100 mg/L) was added to 100-µL serum as an internal standard. The extract was reconstituted with 100µL mobile phase (volumetric methanol: water, 95:5) and 20µL was injected into a guard-fitted, normal-phase stainless steel column (microbondapak C18, 3.9 x 300, mm particle size 10µm; Waters Associates, Milford, MA). The cut off of < 10 µg/dL, 10-20 µg/dL were used to indicate acute and moderate risk of vitamin A deficiency status respectively (36). In all, 3237 serum samples from 945 children, 1674 mothers and 618 adult males were analyzed.

S-zinc analysis

The protocol derived from Dawson et al (35) was adopted in zinc analysis. In this study, a ratio of 1 unit of serum to 9 units of double distilled water was vortex mixed. This approach is believed to be free from interference effects by protein. Preliminary findings showed an exponential increase in zinc concentration after reconstitution of the serum and the standards. This could correspond to freeing up the firmly bound zinc by proteins. Consequently, all samples were analysed within 3 hours after reconstitution.

All determinations were carried out using an atomic absorption spectrophotometer (Shimadzu AA-680), which had previously been calibrated using serum zinc standards (Seronorm™ - Nycomed Pharma AS, Oslo, Norway) and periodically checked using internal standards. All measurements were carried at 231.09 nm, using a gas flow rate of 2.4 L/min of analytical grade acetylene and 8 L/min of filtered air and in a background correction mode. In view of established difficulties in determining precise nutrition state at community level, cut-off for high risk of zinc deficiency was adopted in this survey. Since practically all samples were non-fasting, a cut-off of 65 µg/dL was used in analysis and interpretation. This report was based on results of 1093 mothers, 541 children and 343 adult males.

2.2.7. *Dietary assessments*

A 24-hour dietary recall survey was carried in 10 to 20 households per cluster. The mothers were sequentially sampled at the clinic and walked to their respective homes where the interviews and estimation of food consumption was carried out by locally based nutrition technicians (Annex 2.2). The exception to this was Garissa district where logistical difficulties could not permit visiting the desired number of households.

2.2.8. *Facility assessments*

Facilities identified by the households as the main source of health care were visited. A structured questionnaire was filled by the in - charge or by respective departments with respect to range of available services pertinent to the prevention and control of anemia and their utilization (Annex 2.3).

2.2.9. *Survey coverage*

Based on the adjusted sample sizes, the response rates for HbC and clinical examinations ranged between 40% and 97.1% among the mother-child pairs. Using the minimum cluster sample this translates to 60% to 124.5%. However, using actual HbC assessments that form basis of this report, the cluster coverage towards the district area sample ranged between 28 % and 96.7%. Overall, this translates to an effective coverage of 74% compared to 79.2 % response rate (Table 2.2). The implementation efficiency (ratio of analyzed data to the response rate) ranged between 70% and 100%. It should be noted clusters in Mombasa, Garissa and Nyandarua districts had the lowest participation. In addition, overall participation among males (27%) was lower than expected. The response rate ranged between 3% and 64%. The dominant reasons included fear for HIV testing, religious beliefs about blood and demanding priority duties especially among men, and logistical difficulties. Whenever possible, school boys aged 15 years and over attending local schools were examined for HbC and parasitological infections, and their clinical histories recorded with a view to boost the number of adult males. For ease of text presentation, in Baringo, Kitui and Garissa districts where sparsity of population necessitated sampling of two adjacent clusters, the name of the lead cluster will be used in the rest of the report.

It should be noted that because of logistic reasons, Nairobi was not sampled. An attempt was made to gain insight into the state of anemia among children from lower middle socio-economic settlements by twining activities of an on-going M.Med research study by Dr. W. Otieno to the national survey. In this study 309 children aged 6 to 60 months were recruited from an out - patient clinic proximal to the Kibera slums. The children were examined and blood collected for hematological analysis and examination for malaria parasitaemia. HbC was determined using a calibrated coulter machine. Stool samples were analyzed for intestinal helminths. From a sub-sample of 67 children, blood samples were collected using the survey protocol and separated for s-ferritin, s-retinol and zinc analyses. Only highlights of the main findings are included in this report. Highlights of findings by Dr. Otieno are shown in Annex 3.2. Similarly, logistical difficulties could not permit us to cover the school age children and the elderly. A situation analysis was therefore restricted to review of pertinent literature. A review of available information about anaemia among school age children (6-18 years) and the elderly (>50 years) is presented in Annex 4.1.

2.3 Data analyses

In conceptualizing this study, three levels of presentation of outcomes were envisaged. These were population specific group results namely, children, mothers and adult males at cluster level; households on the basis of mother-child pair or mother-child-father trio at cluster level and finally sub-regional levels based on cluster with similar agro-ecological potential, altitude and socio-economic characteristics (Table 2.1). Pooling of these data also took into account statistical significance of differences in the principal dependent variables. This construction was assumed to be sufficiently effective to yield the critical information required in derivation of an objective tree for anemia intervention as a first step in strengthening of on-going programmes and initiating activities towards a comprehensive anemia and micronutrients deficiencies prevention and control package.

The response rates recorded in this survey did not permit pooling of the data according to district areas. However, the coverage for anemia assessment was sufficiently high in all but three clusters to merit extrapolation to similar zones without directly considering individual districts areas. The findings of the survey are therefore presented at cluster level excepting for sub-sample analysis where sub-regional or district pooling was adopted for convenience. The conduct of the survey consisted of several steps and variations can be expected. Thus, variations in the coverage especially for coverage of laboratory investigations resulted in fluctuations of the denominator for the various indices that were analyzed. In cases where the response was considered low ($\eta \leq 23$), absolute numbers are reported in ***bolded italics***.

Preliminary scatter plots of HbC approximated normal distribution. For ferritin, retinol and zinc, data was not normally distributed and geometric means were used in descriptive statistics. Altitude adjusted WHO recommended HbC cut-offs (Table 2.3) were used in grading prevalence and severity of anemia (36). Altitude adjustments were based on an increase of 0.25 g/dL per 1000 m rise *asl.* The adjustments ranged from 0.01 g/dL for clusters proximal to the sea to 0.68 g/dL for those living on central highlands (Annex 2.4). From the findings of this survey, the change in HbC with altitude was estimated to be four fold that recommended by WHO. The implications of this difference was build in both results and Table 2.2: Survey coverage based on children assessed for anemia in the field and actual sample used in this report discussions. In addition, in view of increased erythropoiesis after 6 months of age, NHCS has used different cutoffs for 1-2 year-olds (11.0 g/dL), 3-5 year-olds (11.2 g/dL) and 6-11 year-olds (11.8 g/dL) (3). In this study, a mean monthly increase in HbC for 6-months-olds and over was estimated. Subsequently, adjustments were made in estimating overall anemia rates. In order to facilitate interpretation of observed anemia rates from a public health viewpoint, modifications were made to the WHO recommended cut-offs through introduction of weighted scores of severity of anemia (Table 2.3). Scores ranging between 0 and 4 were assigned to average HbC in which the severer forms were given higher scores than mild forms. The clusters with HbC above the range provided were assigned score 0 while those with a mean of <40 g/L were given a score of 4. Using prevalence cut-offs, scores ranging from 0 to 3 were assigned depending on prevalence. Combining mean concentration and prevalence yielded a sum of scores ranging between 0 and 10. The following categories were assigned to the total scores: none/low significance (<2), mild/moderately significant (2-4), moderate/ moderate to high significance (5-7), severe and highly significant public health problem (8-10).

Table 2.2: Survey coverage based on children assessed for anemia in the field and actual sample used in this report

District	Cluster	Estimated cluster sample	Contribution to district areas	Field sample coverage	Actual sample coverage	District area response rate, %	Cluster response rate %	Implementation efficiency %
Kisumu Nyando	Osiri	200	240	197	194	79.2	97.0	98.5
	Kandianga	200	240	188	186		95.0	98.9
Bungoma	Nakhwana	200	240	233	230	85.0	115.0	98.7
	Misikhu	200	240	179	178		89.0	99.4
Mombasa	Miritini	200	240	175	142	52.9	71.0	81.1
	Utange	200	240	176	112		56.0	63.6
Kwale	Kifyonzo	200	240	188	172	79.6	86.0	91.5
	Kikoneni	200	240	225	210		105.0	93.3
Kisii	Mwamosioma	200	240	213	212	79.0	106.0	99.5
	Birongo	200	240	167	167		83.5	100.0
Busia	Sisenye	200	200	184	180	-	90.0	97.8
Baringo	Sirwet	110	165	144	143	73.6	130.0	99.3
	Ng'aratuko	110	165	108	100		90.9	92.6
Nyandarua	Rurii	110	165	137	133	66.4	120.9	97.1
	Njabini	110	165	90	86		78.2	95.0
Meru	Kibureni	110	165	158	158	75.0	143.6	100.0
	Kibaranyaki	110	165	142	142		129.1	100.0
Kitui	Kyatune	167	200	184	184	81.3	92.0	100.0
	Wii	167	200	144	141		70.5	97.9
Garissa	Korkora	100	150	104	100	53.0	100.0	96.2
	Elan	100	150	60	59		59.0	98.3
Overall		3434	4290	3396	3229	74.8	94.0	95.1

Table 2.3: WHO guidelines on cut-offs for public health importance of anemia and proposed rank scoring criteria

Grade of anemia and its public health importance	HbC, g/dL	Score	Prevalence of anemia and grade, %			
			Mild and moderate	Score	Severe	Score
No problem	>11.0	0	<1	0	<0.1	0
Mild/mild problem	10.1 - 10.9	1	1 - 9	1	0.1 - 1	1
Moderate/moderate problem	7.0 - 10.0	2	9.1- 39.9	2	1 - 9	2
Severe/severe problem	4.0 - 6.9	3	≥4.0	3	≥9	3
Very severe	<4.0	4	-	-	-	-

Nutritional anthropometry indices of children were estimated using length or height-for-age, weight-for-age and weight-for-height indices. The Z scores (L/HAZ, WAZ and WH/LZ) were computed on the basis of NCHS-WHO reference growth curves. Maternal body mass index (BMI) was computed as weight in kgs divided by height in meters squared. Additional nutritional indices centered on breastfeeding, weaning foods from the view of point of nutrient and inhibitor densities. Household food security was estimated from the household dietary questionnaire. For parasitic infections, analysis was restricted to prevalence and categorical intensity outcomes. Intensity cut-offs for helminth and schistosoma infections described in WHO published monographs (37,39) were applied in the categorical analyses. In case of malaria parasitaemia, the categorical cut-offs for very light, light, moderate, severe and very severe intensities were applied. Univariate analysis to test for association between the distribution of dependent variables (anemia defined using HbC, s-ferritin, s-retinol and s-zinc) and selected independent variables listed in this chapter were carried out using chi-square test. Where the cell number were less than 5, Fishers' exact test was applied. Linear and logistic regression analyses were carried out to identify and estimate the significance of predictors risk factors captured during the survey. The significance of association was based on less than 0.05 cut-off point and described as weak if found to be between >0.05 and <0.09 cutoff points. In assessment of occurrence of the main dependent and independent variables at household level, percent agreement method was adopted. In order to increase the likelihood of intra-household variations among the targeted family members, only positive cases were included in the analyses.

Data from a sample of 24 health facilities (mainly public) from 7 districts was analyzed for workload characteristics and capacity of respective category of providers with respect to control of micronutrients deficiencies. Finally, service utilization statistics from public facilities for the period 1995 to 1999 were reviewed with a focus on burden of anemia reported to the HIS at the Ministry of Health headquarters.

2.4 Ethical considerations

The National Ethical Review Committee sitting in KEMRI granted ethical approval for this survey. Within limits of the project capacity all study participants who were considered ill were treated and or referred to the nearest facility for follow-up. Single use disposable needles, syringes, lancets, urine and stool containers were used. All laboratory personnel who were handling biological specimens wore gloves. All used expendable materials were disposed into pit latrines or incinerated while glassware were soaked in high-level disinfectants over night before cleaning. Similar bio-safety precautions were applied during detailed laboratory analyses in Nairobi.

CHAPTER 3: HAEMOGLOBIN, S-FERRITIN, S-RETINOL AND S-ZINC STATUS AND ASSOCIATED FACTORS AMONG CHILDREN

In this chapter, findings of anemia, s-ferritin, s-retinol and s-zinc along with a series of independent variables among children are presented.

3.1 Sample characteristics

The findings are based on a sample of 3229 children. The mean age by cluster ranged between 18.7 ± 13.7 months and 28.7 ± 16.3 months. Overall, 29.5% of the children were infants, 56.2% of the children were 24 month old and below. 24.7% of the children were 36 months old and over. Detailed cluster wise age distribution is shown in Annex 3.1. For the entire population, 51.2% and 48.8% of the children were boys and girls respectively. The only exception to the estimated boys to girls ratio of 1:1 was Korkora where a ratio of 3:2 was observed.

3.2 Distribution of anaemia and physical signs

3.2.1. Haemoglobin concentration and anaemia

The 6-72 month-olds in clusters situated in lake basin, semi arid midlands and coastal sub regions had significantly lower hemoglobin concentration (HbC) than other sub regions (7.8 ± 2.01 to 11.1 ± 1.35 g/dL *vs* 11.6 ± 1.62 to 12.61 ± 1.3 g/dL), (Table 3.1). With exception of four highland clusters, the mean HbC was below the altitude-adjusted cut-off (Appendix 3.1). In addition, except the central highlands, the mean Hb concentration among the < 6 month-olds was markedly low ranging between 6.84 ± 1.68 g/L and 10.89 ± 1.6 g/dL. In 14 clusters, the mean HbC among girls was greater than that of boys and vice versa in 7 clusters but the overall differences were not significant (data not shown).

The correlation between mean HbC and altitude for both < 6 month-olds and 6 - 72 month-olds was 0.81 and 0.90 (P< 0.0001) respectively (Appendix 3.2). Linear regression indicated significantly higher rates of increase of HbC with increase in altitude than the reference (1.17 and 1.3 g/dL per 1000 m rise *asl* among <6 month- and ≥ 6 month-olds respectively *vs* 0.25 g/dL per 1000 m rise *asl*). The mean HbC of all 6-72 month-olds who lived below 1900 m *asl* was below the altitude adjusted cut-off.

The prevalence of all anemias among the 6-72 month-olds ranged between 17.0% in the central highlands and 98.0% in the coastal and semi-arid lowland sub regions (Table 3.2). The prevalence of anaemia in the three central highland clusters was below 50%. In general, there was no obvious difference between occurrence of all anemias among male and female children (73.1% *vs* 72.7%).

Table 3.1: Distribution of mean Hb concentration of children by cluster.

Sub-region	Clusters (District)	6-72 month-olds			< 6 month-olds		
		n	Hb conc. g/dL		n	Hb conc. g/dL	
			Mean	SD		Mean	SD
Lake basin midlands	Osiri (Ksm)	150	8.91	1.77	36	9.03	1.91
	Kandiang'a (Nyo)	153	9.07	1.98	31	9.87	1.40
	Sisenye (Bus)	147	9.07	1.80	25	8.82	2.12
Western highlands sub region	Nakhwana (Bun)	193	8.98	1.85	33	9.30	1.43
	Misikhu (Bun)	151	9.92	2.04	15	10.76	2.25
	Mwamosioma (Kis)	186	10.35	1.85	19	10.89	1.60
	Birongo (Kis)	145	11.60	1.62	22	10.74	1.75
Central and mid west highlands	Sirwet (Bar)	121	11.36	1.45	20	10.40	1.90
	Rurii (Nya)	117	12.61	1.31	16	11.32	1.40
	Njabini (Nya)	72	12.55	1.39	9	12.04	0.79
	Kibaranyaki (Mer)	133	12.19	1.20	9	11.30	0.89
Dry humid and semi-arid mid lands	Ng'arátuko (Bar)	88	9.70	2.40	10	9.33	1.32
	Kibureni (Mer)	133	10.55	1.80	23	9.80	1.93
	Kyatune (Kit)	161	10.60	1.74	20	10.53	1.60
	Wii (Kit)	129	11.06	1.35	10	10.37	1.42
Coastal and semi arid lowlands	Elan (Gar)	52	8.08	2.10	6	8.50	2.68
	Kikoneni (Kwa)	177	9.62	1.94	23	6.84	1.68
	Kifyonzo (Kwa)	131	9.20	1.75	30	8.02	1.72
	Miritini (Msa)	122	9.23	2.00	20	9.40	1.35
	Utange (Msa)	92	9.70	2.00	13	10.10	1.21
	Korkora (Gar)	82	7.80	2.01	6	8.73	1.97
Overall		**2734**	**10.10**	**2.17**	**394**	**9.63**	**1.99**

Among the < 6 months old, practically all the infants were anaemic but the severity varied between clusters. With exception of Njabini and Kibaranyaki clusters in central highlands, moderate and severe grades of anaemia were dominant (Table 3.2). The highest prevalence of moderate to severe anaemia occurred in the coastal and semi-arid lowlands, the lake basin and western highlands sub regions. Overall, 99.5% of the <6 month-olds (n=396) and 69.0% of 6-72 month-olds (n=2738) were anaemic.

With regard to effects of age, the mean HbC among the <6 month-olds decreased from 9.93 $\pm$ 2.13 g/dL to 9.3 $\pm$ 2.27 g/dL between the 2nd and the 6th month of age. The correlation coefficient was high (-0.81) but not significant (P=0.09). Among children aged 6 month and over, the mean HbC increased by 0.36 g/dL per 6 months increase in age. Adjusting for age resulted in an overall increase of the prevalence of anaemia by 1.6% and shifts ranging between 0.4% and 5.5% mainly in clusters where prevalence was below 85% (Appendix 3.3a). When an altitude adjustment factor of 1.0 g/dL per 1000 m *asl* was used the overall ratio of non-anemic to anaemic children increased from 1:3 to 1:8. These shifts were predominantly evident in moderate (+12.2%) and severe (+6.3%) forms of anaemia respectively. With regard to age groups, the prevalence increase ranged between 0.4% and 3.7%. The correlation coefficient between prevalence of both pooled and moderate to severe categories of anaemia and age (based on groups) was -0.98 (P>0.05). From pooled data, the prevalence of all anemias moderate to severe grades decreased by 4.5% and 4.8% respectively per every 6 months increase in age. Significant variations in prevalence by age were evident at cluster and sub regional levels (Appendix 3.3b).

3.3 Pallor of the palms and nail beds

A significantly large proportion of children with palmar and nail bed pallor was seen in the lake basin, western highlands, and the coastal and semi-arid lowlands (Table 3.3). While significant correlation between palmar and nail bed pallor was evident, the prevalence of both indicator corresponded with that of anaemia (Table 3.3). In addition, the distribution of all anemias and that of palmar pallor were significantly associated in the following clusters; Osiri (P=0.021), Kandiang'a (P= 0.001), Sisenye (P=0.012), Nakhwana (P<0.001), Misikhu (P=0.003), Mwamosioma (P=0.005), Birongo (P=0.004), Kyatune (P=0.003), Wii (P=0.001), Kibureni (P=0.005), Kibaranyaki (P=0.023). The correlation between palmar pallor and moderate to severe anaemia was significantly higher than that between palmer pallor and all anemias (P=0.003 to P=0.001). In addition, significant association became evident in Miritini (P=0.005), Ng'aratuko (P=0.05), Sirwet (P=0.021) and Korkora (P=0.035). The associations with nail bed pallor were similar except in Birongo, Kikoneni, Miritini and Sirwet when pooled anaemia and moderate to severe forms respectively were considered.

Table 3.2 Distribution of prevalence of anaemia among children based on altitude-adjusted cut-offs (bold= absolute numbers).

Sub region	Cluster	% Anaemia									
		n	>6-72 month-olds				n	< 6 month-olds			
			All	Mild	Moderate	Severe		All	Mild	Moderate	Severe
Lake basin midlands	Osiri(Ksm)	150	93.0	14.7	58.0	20.7	36	97	16.7	61.1	19.4
	Kandiang'a(Nyo)	153	90.0	14.4	52.9	22.2	31	100	38.7	58.1	3.2
	Sisenye(Bus)	147	91.0	15.0	59.2	16.3	25	100	24	52	24
Western highlands	Nakhwana(Bun)	194	91.0	13.9	59.3	17.5	33	100	15.2	72.7	12.1
	Misikhu(Bun)	151	74.0	15.9	43.7	14.0	**15**	**14**	**7**	**6**	**1**
	Mwamusioma(Kis)	187	67.0	18.2	40.6	8.6	**19**	**19**	**15**	**4**	**0**
	Birongo(Kis)	145	42.0	22.1	17.2	2.8	22	100	59.1	36.4	4.5
Central and mid west highlands	Sirwet(Bar)	121	49.0	19.8	28.1	0.8	21	100	65.0	20.0	15.0
	Rurii(Nya)	117	17.0	9.4	7.7	0	**16**	**16**	**11**	**5**	**0**
	Njabini(Nya)	72	19.0	11.1	8.3	0	**9**	**9**	**8**	**1**	**0**
	Kibaranyaki(Mer)	132	35.0	23.5	11.4	0	**9**	**9**	**7**	**2**	**0**
Dry humid and semi-arid midlands	Ng'aratuko(Bar)	88	68.0	19.3	33.0	16.0	**10**	**10**	**1**	**8**	**1**
	Kibureni(Mer)	133	58.0	13.5	39.1	5.3	23	100	30.4	56.5	13.0
	Kyatune(Kit)	160	63.0	24.4	35.0	3.1	20	20	65.0	30.0	5.0
	Wii(Kit)	129	46.0	27.9	26.4	0	**10**	**10**	**5**	**5**	**0**
Coastal and semi-arid lowlands	Elan(Gar)	52	90.0	7.7	51.9	31.0	**6**	**6**	**1**	**2**	**3**
	Kikoneni(Kwa)	180	77.0	15.6	51.7	9.4	23	100	4.3	30.4	65.2
	Kifyonzo(Kwa)	131	87.0	8.4	69.5	9.2	30	100	13.3	63.3	23.3
	Miritini(Msa)	122	86.0	22.1	50.0	14.0	20	100	35.0	60.0	5.0
	Utange(Msa)	92	83.0	25.0	50.0	7.6	**13**	**13**	**5**	**8**	**0**
	Korkora(Gar)	82	98.0	8.5	56.1	33.0	**6**	**6**	**1**	**5**	**0**
All areas	**Overall**	**2738**	**69.0**	**17.1**	**41.5**	**11.0**	**396**	**99.5**	**37.4**	**48.7**	**13.4**

Among these clusters, the sensitivity of palmar pallor ranged from 55.3% to 97.4%. In 6 of the 15 clusters, sensitivity was 87.8% and over. The specificity ranged between 16.1% and 88.0%. In 9 clusters, specificity ranged between 51.4% and 72.0%.

Specificity of 80.4% and over was observed in only 3 clusters. The positive predictive value (PPV) of pallor for moderate to severe anaemia ranged between 18.4% and 85.1%. PPV values of 70% and over were observed in only 7 clusters. In the remaining clusters the PPV of pallor with respect to moderate to severe anaemia was 57.3% and below.

3.4 Serum ferritin status

The geometric mean of s-ferritin concentration in the semi-arid lowland clusters (Korkora and Elan) and the Midwest highlands (Sirwet) showed acute s-ferritin deficiency (Table 3.4). The mean s-ferritin levels in clusters in the dry humid and semi-arid sub-regions namely, Ng'aratuko, Wii, Kyatune, and highlands clusters namely Birongo, Rurii, Njabini and Kibaranyaki as well as Osiri and Kandianga in the lake basin and Miritini in the Coast showed marginal deficiency. In the remaining clusters, the mean values were in the normal range and wide dispersions were evident. In the lake basin and western highland clusters that had low proportions of deficiency and high median s-ferritin concentration, an increased tendency for excess levels was evident. The proportion of marginal to severe s-ferritin deficiency was relatively uniform across all age groups. The following distribution was observed;- 30.3% among <6 month-olds; 35.2% among 6-12 month-olds, 38.0% among 13-24 month-olds, 29.1% among 25-36 month-olds, 32.0% among 37-48 month-olds and 46.0% among >49 month-olds.

With regard to prevalence, the largest proportions of severe deficiency were observed in Korkora (81.6%), Ng'aratuko (42.8%) and Kyatune (30.6%) clusters (Table 3.4). These clusters were in the dry humid and semi-arid midland or lowland sub-regions. In the central highlands, nearly one-fifth of the children and over were marginally s-ferritin deficient. In two of these clusters (Rurii and Kibaranyaki) the pool of both marginal and acute deficiency ranged between 4.9% and 41.5%.

Significant association between pooled anaemia and s-ferritin based on the 20 µg/L cut-off was observed in Misikhu (P=0.037) and midlands clusters (P=0.046). Using the s-ferritin cut-off of <40 µg/L significant association with pooled anaemia was observed in Kandiang'a (P=0.034), Mwamosioma (P=0.012) and pooled semi-arid clusters (P=0.019). In the lake basin and western highlands, the prevalence of acute ferritin deficiency ranged between 0 and 29.2%. With the exception Birongo, the proportions of marginal s-ferritin deficiency were relatively comparable in both sub-regions. From pooled coastal sub-region data the proportion of severe and marginally deficient was 14.9% in both cases. In general, about 32% of the children were either borderline or deficient. Overall, the proportion of children with concentration >300 µg/L ranged between 0 and 7.0% (Table 3.4). The highest HbC was 14.7 g/dL. Fever based on 37.5°C cut-off was significantly associated with ferritin at <20 µg/L (P=0.017) and <40 µg/L (P=0.002) cut-offs.

Table 3.3: Distribution of prevalence of palmar and nail bed pallor in different clusters.

Sub-region	Clusters/District	n	Pallor		
			Palms	Finger nail beds	Both
Lake basin midlands	Osiri (Ksm)	188	52.1	51.3	51.1
	Kandiang'a (Nyo)	185	53.5	56.2	53.5
	Sisenye (Bus)	175	38.9	36.0	25.1
Western highlands	Nakhwana (Bun)	227	45.4	47.6	45.4
	Misikhu (Bun)	173	27.2	27.2	25.4
	Mwamosioma (Kis)	210	17.6	32.0	15.7
	Birongo (Kis)	167	5.4	12.6	3.6
Central and mid western highlands	Sirwet (Bar)	142	12.7	0.7	0.7
	Rurii (Nya)	135	9.1	6.7	3.7
	Njabini (Nya)	87	4.6	8.0	0
	Kibaranyaki (Mer)	141	4.3	4.3	1.4
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	97	67.0	15.0	12.0
	Kibureni (Mer)	158	17.1	17.7	12.0
	Kyatune (Kit)	170	55.3	6.6	3.8
	Wii (Kit)	141	33.3	6.40	3.5
Coastal and semi arid low lands	Elan (Gar)	59	47.5	18.6	11.9
	Kikoneni (Kwa)	223	76.7	29.6	29.1
	Kifyonzo (Kwa)	178	65.7	60.1	54.5
	Miritini (Msa)	146	62.3	43.8	43.2
	Utange (Msa)	117	70.9	54.7	53 .0
	Korkora (Gar)	102	39.2	31.4	19.6
Overall		**3236**	**39.0**	**28.6**	**24.4**

Table 3.4. Distribution of geometric mean and s-ferritin status among children by cluster (Bold- absolute numbers).

Sub-region	Cluster/ District	n	S-ferritin concentration µg/L, proportion %							
			Mean	95% CI	<12	12-20	>20-40	>40-160	>160-300	>300
Lake basin midlands	Osiri(Ksm)	43	32.9	24.7-44.7	16.3	9.3	30.2	39.5	4.7	0
	Kandiang'a(Nyo)	47	35.3	27.2-46.9	14.9	8.5	34.0	40.4	2.1	0
	Sisenye (Bus)	44	52.7	39.7-69.8	4.5	9.1	27.3	45.5	9.1	4.5
Western highlands	Nakhwana(Bun)	47	78.4	63.6-99.0	0	2.1	21.3	57.4	17.0	2.1
	Misikhu(Bun)	44	59.3	45.8-76.6	6.8	9.1	15.9	61.4	6.8	0
	Mwamosioma (Kis)	43	55.2	37.9-80.3	14.0	4.7	18.6	39.5	16.3	7.0
	Birongo (Kis)	48	21.4	16.0-28.5	29.2	20.8	31.3	14.6	0	4.2
Central and mid west highlands	Sirwet (Bar)	**20**	11.0	6.24-19.0	**10**	**2**	**6**	**2**	**0**	**0**
	Rurii (Nya)	41	32.9	26.5-41.7	4.9	17.1	41.5	34.1	0	2.4
	Njabini (Nya)	27	21.9	17.2-27.8	22.2	22.2	37.0	18.5	**0**	**0**
	Kibaranyaki(Mer)	43	20.9	16.8-25.3	20.9	27.9	34.9	16.3	0	0
Dry humid and semi-arid midlands	Ng'aratuko(Bar)	**7**	**20.9**	**7.7-54.0**	**3**	**0**	**0**	**4**	**0**	**0**
	Kibureni(Mer)	51	42.7	32.1-55.2	7.8	13.7	29.4	39.2	9.8	0
	Kyatune (Kit)	36	22.4	16.8-30.6	30.6	13.9	27.8	25.0	2.8	0
	Wii (Kit)	23	21.4	13.5-32.9	26.1	13.0	30.4	30.4	0	0
Coastal and semi arid low lands	Elan (Gar)	**7**	**4.3**	**2.0-8.1**	**5**	**2**	**0**	**0**	**0**	**0**
	Kikoneni(Kwa)	27	48.0	37.9-60.7	3.7	0	37.0	51.9	7.4	0
	Kifyonzo(Kwa)	**8**	**76.4**	**40.7-146.9**	**0**	**1**	**1**	**5**	**1**	**0**
	Miritini(Msa)	**7**	**29.2**	**15.6-54.0**	**1**	**2**	**1**	**3**	**0**	**0**
	Utange (Msa)	**10**	**40.7**	**18.1-90.2**	**1**	**2**	**2**	**3**	**1**	**1**
	Korkora(Gar)	38	5.5	3.9-7.3	81.6	7.9	7.9	2.6	0	0
Overall		**661**	**31.4**	**28.5-34.5**	**19.5**	**12.3**	**36.9**	**34.5**	**5.3**	**1.5**

3.5 Factors associated with anaemia

3.5.1 Organomegaly, fever and red cell sickling

Spleno- and hepatomegaly: The rates for splenomegaly ranged between 0% and 64.9% and were predominantly observed in the lake basin, western highlands, coast and midlands sub-regions (Table 3.5). Cluster-wise the enlargements ranged between 1 cm and 14 cm. The mean enlargement ranged between 3.67 $\pm$ 0.76 cm in Ng'aratuko and 6.75 $\pm$ 2 cm in Osiri. There was a dominance of enlargements greater than 2 cm (95.8%, n=689) of positive children. The overall mean for this group was 5.88 $\pm$ 1.97 cm. The hepatomegaly rates ranged between 1.0% and 7.7%. In 11 clusters with hepatomegaly, 90.6% (n=64) of the children had enlargements exceeding 2 cm. At cluster level, the enlargements ranged between 1 and 8.0 cm and the mean value was 4.53 $\pm$ 1.48 cm. Hepatomegaly occurred mainly in the same sub-regions as splenomegaly. While significant association between hepatomegaly and moderate to severe anemia was only evident in Kikoneni (P=0.033), splenomegaly exhibited significant association in several clusters, namely Kifyonzo (P=0.002), Kikoneni (P=0.007), Miritini (P=0.004), Kandiang'a (P<0.001), Misikhu (P<0.001), Nakhwana (P<0.001), Sisenye (P<0.001), Birongo (P<0.001), Mwamosioma (P<0.001) and Kibureni (P=0.016). Overall, the ranges of sensitivity and specificity were 14.8% to 72.2% and 66.2 to 91.7% respectively. The PPV ranged between 76.9% and 99.1%. From a pooled sample of clusters where splenomegaly was demonstrated, significant association between its distribution and that of s-ferritin at < 20 µg/L (P=0.03) and < 40 µg/L (P=0.012) cut-offs was observed.

Fever: Elevated axilla temperature (>37.5°C) varied between 1.4% among children in Wii in the midlands and 24.5% among children in lake basin clusters (Table 3.5). Overall, the lake basin and western highlands had distinctly larger proportions of febrile children while the semi-arid midlands had the lowest proportion with exception of Kibureni cluster. Acute febrile episodes (>38.5°C) were observed in 19 clusters. The largest burden (5.7 - 12.2%) was observed in the lake basin and western highlands sub-regions (Table 3.5). In other sub-regions the proportion with acute fever ranged between 0 and 4.5%. Significant association between distribution of fever and moderate to severe anemia was only elicited in Kyatune (p<0.001) and Korkora (P=0.013).

Sickling of red cells: Sickling of red blood cells was mainly observed in the lake basin, western highlands and coastal sub-regions. The prevalence of sickling ranged between 0% and 21.1% (Table 3.5). There was no significant association in the distribution of pooled anemias and red cell sickling. There was no obvious association between the distribution of red cell sickling and anemia.

Table 3.5 Occurrence of organomegaly, fever and sickling among young children.

Sub-region	Cluster/ District	Spleno-megaly		Hepato-megaly		Fever			Sickling of red cells	
		n	%	n	%	n	>37.5° C	>38.5 °C	n	%
Lake basin midlands	Osiri (Ksm)	160	64.9	152	2.0	188	24.5	9.6	191	13.6
	Kandiang'a (Nyo)	154	51.2	147	2.0	185	18.9	7.0	185	18.9
	Sisenye (Bus)	160	55.5	156	7.7	175	22.3	7.4	173	13.3
Western highlands	Nakhwana (Bun)	181	64.7	177	0	227	21.7	5.7	228	21.1
	Misikhu (Bun)	164	26.3	164	0.6	172	22.1	12.2	174	12.1
	Mwamosioma (Kis)	169	26.5	163	1.8	210	10.0	2.9	212	5.6
	Birongo (Kis)	167	3.6	167	0	167	7.2	1.8	165	1.2
Central and mid west highlands	Sirwet (Bar)	111	0	111	0	142	8.5	1.4	139	0
	Rurii (Nya)	111	0	111	0	135	3.7	0.7	133	0
	Njabini (Nya)	75	1.3	75	0	87	9.2	2.3	86	0
	Kibaranyaki Mer)	138	0	138	0	141	10.6	1.4	142	0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	94	3.2	94	6.4	99	8.1	2.0	100	1.0
	Kibureni (Mer)	158	29.7	158	4.4	158	13.9	2.5	158	0
	Kyatune (Kit)	218	0.9	216	0	178	2.8	0.6	183	1.6
	Wii (Kit)	176	0	176	0	138	1.4	0	140	2.1
Coastal and semi-arid lowlands	Elan (Gar)	46	0	46	0	59	13.6	0	59	0
	Kikoneni (Kwa)	217	46.6	217	5.9	223	11.7	4.5	209	7.2
	Kifyonzo (Kwa)	177	28.2	177	2.8	178	14.0	3.9	172	19.8
	Miritini (Msa)	139	16.6	140	5.0	143	6.3	2.1	142	4.2
	Utange (Msa)	112	14.3	111	3.6	116	7.8	4.3	109	11.0
	Korkora (Gar)	90	0	96	0	102	12.7	0	100	0
Overall		**3001**	**25.1**	**2927**	**2.2**	**3223**	**12.6**	**3.9**	**3205**	**7.3**

3.5.2. Prevalence and intensity of parasitic diseases

Malaria: The prevalence of malaria parasitaemia ranged between 0% and 80.4%. Parasitaemia was demonstrated mainly in lake basin and western highlands, the coast and semi-arid sub-regions (Table 3.6). Only Kibureni among the midlands clusters had significant prevalence of malaria. With regard to intensity in general, the proportions with very light (32.4%), light (29.9%) and moderate (30.1%) parasitaemia were comparable (n=3070). 7.5% and 1.8% of the children had heavy and very heavy parasitaemia respectively. Among the coastal clusters, parasitaemia rates were predominantly of very light category. Excepting, Birongo, the clusters in lake basin and western highlands were in light to moderate grade categories. Heavy parasitaemia was mainly observed in the same clusters.

The distribution of parasitaemia in clusters where prevalence was 30% and over revealed peaks among the 24-36 month-olds in 8 of 12 clusters (Table 3.7). In two clusters, the peak occurred among the 13-18 month-olds.

Significant association between distribution of parasitaemia and pooled anemias was demonstrated in Sisenye (P<0.001), Nakhwana (P=0.012), Misikhu (P=0.034), Birongo (P=0.006), Kibureni (P=0.01), Kifyonzo (P=0.025) and Kikoneni (P<0.001). The following clusters exhibited significant association when moderate and severe anemia was considered; Kikoneni (P=0.003), Osiri (P=0.004), Kandiang'a (P=0.006), Misikhu (P=0.002), Nakhwana (P<0.001), Sisenye (P<0.001), Kibureni (P=0.027), Birongo (P=0.002) and Mwamosioma (P=0.043). In these clusters an overall decrease in Hb concentration with increasing intensity was evident (100.2±18.5 g/L in a parasitaemic children to 76.6±39.9 g/L in parasitaemic children with parasite density >1000 per 200 WBC). The association was highly significant when both pooled anemias and moderate to severe grades were considered (P<0.001). The association remained when all anemias data was pooled up to sub-regional level; that is lake basin P=0.01), western highlands (P<0.001), dry humid to semi-arid midlands (P=0.015) and coastal (P=0.003). Parasitaemia was associated with s-ferritin distribution based on <20 µg/L and <40 µg/L cut-offs (P<0.001). Overall, distribution of ferritin based on the <20 µg/L, 40 µg/L and <12 µg/L to >300 µg/L range categories was significantly associated parasite density (P=0.044), P=0.042 and P=0.005) in that order.

Hookworm: Hookworm infection was predominantly evident in the coastal clusters, lake basin and western highlands (Table 3.6). The prevalence ranged between 0% and 18.1% in the coastal clusters and 4.5% and 28.0% in the lake basin and western highlands (Table 3.6). The rates in lake basin and western highlands were significantly greater than those in the coastal cluster. Hookworm infection was not detected in the semi-arid and central and midwest highlands clusters. The infections were predominantly light in intensity with 98.9% (n=187) of the infected clusters having <1000 epgf. Significant association between distribution of hookworm prevalence and moderate to severe anemia was evident only in Sisenye (P=0.029).

Schistosomiasis: *S. haematobium* infection was mainly demonstrated in the coastal and midlands clusters. The prevalence ranged between 0% and 18.4%. *S. mansoni* was demonstrated in the lake basin sub region (Table 3.6). The infection intensity was largely light to moderate in the case of *S. mansoni* (<400 epgf). *S. haematobium* infection intensity was mainly light to moderate (<50 eggs/10 mL of urine). The affected children in Mombasa clusters were all in this category. 2.1 % and 0.6% of children in Kwale clusters had intensities of >50 eggs/10mL of urine. There was no demonstratable association between occurrence of schistosoma infection and pooled anemia.

Ascaris trichuris infestation and filariasis: Ascaris infestation ranging between 1.1% and 16.5% was observed in 14 clusters (n=1867). In 7 clusters, namely Ng'aratuko, Wii, Kibureni, Kibaranyaki, Korkora and Elan, ascaris was not evident. Majority (61.5%) of those infected (n=135) had light infestation, 8.9% had very heavy infestation and the remainder had moderate to heavy infestation. Light *T. trichura* infestation was demonstrated in 4.6% of the children (n=1893). *W. bancrofti* antigens were demonstrated in only one child (n=14) sampled from villages in Kikoneni.

E. histolytica: Among the 16 clusters that had adequate sample size (n=27 to n=81), the prevalence of E. histolytica ranged between 0% (n=34) in Korkora and 29.3% in Mwamosioma. In 14 clusters the prevalence ranged between 1.1% (n=87) in Kibureni and 11.9% (n=59) in Rurii.

Table 3.6 Prevalence of malaria parasitaemia, hookworm and schistosomal infection in children.

Sub-region	Cluster	Malaria		Hookworm		*Schistosoma*	
		n	%	n	%	n	%
Lake basin midlands	Osiri[1] (Ksm)	189	80.4	97	7.2	97	0
	Kandiang'a[1] (Nyo)	184	65.8	82	12.3	79	5.1
	Sisenye[1] (Bus)	171	68.4	133	13.5	130	0.8
Western highlands	Nakhwana[1] (Bun)	226	78.8	143	28.0	170	2.0
	Misikhu (Bun)	173	57.8	94	16.0	93	0
	Mwamosioma[1] (Kis)	203	43.3	144	18.1	138	0
	Birongo[1] (Kis)	162	19.8	111	4.5	111	0
Central and mid west highlands	Sirwet (Bar)	139	6.5	94	0	95	0
	Rurii[1] (Nya)	117	9.4	79	2.5	78	0
	Njabini[1] (Nya)	77	0	48	0	50	0
	Kibaranyaki[1] (Mer)	138	9.4	122	0	121	0
Dry humid and semi-arid midlands	Ng'aratuko[1] (Bar)	100	3.0	78	0	75	0
	Kibureni[1] (Mer)	156	37.2	136	2.9	134	0
	Kyatune[2] (Kit)	153	2.0	104	3.8	143	0.7
	Wii[2] (Kit)	140	0	89	2.2	127	1.6
Coastal and semi-arid lowlands	Elan[1] (Gar)	59	5.1	21	0	20	0
	Kikoneni[2] (Kwa)	179	42.5	139	18.0	175	8.6
	Kifyonzo[2] (Kwa)	166	51.8	138	18.1	141	18.4
	Miritini[2] (Msa)	133	26.3	115	6.1	86	2.3
	Utange[2] (Msa)	106	34.0	86	8.1	83	8.9
	Korkora[2] (Gar)	99	12.1	56	0	56	0
Overall		**3068**	**36.9**	**2112**	**9.3**	**2081**	**4.1**

Sample size for schistosomiasis infection was based on *S. mansoni* (1) or *S. haematobium* (2)

Table 3.7: Distribution of malaria parasitaemia prevalence by age in endemic areas (>30%).

Sub-region	Cluster/District	Age groups⁻ in months and malaria prevalence %							
		n	<6	6-12	13-18	19-24	24-30	31-36	>36
Lake basin midlands	Osiri (Ksm)	186	56.0	88.4	86.4	90.0	89.2	78.6	73.0
	Kandiang'a (Nyo)	183	40.0	55.3	57.1	80.6	92.9	100	54.0
	Sisenye (Bus)	170	50.0	69.0	78.9	59.3	84.0	80.0	60.0
Combined	**Overall lake area**	**539**	**52.2**	**71.4**	**74.6**	**71.6**	**91.3**	**75.7**	**72.5**
Western highlands	Nakhwana (Bun)	226	72.0	73.1	64.9	89.7	86.4	94.4	75.0
	Misikhu (Bun)	165	47.0	50	58.8	64.0	55.6	64.7	50.0
	Mwamosioma (Kis)	199	22.0	40.5	44.4	39.1	53.8	53.8	40.0
	Birongo (Kis)	162	41.0	11.1	13.0	25.0	59.6	33.3	13.3
Combined	**Western areas**	**752**	**47.7**	**47.3**	**47.6**	**52.7**	**61.1**	**57.8**	**53.5**
Dry humid and semiarid midlands	Kibureni (Mer)	154	25.0	36.8	53.8	38.9	33.3	25.0	36.4
Coastal and semi-arid lowlands	Kikoneni (Kwa)	173	37.0	46.4	42.3	36.7	47.4	40.0	43.0
	Kifyonzo (Kwa)	155	32.0	62.9	64.7	57.9	31.3	50.0	40.0
	Miritini (Msa)	133	12.0	16.1	25.0	33.3	26.7	36.4	33.3
	Utange (Msa)	102	30.0	42.1	30.8	38.9	35.7	25.0	20.0
Overall Coastal and semi arid		**563**	**32.9**	**40.7**	**40.8**	**39.2**	**40.0**	**41.7**	**39.3**

- Reflects applicable sample. Detailed age distribution is shown in Annex 3.1. Sample size fluctuations are due to missing details during data processing

3.5.3. Illnesses, signs and symptoms

From clinical history, the proportions of mothers reporting febrile episodes of the index children at the time of the survey ranged between 6.4% and 81.8% (Table 3.8). The largest proportion of febrile episodes was reported in the lake basin and western highlands, and the coastal and semi-arid lowland sub-regions. The lowest proportion (6.4%) was reported in the central highlands cluster of Kibaranyaki. The distribution of episodes of current or recent fever was significantly associated with all anemias in 4 clusters namely Kandiang'a (p=0.017), Nakhwana (P=0.04), Birongo (P=0.03) and Kikoneni (P=0.017).

In general, both level of significance and number of clusters in which significant association was observed increased when moderate to severe forms of anemia were considered. The following clusters exhibited significant association; Utange (P=0.025), Miritini (P=0.037), Osiri (P=0.036), Kandiang'a (P=0.011), Misikhu (P=0.003), Wii (P=0.046), Nakhwana (P=0.006), Ng'aratuko (P=0.051), Kibureni (P=0.026) and Birongo (P=0.002). History of fever currently or during the past month was associated with ferritin at <20 µg/L (P=0.043 and P=0.021) and <40 µg/L (P<0.001) cut-offs.

Mother's diagnosis for current malaria infection was observed in all sub-regions (Table 3.8). The largest proportions of suspected malaria episodes were reported in lake basin and western highlands sub-regions. Between 2.4% and 25.4% of mothers in the central and mid west highlands also reported malaria infection in their children. Significant association between history of mothers diagnosed as having malaria and all anemias was only observed in Mwamosicma (p=0.028). The significance level of association with moderate to severe grades of anemia increased to P=0.001. The association was also significant in Wii (p=0.012). History of perceived malaria infection was significantly associated with ferritin when cut-offs of <20 µg/L (P=0.013) and <40 µg/L (P=0.001) were applied.

Coughs and other infections of the respiratory tract affected large proportions of children in all sub-regions. The prevalence of coughs among children in the lake basin and western regions ranged between 38.4% and 75.3%, while in all other clusters it ranged between 20.1% and 60.2%. The distribution of reported current or recent episodes of coughing was significantly associated with all anemias in Osiri (P=0.03), Birongo (P=0.027), Rurii (P=0.043), Kibureni (P=0.024) and Birongo (P=0.022). With moderate to severe forms of anemia, the clusters that exhibited significant association included Sisenye (P=0.01), Njabini (P=0.007), Kandiang'a (P=0.004) and Birongo (P=0.012).

Diarrhea was reported in 25% and over of children in the lake basin sub-region and some clusters in western highlands, the coastal and semi-arid lowlands and midlands sub-regions. Significant association between diarrhea and pooled anemias was observed in Nakhwana (P=0.003), Birongo (P=0.033), Ng'aratuko (P=0.001), Kyatune (P=0.034) and Wii (P=0.013). Poor appetite was reported overall in 45.2% of all children and was relatively uniformly distributed in all the sub-regions.

Moderate to severe forms of anaemia were significantly associated in current or recent episodes of diarrhoea in Osiri (P=0.027), Nakhwana (P=0.011), Sisenye (P=0.032), Ng'aratuko (P=0.007), Kyatune (P=0.017). Significant association in the distribution of appetite and pooled anemias was evident in only Sisenye (P=0.05) and Mwamosioma (P=0.025).

Table 3.8: Distribution of mother's perceptions of illnesses among children in different clusters.

Sub-region	Clusters/ District	n	Fever		Mala-ria	Resp. Tract disease cough	Diarrhoea		Poor appe tite
			Cur-rent	Past 1 month			Cur rent	Past 1 month	
Lake basin	Osiri (Ksm)	188	70.7	80.9	51.1	53.7	35.6	44.1	53.4
	Kandiang'a (Nya)	185	64.9	38.4	65.9	38.4	27.0	20.5	60.0
	Sisenye (Bus)	176	33.0	97.2	96.6	74.4	31.8	50.0	41.5
Western highlands	Nakhwana (Bun)	225	81.8	14.7	16.4	65.3	36.9	6.7	40.4
	Misikhu (Bun)	174	74.1	6.9	1.7	75.3	32.2	4.6	53.4
	Mwamosioma (Kis)	209	37.3	67.9	84.7	56.0	13.9	17.2	41.6
	Birongo (Kis)	167	34.1	19.8	58.7	58.7	12.6	6.0	39.5
Central and mid west highlands	Sirwet (Bar)	137	8.0	38.7	8.8	20.4	8.8	17.3	48.9
	Rurii (Nya)	134	19.4	27.6	25.4	47.0	18.7	20.9	64.9
	Njabini (Nya)	85	20.0	7.1	2.4	32.9	15.3	3.5	30.6
	Kibaranyaki (Mer)	141	6.4	5.0	18.4	52.5	1.4	2.1	58.2
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	98	24.5	11.2	17.3	60.2	31.6	17.3	15.3
	Kibureni (Mer)	158	14.6	21.5	51.9	58.9	5.7	5.7	52.5
	Kyatune (Kit)	174	8.0	43.1	27.6	20.1	9.8	22.4	71.3
	Wii (Kit)	141	12.1	43.3	37.6	27.0	5.7	14.2	48.2
Coastal and semi arid lowlands	Elan (Gar)	59	54.2	67.9	52.5	49.2	22.0	37.3	42.4
	Kikoneni (Kwa)	224	33.0	11.2	11.6	33.5	5.4	1.3	26.8
	Kifyonzo (Kwa)	178	36.5	28.7	23.6	31.5	10.1	7.3	32.6
	Miritini (Msa)	146	34.2	4.8	34.9	45.2	19.2	3.4	33.6
	Utange (Msa)	116	37.1	5.2	37.1	37.1	21.6	6.9	37.9
	Korkora (Gar)	102	56.9	38.2	34.3	44.1	17.6	33.3	43.1
Overall		3217	38.0	33.1	37.5	47.5	18.4	15.8	45.2

3.6 Serum retinol status

The geometric mean concentration ranged between 6.2 µg/dL and 20.9 µg/dL in all the clusters and thus indicated significant marginal to acute deficiency status (Table 3.9). Acute deficiency (<10 µg/dL) was prevalent in the lake basin and western highlands (13.0% to 52.4%). In addition, marginal deficiency (10-20 µg/dL) was highly prevalent (36.6% to 71.0%) in both sub regions. Assuming that Kikoneni typified coastal clusters, nearly 90% of the children sampled were either acutely or marginally deficient in the sub-region. In addition, with exception of Kibureni, the proportions of children in the dry humid and semi-arid midlands and central and midwest highlands that had acute deficiency were relatively few (0% to 5.5%). Majority of the children in these sub-regions were marginally deficient (57.8 to 82.2%). The central highlands clusters exhibited a situation comparable to that of the midlands.

From a sub-sample of children, (n=926), the following distribution of severe s-retinol deficiency (<10 µg/dL) was observed: 34.3% among <6 month-olds, 22.3% among 6-12 month-olds, 25.9% among 13-24 month-olds, 19.5% among 25-34 month-olds, 27.7% among 37-48 month-olds, 24.5% among 49-60 month-olds. The distribution of marginal deficiency (10-20 µg/dL) was relatively uniform and ranged between 54.3% and 63.7%.

The association between fever using 37.5°C cut-off and current history of fever were weakly associated with pooled s-retinol (P=0.066) and (P=0.068) respectively. Malaria parasitaemia was significantly associated with s-retinol deficiency (P<0.001). In addition, the distribution of pooled anemias and s-retinol deficiency based on <20 µg/dL cut-off were significantly associated (P=0.045). There was no significant association between s-retinol and s-ferritin.

3.7 Serum zinc status

From a sub sample of 541 children, the geometric mean of s-zinc concentration ranged between 55.2 (95% CI: 51.5-59.3) µg/dL and 86.1 (95% CI: 78.4-96.7) µg/dL (Table 3.10). In the semi-arid clusters of Garissa and the central highlands in Nyandarua, the mean s-zinc concentration was markedly higher than in all other clusters. The overall sample mean was 65.1(95% CI: 63.4-66.6) µg/dL (median 68.06 µg/dL) and the proportion of low s-zinc (<65 µg/dL) was 50.8%.

The risk of zinc deficiency was significantly associated with fever (P=0.006), malaria parasitaemia and splenomegaly (P<0.0001), diarrhoea (P=0.001) and weakly in case of hookworm (P=0.05).

Table 3.9: Distribution of geometric mean and prevalence of s-retinol deficiencies among children (Bold - absolute number).

Sub-region	Cluster/District	n	S-retinol concentration, µg/dL, proportion %				
			Mean	95% CI	≤10	10 - 20	>20
Lake basin midlands	Osiri (Ksm)	60	11	9.23-13.5	40	51.7	8.3
	Kandiang'a (Nyo)	65	11.3	10.0-13.1	27.7	63.1	9.2
	Sisenye (Bus)	78	12.5	11.0-14.1	30.8	59	10.3
Western highlands	Nakhwana (Bun)	82	10.2	9.0-11.3	52.4	36.6	11
	Misikhu (Bun)	75	9.97	8.7-11.3	44	50.7	5.3
	Mwamosioma (Kis)	79	13.8	12.5-14.8	20.3	67.1	12.7
	Birongo (Kis)	69	14.1	13.1-15.2	13	71	15.9
Central and mid west highlands	Sirwet (Bar)	*26*	*16.4*	*14.5-19.0*	*3.8*	*73.1*	*23.1*
	Rurii (Nya)	73	17.6	16.4-19.0	5.5	61.6	32.9
	Njabini (Nya)	*45*	*15.2*	*13.1-17.6*	*4.4*	*82.2*	*13.3*
	Kibaranyaki (Mer)	64	17.6	16.0-20.0	4.7	57.8	37.5
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	**8**	**16.8**	**13.5-20.9**	**0**	**6**	**2**
	Kibureni (Mer)	63	13.8	12.5-15.2	19	69.8	11.1
	Kyatune (Kit)	37	18.1	16.8-19.9	0	78.4	21.6
	Wii (Kit)	25	20.9	19.0-23.0	0	60	40
Coastal and semi arid low lands	Elan (Gar)	***8***	***15.2***	***12.5-19.0***	***0***	***6***	***2***
	Kikoneni (Kwa)	35	8.8	7.1-10.8	57.1	40	2.9
	Kifyonzo (Kwa)	***8***	***14.1***	***10.5-18.5***	***1***	***6***	***1***
	Miritini (Msa)	***6***	***6.2***	***3.9-9.7***	***4***	***2***	***0***
	Utange (Msa)	***9***	***7.5***	***5.2-10.5***	***5***	***4***	***0***
	Korkora (Gar)	30	11.6	9.7-13.5	33.3	56.7	10
Overall		945	13.1	12.8-13.8	24.2	60.2	15.6

Table 3.10: Distribution of geometric mean serum zinc concentration and deficiency risk category among children.

Sub region	Cluster	n	s-zinc, µg/dL		Category of risk of zinc deficiency	
			Mean	95% CI	High: <65 µg/dL	Low: 65-150 µg/ dL
Lake basin midlands	Osiri (Ksm)	*20*	*65.1*	*60.7-71.4*	*11*	*9*
	Kandiang'a(Nyo)	50	55.2	51.5-59.3	78	22
	Sisenye (Bus)	57	60.6	56.5-65.1	54.4	45.6
Western highlands	Nakhwana (Bun)	26	59.3	55.2-65.1	73.1	26.9
	Misikhu (Bun)	33	63.6	57.9-71.4	57.6	42.4
	Mwamosioma (Kis)	52	66.6	60.7-71.4	46.2	53.8
	Birongo (Kis)	42	63..6	60.7-66.6	50	50
Central and mid west highlands	Sirwet (Bar)	***17***	***66.6***	***62.1-73.1***	***9***	***8***
	Rurii (Nya)	40	86.1	78.4-92.3	15	85
	Njabini (Nya)	24	86.1	78.4-96.7	4.2	95.8
	Kibaranyaki (Mer)	60	65.1	60.7-68.2	50	50
Dry humid and semi-arid midlands	Nga'ratuko (Bar)	***5***	***50.3***	***46.9-54.0***	***5***	***0***
	Kibureni (Mer)	40	60.7	56.6-65.1	62.5	37.5
	Kyatune (Kit)	24	71.4	63.6-80.3	41.7	58.3
	Wii (Kit)	***15***	***66.6***	***60.7-73.1***	***7***	***8***
Coastal and semi arid lowlands	Elan (Gar)	***5***	***84.1***	***69.8-101.3***	***1***	***4***
	Kikoneni (Kwa)	***16***	***62.1***	***59.3-66.6***	***11***	***5***
	Kifyonzo (Kwa)	***1***	***59.3***	-	***1***	***0***
	Miritini (Msa)	***2***	***60.7***	***43.7-82.2***	***1***	***1***
	Utange (Msa)	***5***	***65.1***	***55.2-76.6***	***2***	***3***
	Korkora (Gar)	***7***	***80.3***	***60.6-108.7***	***2***	***5***
Overall		*541*	*65.1*	*63.4-66.6*	*50.8*	*49.2*

3.8. Nutritional status (Anthropometric)

3.8.1 Stunting

The mean Z-scores for height-for-age index were relatively evenly distributed and ranged between -0.49 ± 1.25 and -1.75 ± 1.51 (Table 3.11). The lowest mean scores were observed in the central, midlands, coastal and semi-arid lowland sub-regions (Kitui and Kwale districts). The prevalence of stunting ranged between 10.1% and 39.7%. The clusters with prevalence exceeding 30% were located in the dry humid and semi-arid midlands, lake basin, western highlands and coastal sub-regions. Out of the 5 clusters with prevalence below 20%, 3 were situated in the central highlands (Table 3.11). Inter cluster variations were most distinct in the lake basin (19.1% to 39.1%) and the central and mid west highlands (10.1% to 28.8%).

Age- wise distribution pattern of stunting showed precipitous decrease in the mean Z-score in the 6-18 month-olds (Appendix 3.4). The corresponding distribution of prevalence indicated a doubling of the proportion stunted with increasing age from <6 month-olds to 18-24 month-olds. Changes in both mean score and prevalence were relatively small in the older children (Appendix 3.5).

There was no significant association between stunting and pooled anemia. The distribution of stunting was significantly associated with that of moderate to severe anemia in Miritini (P=0.038) and Misikhu P=0.012).

3.8.2 Underweight

The mean Z-scores ranged between -0.26 ± 1.16 and -1.72 ± 1.23 and were consistently higher in the dry humid and semi-arid midlands and the coastal and semi-arid lowland sub-regions (Table 3.11). The highest and lowest mean Z-scores were observed in Baringo district (Ng'aratuko) and the central highlands in Meru district (Kibaranyaki). The most marked inter cluster variations in mean Z-score were observed in the central and mid west highlands (-0.26 to -1.21). The mean overall scores decreased steeply in the 6-12 month-old to the 18-24 month-old group (Appendix 3.4).

With exception of Kibureni in the midlands, the prevalence of underweight in the dry humid and semi-arid, and coastal lowlands ranged between 24.6% and 44.0% (Table 3.11). The prevalence of under-weight in clusters in the lake basin and western highlands varied from 17.4% to 25.0%. The most marked inter cluster variations in prevalence were observed in the central and mid west highlands. Age-wise increase in the prevalence showed a doubling in the proportion affected with increasing age from <6 month-olds to 18-24 month-olds (Appendix 3.5)

Significant association between distribution of WAZ scores and pooled anemias was observed in Sirwet (P=0.032) and Rurii (P=0.035). Significant association with moderate to severe anaemia was observed in 6 clusters namely Miritini (P=0.016), Korkora (P=0.005), Osiri (P=0.038), Kadiang'a (P=0.042), Misikhu (P=0.003) and Sisenye (P=0.045). When s-ferritin deficiency based on the <40 µg/L cut-off was considered, significant association was observed in Misikhu (P=0.049) and Birongo (P=0.044).

3.8.3 Wasting

The mean weight-for-height Z-score ranged between -0.13 $\pm$ 1.27 and -1.22 $\pm$ 1.08 (Table 3.11). With the exception of the coastal and semi-arid sub-region, 12 out of the 15 clusters had a mean Z-score below -0.5. Three clusters located within the dry humid and semi-arid midlands and semi-arid lowlands had a mean >1.0. Age-wise distribution for the pooled data showed a rapid decrease from +0.30 Z-score among the <6 month-olds to -0.61 Z-score among the 12-18 month-olds (Appendix 3.4)

The prevalence of wasting ranged between 3.0% and 25%. While all clusters in the coastal and semi-arid lowlands had prevalence of $\geq$13%, three clusters in the semi arid midlands and lowlands, namely Ng'aratuko in Baringo district, and Korkora and Elan in Garissa district had prevalence of ≥21% (Table 3.11). From Appendix 3.5, the prevalence of wasting stabilized by the age of 2 years. In Kikoneni, Sirwet and Elan, significant association between distribution of both pooled anemia and wasting was evident at P=0.032, P=0.029 and P=0.049 in that order. Significant association in the distribution of wasting and moderate to severe anemia was demonstrated only in Misikhu (P=0.025).

3.9. Infant and child care practices

3.9.1. Breastfeeding

For children who had been weaned, the mean breastfeeding period ranged between 8.9 $\pm$ 9.7 months in Ng'aratuko in the semi-arid midlands and 20.6 $\pm$ 8.5 months in Mwamosioma in western highlands (Table 3.12). The proportion of mothers exclusively feeding the index child on breast milk by two months of age was estimated at 71.3% and varied between low rates of 44.6 % in kibureni (central highlands), 46.4% in mwamosioma (Kisii) and high rates of 98.5% in Kibaranyaki (central highlands) and 98.4% in Kandiang'a (Lake basin region) (Table 3.13). The overall proportion of mothers exclusively breastfeeding up to four months was 19.7% but varied between clusters with low rates of 5.5% and 5.8% in mwamosioma (Kisii) and Wii (Kitui) respectively and high rates of 50.0% and 48.8% in Kibaranyaki (central highlands) and Kondiang'a (Lake basin region). The proportion of mothers exclusively breastfeeding the index child less than one year was comparatively similar (15.4%) up to 4 months and 71.3% below two months.

Table 3.11: Distribution of mean HA-, WA- and WH- Z scores and prevalence of malnutrition among children.

Sub-region	Clusters (District)	n	HAZ-score			WAZ-score			WHZ-score		
			Mean	SD	<-2Z, %	Mean	SD	<-2Z, %	Mean	SD	<-2Z, %
Lake basin	Osiri (Ksm)	186	-1.05	2.02	28.5	-0.1	1.5	21	-0.42	1.09	8.1
	Kandiang'a (Nyo)	188	-0.5	1.79	19.1	-0.68	1.39	14.4	-0.49	1.17	8
	Sisenye (Bus)	174	-1.03	1.73	39.1	-1.04	1.32	20.7	-0.23	1.05	4.6
Western highlands	Nakhwana Bun)	228	-1.16	1.44	29.8	-0.98	1.32	19.3	-0.31	1.2	9.6
	Misikhu (Bun)	164	-1.05	1.65	26.8	-1.22	1.2	25	-0.72	1.1	11
	Mwamosioma (Kis)	208	-1.03	1.78	30.3	-0.89	1.25	17.8	-0.3	0.97	4.8
	Birongo (Kis)	167	-0.81	1.51	17.4	-0.87	1.17	17.4	-0.39	1.06	5.3
Central and mid west highlands	Sirwet (Bar)	141	-1.11	1.5	24.8	-1.21	1.25	29.8	-0.67	1.15	11.3
	Rurii (Nya)	132	-1.41	1.29	28.8	-0.78	1.15	12.2	-0.2	1.23	3
	Njabini (Nya)	77	-0.68	1.63	19.5	-0.71	1.34	11.7	-0.39	1.2	13
	Kibaranyaki (Mer)	139	-0.49	1.25	10.1	-0.26	1.16	3.6	-0.13	1.27	3.6
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	100	-1.16	1.64	31	-1.72	1.23	44	-1.22	1.08	25
	Kibureni (Mer)	154	-0.71	1.82	20.8	-0.68	1.34	13.6	-0.31	1.16	7.1
	Kyatune (Kit)	174	-1.75	1.51	39.7	-1.23	1.23	27	-0.18	1.12	5.7
	Wii (Kit)	136	-1.58	1.34	36	-1.25	1.16	27.2	-0.33	1.04	3.7
Coastal and semi arid low lands	Elan (Gar)	57	-0.18	1.77	15.8	-1.04	1.21	24.6	-1.16	0.99	24.6
	Kikoneni (Kwa)	210	-1.57	1.39	33.3	-1.54	1.12	31.9	-0.73	1.2	13.3
	Kifyonzo (Kwa)	165	-1.68	1.31	37.6	-1.52	1.31	37.6	-0.59	1.33	13.3
	Miritini (Msa)	146	-0.95	1.58	23.3	-1.18	1.37	32.2	-0.69	1.39	17.1
	Utange (Msa)	109	-1.17	1.47	27.5	-1.19	1.54	31.2	-0.59	1.53	13.8
	Korkora (Gar)	90	-1.03	1.52	24.4	-1.58	1.15	40	-1.14	1.27	21.1
All areas	Overall	3180	-1.08	2.01	27.9	-1.02	1.53	23.2	-0.36	1.62	10.2

3.9.2. *Introduction of liquids into infant diet*

In general, the mean age at which liquids were first introduced into the infants' diets ranged between 2.2 $\pm$ 2.0 months and 5.1 $\pm$ 1.9 months (Table 3.12). Overall, there were no characteristic sub-regional peculiarities. Introduction of liquids to infants younger than one month was reported in 8 clusters distributed across the country. The proportion ranged between 1.3% and 8.6%. Majority of the mothers (37.3% to 78.3%) introduced liquids to the infants diet between the 2nd and 4th months. In Kandiang'a, Kibaranyaki, Ng'aratuko, Misikhu and Utange 20 to 50% of the mothers reported introduction of liquids after the 4th month.

The liquids introduced were mainly cow's milk and water (Table 3.14). Relatively large proportions of households in Njabini, Kibureni, Kyatune and Wii used sugar and salt solutions. Fruit juices and tea were relatively uncommon except in Kikoneni, Wii, Osiri, Njabini, Nakhwana and Mwamosioma. Overall, significant association was observed between uji and occurrence of pooled anaemia (P=0.014).

3.9.3. *Introduction of semi-solid foods*

The mean age at the time semi solids were introduced into the infants diets ranged between 3.7 $\pm$ 2.5 months in Sisenye and 12.77.6 months in Korkora respectively (Table 3.12). The dominant semi solid energy giving foods were cereal or potato based. With exception of Utange and Miritini, gruel (*uji*) was consumed in over 50% households (Table 3.15). Thick porridge (*ugali*) with milk or soup was also consumed in most clusters except Sirwet and Elan. Surprisingly, relatively small proportions of households reported fish consumption in lake basin and coastal sub-regions. Potatoes were also commonly used but the proportions of households reporting in non-potato growing clusters in Busia, Baringo and Kitui were relatively small (Table 3.15).

The main protein sources were legumes and fish. The former was reported in all but 7 clusters but the proportions were relatively small. Fish was consumed in clusters in the lake basin and coastal sub-regions. The proportions ranged between 0% and 5.7%. Meat and blood were rarely reported. Consumption of fruits, albeit by small proportions (0% to 7.4%) was reported in all clusters except Sirwet, Kifyonzo and Elan.

Table 3.12: Distribution of mean duration of breastfeeding and age at the introduction of liquids and semi-solid foods.

Sub-region	Clusters/ District	Breast feeding period, months			Introduction of liquids, months			Introduction of semi-solid foods, months		
		n	Mean	SD	n	Mean	SD	n	Mean	SD
Lake basin midlands	Osiri (Ksm)	76	9.8	7.7	173	4	2.1	142	6.7	2.5
	Kandiang'a Nya)	100	15.2	9.5	156	4.7	2.8	141	8.3	4
	Sisenye (Bus)	101	10.5	8.1	169	2.3	2.5	165	3.7	2.5
Western highlands	Nakhwana (Bun)	161	11.2	10	228	3.5	2.3	214	5.7	2.5
	Misikhu (Bun)	117	15.1	9	187	2.8	2.1	117	5.4	2.8
	Mwamosioma (Kis)	116	20.6	8.5	167	2.2	2.2	194	3.9	2.2
	Birongo (Kis)	74	17.6	7.4	146	2.5	1.6	147	4	1.9
Central and mid west highlands	Sirwet (Bar)	76	12 .0	9.7	117	2.8	3.4	115	4.2	1.5
	Kibaranyaki (Mer)	112	12.9	8.2	132	5.1	1.9	132	7	6.8
	Rurii (Nya)	88	15.7	8.8	126	3.6	1.9	127	4.2	2.6
	Njabini (Nya)	48	11.5	9.7	61	3.8	2.1	64	4.9	3
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	74	8.9	9.7	134	4.3	8.4	129	5.5	2.1
	Kibureni (Mer)	56	13	9.4	130	2.2	2	120	3.8	3.1
	Kyatune (Kit)	82	18.2	13	157	3.3	3.3	156	5.2	2.3
	Wii (Kit)	60	19.3	8.7	128	2.3	1.9	137	4.3	2.7
Coastal and semi-arid lowlands	Kikoneni (Kwa)	103	18.1	9.4	183	3.4	3.5	166	6.8	7.1
	Miritini (Msa)	106	15.4	10.9	177	3.5	2.3	168	6.9	6.3
	Utange (Msa)	118	17.8	13.4	176	3.8	2.5	168	6.2	3.6
	Kifyonzo (Kwa)	100	19	9.3	207	4.3	3.3	181	7.2	4
	Korkora (Gar)	24	9.6	10	33	3.2	3	29	12.7	7.6
	Elan (Gar)	**4**	19	11	**3**	6.7	0.6	**2**	8	1.4
All areas	Overall	1616	25	10.2	2699	3.3	2.6	2604	5.5	4.1

Table 3.13: Distribution of proportion of mothers exclusively breastfeeding the index child by age and cluster.

Sub-region	Clusters/ District	Proportion, %		
		n	Before 2 months	Up to 4 months
Lake basin midlands	Osiri (Ksm)	160	90	32.5
	Kandiang'a (Nya)	129	98.4	48.8
	Sisenye (Bus)	161	47.9	9.9
Western highlands	Nakhwana (Bun)	206	86.9	17
	Misikhu (Bun)	157	65.5	19.7
	Mwamosioma (Kis)	165	46.7	5.5
	Birongo (Kis)	146	63.7	13
Central and mid west highlands	Sirwet (Bar)	121	61.1	10.7
	Rurii (Nya)	121	57	7.4
	Njabini (Nya)	50	88	22
	Kibaranyaki (Mer)	132	98.5	50
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	106	60.8	17.6
	Kibureni (Mer)	130	44.6	13.2
	Kyatune (Kit)	157	66.8	19.7
	Wii (Kit)	120	56.7	5.9
	Kikoneni (Kwa)	153	93.5	11.1
	Kifyonzo (kwa)	171	90.1	32.2
	Miritini (Msa)	160	82.5	20
	Utange (Msa)	161	91.9	16.8
	Korkora (Gar)	25	80	32
All areas	Overall	2699	73.7	19.7

3.9.4. Choice of cereals

Porridge was predominantly made from maize flour alone or as mixture with other cereals (Table 3.16). Millet on its own was most commonly used in the urban coastal clusters and in Ng'aratuko. Sorghum on its own was used in clusters in Kisumu, Nyandarua, Kitui, Kwale and Mombasa districts. The practice of using mixed cereals was randomly distributed except in clusters in Mombasa, Kwale and Garissa districts. Cassava flour was commonly used in clusters in the coastal and lake basin sub-regions. The proportion of households used that sifted flour ranged between 6.8% in Mwamosioma and 100% in Utange and Miritini. In 13 clusters, over 50% of the households used sifted flour.

Overall, the distribution in the use of mixed flour was significantly associated with pooled anemia (P=0.001). Use of fish enriched porridge was also associated with distribution of all anemias when clusters in the lake basin (P=0.015) as well as overall scenario were considered (P=0.028). There was no obvious association between anemia and use of fermentation and partial germination process in child food processing.

3.9.5. Child care practices

With exception of the clusters in Nyandarua and Kifyonzo, children were left behind by 61.9% of the mothers and over. In Ng'aratuko, 91.2 % of mothers reported that they left their children behind under the care of other persons. The least proportions of mothers who left their young children behind were observed in Njabini (24.2%, n=62) and Kifyonzo (55.5%, n=110). In all other clusters the proportions ranged between 61.9% and 91.2% in Ng'aratuko.

The child minders were predominantly older siblings followed by relatives. Excepting Kibaranyaki (8.0%, n=88), Kibureni (25.6%, n=90), Kikoneni (12.9%, n=132) and Sisenye (38.2%, n=123), older siblings predominantly cared for the younger children. In the following clusters other relatives including fathers predominantly looked after young children while the mothers were away; Sisenye (42.5%), Kibaranyaki (51.1%), Kibureni (57.7%, n=90), Kyatune (47.8%, n=159) and Wii (72.4%, n=120). House helps constituted a significant proportion of child minders in Kabaranyaki (40.9%), Sirwet (39.8%, n=108), Birongo (26.0%, n=123), Ng'aratuko (32.7%, n=98) and Kikoneni (37.9%, n=132).

Table 3.14: Percentage Distribution of liquids used initially in complementary feeding.

Sub-region	Cluster/District	n	Liquids used in complementary feeding							
			Animal milk	Water	Gruel (Uji)	Fruit Juice	Preserved juice	Sugar/salt solutions	Tea	Others
Lake basin midlands	Osiri (Ksm)	172	55.2	32	9.9	0	14	2.3	0.6	0
	Kandianga (Nya)	158	42.4	39.9	12.7	0	2.5	4.4	0.6	0
	Sisenye (Bus)	172	9.3	41.9	6.4	0	6.4	36.6	0	1.8
Western highlands	Nakhwana (Bun)	218	28.9	8.7	46.8	0.5	2.3	12.8	0	2.3
	Misikhu (Bun)	192	37.5	13.5	23.4	1.6	3.6	22.4	1.6	0
	Mwamosioma (Kis)	188	13.3	51.1	23.9	1.6	3.7	10.1	0	0
	Birongo (Kis)	145	14.5	54.5	26.2	1.4	4.8	3.4	0	0
Central and mid west highlands	Sirwet (Bar)	123	29.3	56.9	3.3	2.4	4.9	0.8	0.8	6.5
	Rurii (Nya)	124	25.8	26.6	12.9	4.8	8.9	25.8	0	4
	Njabini (Nya)	67	29.9	10.4	20.9	7.5	13.9	29.9	1.5	0
	Kibaranyaki (Mer)	133	73.7	0	18	0.8	11.3	5.3	1.5	0.8
Dry humid semi-arid midlands	Ng'aratuko (Mer)	134	63.4	11.9	14.9	2.2	3	1.5	0	6
	Kibureni (Mer)	130	7.7	10	24.6	1.5	2.3	53.8	1.5	0.8
	Kyatune (Kit)	174	43.7	15.5	12.1	0	1.1	27.6	0.6	0.6
	Wii (Kit)	141	36.2	19.9	4.3	4.3	12.8	34	0	1.4
Coastal and semi-arid lowlands	Elan (Gar)	*3*	*3*	*0*	*0*	*0*	*0*	*0*	0	0
	Kikoneni (Kwa)	184	25.5	18.5	31	0.5	34.2	7.1	0	0
	Kifyonzo (Kwa)	193	11.9	26.9	60.1	0.5	1.6	0.5	0	0
	Miritini (Msa)	176	29	13.6	44.9	7.4	13.6	2.8	0.6	1.7
	Utange (Msa)	173	16.2	9.8	53.2	13.9	20	3.5	0.6	2.9
	Korkora (Gar)	31	74.2	25.8	0	0	0	0	0	0
All areas	Overall	3031	38	24.4	48.2	0	8.5	20	2.9	1.7

Table 3.15: Semi-solid foods introduced into infants diets in different clusters.

Sub-region	Cluster/District	n	Gruel (uji)	Fruit	Meat	Blood	Potatoes	Legumes /pulses	Ugali, milk/ soup	Fish	Others
Lake basin midlands	Osiri (Ksm)	182	76.4	3.2	1.3	0.6	2.5	0	10.2	5.7	0
	Kandiang'a (Nyo)	188	76.1	1.4	0	1.4	2.2	0.7	14.5	3.6	0
	Sisenye (Bus)	181	91	1.8	1.2	1.2	1.2	0	1.2	1.8	0.6
Western highlands	Nakhwana (Bun)	249	52.1	0.5	0	0.5	15.7	6	19.8	0	5.5
	Misikhu (Bun)	206	85.4	0.5	0	0	4.3	1.1	8.1	0	0.5
	Mwamosioma Kis)	200	84.3	1	0	0	10.1	0.5	4	0	0
	Birongo (Kis)	147	78.8	2.2	0	0	8.8	1.5	8	0	0.7
Central and mid west semi-arid	Sirwet (Bar)	139	97.6	0	0.8	1.6	0	0	0	0	0
	Rurii (Nya)	136	89.8	3.1	0	0.8	4.7	0	0.8	0	0.8
	Njabini (Nya)	84	54.5	4.5	0	0	27.3	7.6	6.1	0	0
	Kibaranyaki Mer)	142	63.6	5.4	1.6	0.8	18.6	0.8	9.3	0	0
Dry humid semi-arid midlands	Ng'aratuko (Bar)	143	78.6	2.3		0.8	0	1.5	16.8	0	0
	Kibureni (Mer)	157	55.9	0.8	0.8	1.6	24.4	10.2	4.7	0	1.6
	Kyatune (Kit)	182	77.8	0.6	0.6	0	3.6	0	15.6	0	1.8
	Wii (Kit)	144	84.6	2.2	0	0.7	5.9	2.2	3.7	0	0.7
Coastal and semi-arid lowlands	Kikokeni (Kwa)	201	76.4	3.4	0.6	0	7.3	2.8	9.6	0	0
	Kifyonzo (Kwa)	222	83.2	0	0	0	1.1	1.1	13.4	0	1.1
	Miritini (Msa)	188	29.8	5.4	0.6	0	31.5	3	25.6	0.6	3.6
	Utange (Msa)	188	29.8	5.4	0.6	0	31.5	3	25.6	0.6	3.6
	Korkora (Gar)	38	81.5	7.4	0	0	3.7	0	3.7	0	3.7
	Elan (Gar)	*4*	*4*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
All areas	***Overall***	***2932***	***74***	***9.3***	***1***	***0.5***	***22.4***	***6.3***	***30.6***	***4.4***	***3***

Table 3.16: Cereals used to make flour for uji and proportion using sifted type

Sub-region	Cluster/ District	n	Maize	Sorg-hum	Millet	Mixed	Others	Sifted* (%)
Lake basin midlands	Osiri (Ksm)	182	29.7	27.6	3.4	38.6	0.7	45.9
	Kandiang'a (Nya)	188	7	0	2.8	86	4.2	23.5
	Sisenye (Bus)	181	19.3	18.7	17.5	26.5	18.1	71.3
Western highlands	Nakhwana (Bun)	249	65.1	6.2	6.2	25.5	0	65.8
	Misikhu (Bun)	206	85.1	1.2	4.8	7.7	2.4	81.9
	Mwamosioma (Kis)	200	75.9	2.5	5	14.6	2	6.8
	Birongo (Kis)	147	79.3	3	13.3	3	2.2	15.8
Central and mid west highlands	Sirwet (Bar)	139	36.4	0.8	42	19.8	0	65
	Rurii (Nya)	136	36.4	5	7.4	48.8	3.3	62.5
	Njabini (Nya)	84	54.2	22	5.1	15.3	1.7	95.6
	Kibaranyaki (Mer)	142	68.8	2.2	8.6	20.4	1.1	79.3
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	143	56.6	0.8	27.9	14.7	0.8	22.9
	Kibureni (Mer)	201	65.2	21.7	12.5	0	2.2	95.9
	Kyatune (Kit)	182	46.7	20.4	2.9	29.9	0.7	24.6
	Wii (Kit)	144	9.2	10.2	5.4	68.5	0.8	72.6
Coastal and semi-arid lowlands	Elan (Gar)	*4*	*4*	*0*	*0*	*0*	*0*	-
	Kikoneni (Kwa)	184	65.2	21.7	12.5	0	10.9	96.9
	Kifyonzo (Kwa)	222	76.9	0	5.8	0.6	16.8	95.4
	Miritini (Msa)	166	27.7	3.6	41	1.2	26.1	100
	Utange (Msa)	165	41.8	21.8	15.2	10.9	10.9	100
	Korkora (Gar)	27	96.3	0	0	0	3.3	11
All areas	Overall	2698	49.2	10.5	14.1	23.5	6.4	-

* Response rate for sifted flour varied between 59% and 98% that of cereal type.

3.9.6. *Child feeding practices*

The proportion of mothers who reported forcing or threatening their children as a means of facilitating intake of enough food ranged between 5.9% (n=136) in Kibaranyaki to 59.7% (n=159) in Kandiang'a. The clusters with less than 10% of mothers reporting these methods included Njabini and Ng'aratuko while those in 10% to

20% category were Wii, Sirwet, and Mwamosioma clusters in the 21% to 30% category. With the exception of Garissa where the 15 responding households did not practice these methods, the proportion of mothers using threats or force in the remaining clusters namely Utange, Kikoneni and Kandiang'a ranged between 43.7% (n=48) and 59.7% (n=159).

3.9.7. Vitamin and mineral supplements

Periodic use of vitamin and mineral supplements, such as fish liver oil and multivitamin syrups was reported in all clusters. The proportions reporting their use ranged between 2.0% in Kifyonzo and 89.7% in Kibaranyaki. The following ranges were observed in different sub-regions: Coastal clusters 18.4% to >60.0%, lake basin 25.7% to 89.6%, western highlands 25.7% to 89.7%, dry humid and semi-arid midlands 27.4% to 61.5%. Overall, one third or less reported use of supplements in 11 clusters namely: Sisenye, Nakhwana, Misikhu, Sirwet, Rurii, Ng'aratuko, Kyatune, Wii and all clusters in the coast.

3.10 Sub-regional distribution of anaemia

Based on mean HbC and distribution, analysis of the public health importance of anemia by cluster and sub-region indicated that the lake basin, the western highlands as seen in Bungoma district clusters, the semi-arid midlands typified by Ng'aratuko in Baringo district and the coastal and semi-arid lowlands, were most acutely affected with respect to prevalence and severity (Table 3.17). In the Western highlands, as seen in Kisii, Meru (Kibureni) and Kitui sub clusters, anemia was moderate and of moderate to high significance. In the Central and midwest highlands of Nyandarua, Meru and Baringo, anemia was largely mild and of moderately low significance. Using this summary and data available from HIS on anemia burden by district, *isoanaems* (lines joining areas with comparable anemia grades) were estimated (Appendix 3.6). The pattern of anemia burdens partly corresponds to ecological and malaria zones in the country. However, upon adjusting the HbC cut-off by 1.0 g/dL per 1000 m *asl*, the central and mid-west cluster in the category of scores 2-4 shifted to the more serious category with scores 5-7. Thus the country could be divided into two-childhood anemia zones with all highland areas except some in western Kenya falling into one zone.

Attempts to establish a reference sample of children were made by desegregating those who were asymptomatic and had s-ferritin concentration between 40 µg/L and 160 µg/L. Adjusting their median HbC by age and altitude to sea level (for the 0.25 g/dL per 1000 m cutoff) yielded sample median HbC of 8.45 g/dL (n=149). Adjustment using the 1.0g/dL cut-off per 1000 m yielded a median HbC of 7.59 g/dL for the sample. Therefore, the HbC shift model argument could not be realistically applied for the whole sample of children because of the low HbC.

Table 3.17: Distribution of severity of anaemia and public health importance among children by sub-region, district and cluster.

Sub-region	Grade of anaemia/public health importance			
	Severe/highly significant [score 8-10]	Moderate/moderate to high significance [score 5-7]	Mild/moderately low significance [score 2-4]	None/low significance [score < 2]
Lake basin midlands	Kisumu - Osiri Nyando -Kandian'ga Busia - Sisenye	-	-	-
Western highlands	Bungoma-Nakhwana - Misikhu	Kisii-Mwamosioma - Birongo	-	-
Central and mid-west highlands	-	-	Nyandarua-Njabini - Rurii Meru -Kibaranyaki Baringo - Sirwet	-
Dry humid and semi-arid midlands	Baringo -Ng'aratuko	Meru - Kibureni Kitui - Kyatune - Wii	-	-
Coastal and semi-arid lowlands	Mombasa - Utange - Miritini Kwale - Kikoneni - Kifyonzo Garissa - Elan - Korkora	-	-	-

3.11 Distribution of anaemia, s-retinol, s-ferritin, s-zinc by presumed health status

Using both perceived illness and laboratory findings, children were desegrated into well and ill categories. The prevalence of pooled anemia (78.5% *vs* 58.6%) as well as moderate to severe forms (61% *vs* 34.6%) was higher than that of well children ($P \leq 0.001$). The proportion of well children with moderate to acute s-ferritin deficiency was larger than that of ill children, but the difference was not statistically significant (Table 3.18). Overall, 74.5% of well children were either at risk of iron deficiency or were depleted to varying degree.

Similarly, desegregation of s-retinol status between well and ill children showed a dominant shift in proportions with acute deficiency (18.5% *vs* 25.7%, $P<0.001$), (Table 3.18). The mean s-zinc concentration among ill children was significantly lower than that of well children ($P=0.002$) (Table 3.19). Similarly, the proportion of those at high risk of zinc deficiency was higher in ill than well children ($P=0.014$).

Table 3.18: Distribution of s-ferritin and s-retinol status among children by presumed state of health

Health status	n	S-ferritin categories (µg/L) and distribution (%)					
		< 12	12-20	>20-40	>40-160	>160-300	> 300
All	661	19.5	12.3	26.9	34.5	5.3	1.5
Well[L]	139	25.9	16.5	27.3	23.7	4.3	2.2
Ill	522	17.8	11.1	26.8	37.4	5.6	1.3
		S-retinol categories (µg/dL) and distribution (%)					
	n	<10	10-20	>20-50	>50-100	>100	
All	945	24.2	60.2	14.7	0.8	0	
Well[L]	195	18.5	61.5	19.5	0.5	0	
Ill	750	25.7	59.9	13.5	0.9	0	

[L] - Well children: aferbrile, aparasitaemic, no palpable spleen, and current or recent episodes of acute infections and vice versa for ill children.

Table 3.19: Distribution of zinc and risk factors among children by presumed state of health

Health status	n	Deficiency risk category, %	
		High: <65 µg/dL	Low: 65-150 µg/dL
All	541	50.8	49.2
Well	93	41.9	58.1
Ill	448	52.7	47.3

3.12 Risk factors associated with anaemia, and s-retinol, s-ferritin and s-zinc deficiency

From Table 3.20, the dominant independent variables for anemia in malaria endemic areas were splenomegaly followed by malaria parasitaemia. Weight related nutritional indicators (underweight and wasting) were also associated with occurrence of anemia.

The pertinent clinical histories of fever and or perceived malaria or episodes of diarrhea or respiratory tract infection were also significant. S-ferritin was also significantly associated with anemia when considered as an independent factor in some clusters. S-retinol levels except for the overall sample were not significantly associated with anemia.

Multivariate logistic models were constructed in stages, beginning with factors that were widely captured by the overall survey and significantly associated, at univariate level (Table 3.21). In the second stage, findings of those included in the detailed biochemical analysis were used to construct the model. The effects of the biochemical factors (s-retinol and s-ferritin) were investigated through inclusion to test for consistency with the first stage model. In both models, parasitaemia was the strongest risk factor. Febrile illness and diarrhea first carried comparable risk in the model. In the second model, diarrhea and recurrent fever were dropped while perceived malaria and wasting emerged as important risk factors.

Table 3.20: Distribution of commonly observed anemia associated factors (* - semi-arid sub-region; s - stunting, uw - underweight, sw - wasting).

Sub-region	Clusters	Malaria parasitaemia	Splenomegaly	Malnutrition	Current fever	Current diarrhea	Current RTI	s-ferritin	s-retinol
Lake basin midlands	Osiri (Ksm)	√	–	√uw	√	√	√		
	Kandiang'a (Nyo)	√	√	√uw	√	√	–	√	
	Sisenye (Bus)	√	√	√uw	√	√	–		
Western highlands	Nakhwana (Bun)	√	√	–	–	√	–		
	Misikhu (Bun)	√	√	√s-uw	√	–	–		
	Mwamosioma (Kis)	√	√	√uw	–	–	–	√	
	Birongo (Kis)	√	√	√uw	√	–	√		
Central and mid west highlands	Sirwet (Bar)			√uw-sw					
	Rurii (Nya)			√uw			√		
	Njabini (Nya)								
	Kibaranyaki (Mer)					√			
Dry humid and semi-arid midlands	Ng'aratuko* (Bar)				√			√	
	Kibureni (Mer)	√	√	√uw			√		
	Kyatune (Kit)					√		√	
	Wii (Kit)				√	√			
Coastal and semi arid lowlands	Elan* (Gar)			√sw					
	Kikoneni (Kwa)	√	√	√sw					
	Kifyonzo (Kwa)	–	√						
	Miritini (Msa)	–	√	√s-uw	√	–			
	Utange (Msa)				√				
	Korkora* (Gar)			√uw-sw				√	

Table 3. 21: Results from multivariate model of risk factors for childhood anaemia - odds ratios (OR) and 95% confidence intervals (95% CI).

Factors	OR	95% CI	P
Excluding s-retinol **(n=2790)** Current fever	1.82	1.48 - 2.24	<0.601
Recurrent fever	1.31	1.07 - 1.59	0.009
Malaria parasitaemia	2.21	1.75 - 2.79	<0.001
Current diarrhea	1.95	1.46 - 2.60	<0.001
Splenomegaly	4.17	3.01 - 5.84	<0.001
Including s-retinol **(n=757)** Current fever	2.17	1.48 - 3.21	<0.001
Perceived malaria	1.63	1.15 - 2.33	0.006
Malaria parasitaemia	3.32	2.15 - 5.14	<0.001
Wasting	2.07	1.04 - 4.12	0.039
Splenomegaly	6.67	3.57 - 12.48	<0.001
S-retinol	1.79	1.15 - 1.78	0.01

The risk factors for low s-retinol are shown in Table 3.22. The significant factors carried comparable levels of risk with anemia (low HbC) leading. With regard to s-ferritin, the significant risk factors were varied with cut-off. The pooled deficiency and high risk for deficiency were significantly attributed to parasitaemia, hookworm, diarrhea and current fever at significant levels. The dominant risk factor for low s-zinc (increased risk for zinc deficiency) was low HbC.

Table 3. 22: Results from multivariate model of risk factors for low s-retinol, s-ferritin and s-zinc concentration.

Factors for S-retinol <20 µg/dL (n=752)	OR	95% CI	P
Current fever	0.99	0.64 - 1.59	0.999
Raised temperature	2.17	0.89 - 5.14	0.085
Malaria parasitaemia	1.84	1.09 - 3.23	0.028
Splenomegaly	1.35	0.71 - 2.52	0.351
Anaemia	1.81	1.17 - 2.77	0.009
Factors for s-ferritin <20 µg/L# (n=304) S-retinol	1.85	0.99 - 3.45	0.052
Stunting	1.92	1.03 - 3.57	0.041
Splenomegaly	2.78	1.33 - 5.88	0.006
Factors for s-zinc <65 µg/dL (n=300) π Diarrhoea	2.24	1.13 - 4.47	0.022

Using the <40 µg/dL cut-off, fever, parasitaemia, hookworm and diarrhoea were retained in the model

π Anaemia was retained OR=1.59, 95%CI: 0.99 - 2.58 (P = 0.054) as well as hookworm OR=2.17, 95% CI:0. 94-4.98 (P=0.069)

3.13 Anaemia, s-ferritin, s-retinol and s-zinc status

Among well children, the proportion of anaemic children who had acute s-ferritin deficiency increased from normal to mild anaemia, then slightly decreased to moderate/severe anaemia (Table 3.23). Overall, 28.6% and 17.1% of acute s-ferritin deficiency were anaemic and non-anaemic respectively. In addition, the proportion of well ânaemic children who had acute s-retinol deficiency was about two-fold that of anaemic children (20.7% *vs* 10.7%). S-zinc was significantly correlated to HbC (r-0.28, P=0.001).

Table 3.23: Distribution of s-retinol, s-ferritin and s-zinc among children by anemia status

	Anemia status					
	Normal		Mild		Moderate /Severe	
S-retinol µg/dL	Well n=80	Ill n=252	Well n=28	Ill n=124	Well n=23	Ill n=370
<10	6.3	10.7	3.6	25	30.4	36.5
10 - 20	63.8	67.9	71.4	63.7	56.5	52.7
>20 - 50	28.8	21	25	11.3	13	9.2
>50	1.3	0.4	0	0	0	1.6
S-ferritin µg/dL	n=54	n=155	n=25	n=91	n=16	n=272
<12	20.4	11	40	18.7	31.3	21.3
12 - 20	24.1	16.8	28	12.1	6.3	7.7
>20 - 40	35.2	35.5	24	31.9	25	20.2
>40 - 160	18.5	36.1	8	31.9	31.3	39.7
>160 - 300	1.9	0.6	0	5.5	6.3	8.5
>300	0	0	0	0	0	2.5
S-zinc µg/dL	n=45	n=155	n=18	n=75	n=5	n=216
<65	33.3	41.9	50	44	-	63
65 - 150	66.7	58.1	50	56	-	37

3.14 Iron, vitamin A and zinc overloads

Possible iron overloads were observed in 2.9 % (n=3239) of the children. The mean HbC for cases with overloads was 14.2 $\pm$ 0.6 g/dL. S-ferritin concentration for the 22 cases ranged between 14.1 µg/dL and 96.3 g/dL. Three children had marginal s-ferritin deficiency. Over half of the children (12/22) were from the central highlands sub region. None of the children had true or apparent high or excess s-retinol or s-zinc concentration.

CHAPTER 4: HAEMOGLOBIN, S-RETINOL, S-FERRITIN, S-ZINC STATUS AND RISK FACTORS AMONG MOTHERS

4.1 Sample characteristics

The overall proportion of pregnant mothers was 12.6% (n=3126) and ranged between 3.5% in Kibaranyaki and 19.0% in Elan clusters. The mean age of the mothers was 28.31 ± 7.67 years (n=2876).

4.2 Distribution of anemia and physical signs

4.2.1. Hemoglobin concentration and anemia

Among non-pregnant mothers, the mean HbC in all clusters was 12.2 ± 2.2 g/dL (Table 4.1). Among pregnant mothers, the mean HbC was 10.8 ± 2.0 g/dL. Among the non-pregnant mothers, the sub-regions had HbC ranging between 9.0 ± 1.9 g/dL to 14.9 ± 1.4 g/dL while among the pregnant mothers, this range was 7.9 ± 1.4 g/dL to 13.8 ± 0.8 g/dL. The mean HbC among non-pregnant mothers was greater than those of pregnant mothers by between 0.3 and 2.2 g/dL in all clusters.

The correlations between mean HbC and altitude were 0.81 for non pregnant and 0.80 for pregnant mothers ($P<0.0001$) respectively (Appendix 4.2). The rate of increase of mean HbC with altitude was 13.1 g/dL per 1000 m and 1.34 g/dL per 1000 m rise *asl* for non-pregnant mothers and pregnant mothers respectively. With exception of 3 clusters the mean HbC among mothers living 600 m *asl* were greater than the adjusted cut-off for non-pregnant mothers (Appendix 4.2). Among pregnant mothers, only those living 1800 m *asl* had mean HbC above the recommended cut-off.

The prevalence of anemias among non-pregnant mothers ranged between 8.8% in the central highlands sub-regions and 97.0% in the coastal and semi-arid lowlands. In addition, the prevalence of moderate to severe anaemia in the central highlands ranged between 0 and 5.1%. In the coastal and semi-arid sub-region the proportion ranged between 2.0% and 63.6%. With exception of Kandiang'a in the lake basin sub-region, the prevalence of moderate and severe anaemia ranged between 0.7% and 19.7% (Table 4.2). The overall prevalence of all grades of anaemia and, moderate to severe anaemia among non-pregnant mothers was 47.9%, 16.9 and 2.1% respectively.

Table 4.1 Distribution of mean Hb concentration among non-pregnant and pregnant mothers based on altitude adjusted cut-offs

Sub-region	Clusters	Non pregnant mothers			Pregnant mothers		
		n	Hb conc., g/dL Mean SD		n	Hb conc., g/dL Mean SD	
Lake basin midlands	Osiri (Ksm)	160	11.4	1.8	20	10.1	1.5
	Kandiang'a (Nyo)	156	11.5	1.8	18	10.2	1.4
	Sisenye (Bus)	137	11.7	1.6	36	10.7	1.8
Western highlands	Nakhwana (Bun)	181	12.2	1.5	43	11.1	1.7
	Misikhu (Bun)	138	12.6	1.8	35	11.4	1.6
	Mwamosioma (Kis)	178	12.4	1.9	22	10.8	2.1
	Birongo (Kis)	151	13.5	1.9	13	12.8	1.4
Central and mid west highlands	Sirwet (Bar)	120	13.5	1.4	18	12.3	1.0
	Rurii (Nya)	122	14.2	1.4	6	12.0	0.9
	Njabini (Nya)	68	14.9	1.4	12	13.8	0.8
	Kibaranyaki (Mer)	137	14.2	1.6	5	12.3	1.0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	84	12.3	1.8	14	11.5	1.5
	Kibureni (Mer)	142	12.5	1.9	16	10.7	1.9
	Kyatune (Kit)	170	12.5	1.8	13	11.4	1.5
	Wii (Kit)	125	13.1	1.8	15	11.7	1.1
Coastal and semi arid lowlands	Elan (Gar)	34	9.5	2.5	8	8.5	2.2
	Kikoneni (Kwa)	180	11.2	1.7	26	9.8	2.1
	Kifyonzo (Kwa)	147	11.3	1.8	25	10.4	1.7
	Miritini (Msa)	125	10.4	2.4	19	9.0	1.7
	Utange (Msa)	96	10.9	2.0	13	10.6	1.5
	Korkora (Gar)	88	9.0	1.9	10	7.9	1.4
All Areas	All Mothers	2735	12.2	2.2	390	10.8	2.0

Despite relatively small numbers of pregnant mothers, in majority of the clusters, preponderance of moderate and severe anaemia was evident (Table 4.2). Overall, the prevalence of all grades of anaemia was 55% while that of mild and pooled moderate and severe anaemia were 20.3% and 34.9% respectively.

Anaemia and pregnancy

Among pregnant mothers, the prevalence of moderate and severe anaemia increased with gestation period as follows 25 % (n=108) during first trimester, 37.8 % (n=135) during second trimester and 39.4 % (n=147) during third trimester. The corresponding pooled anaemia were 42.6 %, 60 % and 59.9 % in that order. Among non-pregnant mothers, the prevalence of pooled anaemia and moderate to severe anaemia was 47.9% and 18.5% respectively. From the linear regression equation, HbC decreased by 0.095 g/dL per month increase in gestation ($p<0.001$).

4.2.2. Palmar and nail bed pallor and deformation

The prevalence of pallor of the palms and finger nail beds ranged between 4.9% and 47.3% in the lake basin and western highlands. The prevalence in the coastal and semi-arid lowlands ranged between 12.5% and 32.9% (Table 4.3). In the other sub-regions the prevalence ranged between 0.7% and 8.2%. With exception of Korkora in Garissa, the prevalence of deformed finger and toe nail beds was low and did not follow any specific pattern. The distribution of palmar pallor and or nail bed were significantly associated with that of moderate to severe anaemia in the following clusters; Kifyonzo (P=0.004), Kikoneni (P=0.016), Utange (P=0.014), Miritini (P=0.001), Osiri (P=0.012), Kandiang'a (P<0.001), Misikhu (P<0.001), Nakhwana (P<0.001), Sisenye (P<0.001), Rurii (P=0.023), Wii (P=0.002), Kyatune (P=0.001), Kibureni (P<0.001), Birongo (P<0.001), Mwamosioma (P<0.001) and Elan (P=0.014). These observations reflected stronger association than when pooled anemias were considered (data not shown). In addition, significant levels were attained in Osiri and Elan only when moderate to severe grades were considered.

The sensitivity of pallor as an indicator of moderate to severe anaemia ranged between 22.2% and 63.6%. In 6 clusters, sensitivity was below 50.0% and in the remaining 6 clusters, the sensitivity ranged between 50.0% and 63.6%. Specifity ranged between 68.8% and 97.8%. In 10 clusters the specifity values were 81.6% and over. The positive predictive value for pallor ranged between 30.8% and 92.0%. PPV of 70% and over were observed in only 4 clusters.

Table 4.2 Distribution of prevalence of anaemia among non-pregnant and pregnant mothers based on altitude adjusted cut-offs (Bold- absolute numbers)

Sub-region	Clusters	Anaemic proportions, %									
		n	Non pregnant mothers				n	Pregnant mothers			
			All	Mild	Mode rate	Sev ere		All	Mild	Mode rate	Sev ere
Lake basin midlands	Osiri (Ksm)	159	69.4	47.5	16.9	5.0	20	16	5	11	0
	Kandiang'a(Nyo)	156	68.6	41.8	25.5	1.3	21	16	5	11	0
	Sisenye (Bus)	137	65.0	45.0	19.7	0.7	36	67.0	27.8	33.3	5.6
Western highlands	Nakhwana(Bun)	181	49.0	38.1	9.9	0.6	43	49.0	25.6	16.3	7.0
	Misikhu (Bun)	138	41.3	29.0	10.1	2.2	35	43.0	8.6	34.3	0
	Mwamosioma (Kis)	178	47.2	29.2	17.8	0.6	22	13	5	9	0
	Birongo (Kis)	151	15.2	6.6	6.6	2.0	13	4	4	0	0
Central and mid west highlands	Sirwet (Bar)	120	23.0	20.0	2.5	0	18	4	3	1	0
	Rurii (Nya)	121	13.1	12.0	1.6	0	6	2	2	0	0
	Njabini (Nya)	68	8.8	8.8	0	0	12	0	0	0	0
	Kibaranyaki (Mer)	137	14.0	8.8	5.1	0	5	1	1	0	0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	84	51.0	37.0	13.1	1.2	14	5.0	3	2	0
	Kibureni (Mer)	142	45.1	32.0	12.0	0.7	16	11	5	6	0
	Kyatune (Kit)	170	38.5	26.0	11.2	1.2	13	4	0	4	0
	Wii (Kit)	125	26.4	20.0	6.4	0	15	4	3	1	0
Coastal and semi arid low lands	Elan (Gar)	34	88.0	35.0	38.2	15	8	7	1	3	3
	Kikoneni (Kwa)	180	68.0	40.6	25.6	1.7	25	73.1	30.8	26.9	15.4
	Kifyonzo (Kwa)	147	65.3	46.3	17.0	2.0	24	72.0	28.0	40.0	4.0
	Miritini (Msa)	125	77.0	31.2	37.6	8.0	19	16	2	12	2
	Utange (Msa)	96	70.0	32.3	33.3	4.2	13	6	3	3	0
	Korkora (Gar)	88	97.0	22.0	63.6	11	10	10	0	8	2
All areas	Overall	2755	47.9	29.3	16.4	2.1	390	55.1	20.3	30.5	4.4

4.3. Serum ferritin status

With exception of Mwamosioma and Kibaranyaki the median s-ferritin concentration was below lower limits of the normal ranges (100 ± 6.0 µg/dL), in all clusters that had adequate numbers (Table 4.4). In the coastal and semi-arid lowlands and lake basin, an increased tendency for marginal and acute deficiency status was observed.

The prevalence of acute deficiency ranged between 4.5% and 94.6% (Table 4.4). The highest prevalence of deficiency was observed in Korkora (94.6%) and other semi-arid and coastal lowlands, and lake basin clusters. In the former, the prevalence ranged between 18.4% and 94.6%. The corresponding range in the lake basin was 26.8% to 36.4%. In the highlands clusters, while the prevalence of acute deficiency ranged between 4.5% and 25.5%, the prevalence of marginal deficiency ranged between 9.1% and 19.5%. Overall, the proportion of mothers with replete depot iron ranged between 16% and 95%. The proportions of mothers with concentration of >300 µg/L ranged between 0% and 2.4%. Significant association between pooled anaemias and s-ferritin using <20µg/L cut-off was observed in coastal clusters (P=0.001), semi-arid clusters (P<0.001) and midland clusters (P=0.047). Overall, all anaemias were significantly associated with marginal and acute s-ferritin deficiency (P<0.001) and in all individuals with <40 µg/L s-ferritin cut-off (P<0.001).

S-ferritin and pregnancy

The prevalence of marginal and acutely low s-ferritin concentration increased with gestation time. While prevalence of low s-ferritin concentration among pregnant mothers was 31.6% (n=38), 70.0% (n=40), 67.1% (n=35) during first, second and third trimesters in that order among non-pregnant mothers the rate was 47.5% (n=776). The mean s-ferritin concentration decrease by 4.39 µg/L per month increase in gestation time was not significant (P=0.09).

Table 4.3: Distribution of prevalence of pallor and nail bed deformities in different clusters among mothers

Sub-region	Clusters	n	Pallor		
			Palms	Finger nail beds	Both
Lake basin midlands	Osiri (Ksm)	185	45.4	46.5	45.1
	Kandiang'a (Nyo)	182	47.3	49.5	47.3
	Sisenye (Bus)	175	19.5	36.0	13.7
Western highlands	Nakhwana (Bun)	226	11.1	12.8	11.1
	Misikhu (Bun)	172	9.3	10.5	8.7
	Mwamosioma (Kis)	204	12.3	19.6	9.8
	Birongo (Kis)	164	6.1	21.3	4.9
Central and mid west highlands	Sirwet (Bar)	142	9.2	0.7	0.7
	Rurii (Nya)	131	15.3	14.5	4.6
	Njabini (Nya)	83	1.2	18.1	1.3
	Kibaranyaki (Mer)	141	5 .0	14.2	1.4
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	98	61.2	8.2	6.1
	Kibureni (Mer)	158	10.8	13.3	8.2
	Kyatune (Kit)	182	40.1	2.2	1.6
	Wii (Kit)	141	19.1	2.8	2.1
Coastal and semi arid lowlands	Elan (Gar)	43	41.9	25.6	12.5
	Kikoneni (Kwa)	223	58.3	23.3	22.9
	Kifyonzo (Kwa)	178	36.5	38.8	31.5
	Miritini (Msa)	146	54.1	33.6	32.9
	Utange (Msa)	117	51.3	35.9	32.5
	Korkora (Gar)	98	33.7	41.8	13.3
All areas	Overall	3188	27.6	22.5	15.9

Table 4.4: Distribution of median and status categories of s-ferritin concentration among mothers by cluster

Sub-region	Cluster	n	S-ferritin concentration, µg/L							
			Mean	95% CI	% by category					
					<12	12-20	21-40	41-160	160-300	>300
Lake basin midlands	Osiri (Ksm)	41	29.9	20.9-42.7	26.8	9.8	26.8	29.3	6.3	2.4
	Kandiang'a(Nyo)	48	15.6	12.5-19.9	36.4	18.8	39.6	6.3	0	0
	Sisenye (Bus)	48	21.4	16.8-27.8	33.3	14.6	29.2	18.8	4.2	0
Western highlands	Nakhwana (Bun)	47	35.3	29.2-43.7	10.6	17.0	29.8	42.6	0	0
	Misikhu (Bun)	44	37.91	28.5-49.1	13.6	6.8	31.8	43.2	4.5	0
	Mwamosioma (Kis)	44	59.3	44.7-78.4	4.5	9.1	20.5	50.0	13.6	2.3
	Birongo (Kis)	47	25.9	19.9-34.5	25.5	8.5	34.0	27.7	4.3	0
Central and mid west highlands	Sirwet (Bar)	*40*	*31.4*	*24.7-40.7*	*12.5*	*15.0*	*27.5*	*45.0*	*0*	*0*
	Rurii (Nya)	41	31.4	23.6-41.7	12.2	19.5	29.3	34.1	4.9	0
	Njabini (Nya)	*28*	*27.8*	*18.91-40.7*	*21.4*	*10.7*	*32.1*	*35.7*	*0*	*0*
	Kibaranyaki (Mer)	42	34.5	25.9-45.8	14.3	19.0	14.3	52.4	0	0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	43	32.1	22.4-46.9	27.9	7.0	11.6	48.8	4.7	0
	Kibureni (Mer)	51	33.7	25.9-42.7	19.6	7.8	31.4	35.3	5.9	0
	Kyatune (Kit)	46	22.9	17.6-27.1	26.1	19.6	32.6	21.7	0	0
	Wii (Kit)	49	19.9	15.6-25.9	26.5	24.5	32.7	16.3	0	0
Coastal and semi arid low lands	Elan (Gar)	***5***	***7.7***	***3.4-5.9***	***4***	***0***	***1***	***0***	***0***	***0***
	Kikoneni (Kwa)	55	20.1	18.1-22.8	30.0	21.0	34.0	13.0	2.0	0
	Kifyonzo (Kwa)	49	23.0	19.0-27.8	18.4	18.4	44.9	18.4	0	0
	Miritini (Msa)	76	14.9	11.3-11.4	52.6	7.9	21.1	17.1	0	1.3
	Utange (Msa)	42	14.5	10.7-19.4	50.0	21.4	16.7	9.5	0	2.4
	Korkora (Gar)	37	4.8	4.0-5.8	94.6	2.7	2.7	0	0	0
All mothers (Overall)		968	23.6	22.4-25.3	28.6	14.3	27.7	26.7	2.4	0.4

4.4 Factors associated with maternal anaemia

4.4.1. Fever, parasitic diseases and red cell sickling

Fever: The prevalence of febrile episodes ranged between 0% and 16.4% in Wii in the semi-arid midlands and Nakhwana in western highlands respectively (Table 4.5). On average, whilst the lake basin and western highlands had higher occurrence of febrile episodes, there was no obvious distribution pattern across the country. Acute febrile state was elicited in 10 clusters. Among mothers affected, it ranged between 0.4% and 3.8%. In 9 clusters the range was 0.4% to 1.7%. Significant association in the distribution of fever and moderate to severe anemia was demonstrated in Kyatune (P=0.0001) and Korkora (P=0.013).

Malaria: The proportion of parasitaemia positive mothers ranged between 0 and 39.3%. In the lake basin, western highlands and the coastal sub-regions the prevalence of parasitaemia ranged between 18 and 39.3%. In the highlands and midland clusters the prevalence varied between 0 and 12.4% (Table 4.5). Among the parasitaemia positive individuals (19.6%, n=2968), the following intensities were observed; very light 5.2%, light 11.65%, moderate 2.3%, heavy 0.4% and very heavy 0.1%. In the coastal clusters, light infection was dominant, and moderate to heavy infection was rare (0.9-1.1%). In the three lake basin clusters, the midlands cluster of Kibureni and the highlands clusters of Kibaranyaki and Mwamosioma, significant levels of moderate and heavy infection. The largest proportions of moderate to heavy infection were seen in Sisenye where 75% (n=44) had intensities in the moderate to very heavy category. The distribution of all anemias was significantly associated with that of parasitaemia in Osiri (P=0.019), Kandiang'a (P=0.017) and Mwamosioma (P=0.047). Marginal significance was observed in Kyatune (P=0.07). The distribution of parasitaemia and moderate to severe anaemia was significantly associated in Osiri (P=0.007), Kandiang'a (P=0.000), Sisenye (P=0.0008), Misikhu (P=0.049) and Mwamosioma (P=0.033). At sub-region level only lake basin exhibited significance between infection intensity and distribution of pooled anemias (P=0.013). Overall, moderate to severe anemia was significantly associated with intensity of malaria parasitaemia (P<0.001). In addition, when all categories of s-ferritin concentration were considered significant association with parasite intensity (P=0.009) was observed. Parasitaemia was also significantly associated with pooled s-ferritin distribution at <40µg/L cut-off (P=0.035).

Hookworm: Infestation with hookworm ranged between 0 and 87.9 %. The prevalence in the lake basin and western highlands ranged from 28.0% to 87.9% while that in the coastal clusters ranged between 30.0% and 57.0 %. The prevalence in clusters situated in the semi-arid lowlands and midlands and the central and mid west highlands ranged from 0 to 16 % (Table 4.5). The Kibureni and Kyatune clusters in the dry humid midlands had higher prevalences than other midland highland clusters. Overall, 35.3% (n=2344) of examined mothers were infected. Overall, 89.6 % of the infected mothers (n=827) had light infection and the remainder had predominantly moderate to heavy infection intensities. Only one case had very heavy hookworm load. The distribution of all anemias and that of hookworm infection were significantly associated in Kifyonzo (P=0.028). Marginal significance was observed in Nakhwana (P=0.065) and Njabini

(P=0.05). Significant association between the distribution of hookworm and moderate to severe anemia and hookworm was observed in Osiri alone (P=0.028).

Schistosomiasis: Significant proportions of mothers were positive for *S. mansoni* (0% to 13.0%) and *S. haematobium* (0% to 25.7%) in the lake basin and coastal sub-regions (Table 4.6). With the exception of Kyatune (4.1%) and Wii (13.2%) in the midlands (Kitui district), the prevalence of schistosoma infection was relatively low. Mixed infection with both *S. haematobium* and *S. mansoni* was only observed in Osiri and Kyatune clusters. The intensity of infection for both *S. mansoni* and *S. haematobium* was predominantly light or moderate (Table 4.6). In Wii, the proportion of mothers with heavy *S. mansoni* was greater than those with moderate intensity.

Other helminths and microfilaria: Ascaris was demonstrated in 9.8% of mothers (n=1868). In five clusters namely, Ng'aratuko and Sirwet, Wii, Kibureni and Elan there was no demonstrable ascaris. In other clusters, the prevalence ranged between 0.8% (n=56) in Njabini to 31.1% (n=104) in Mwamosioma. In Birongo, Kandianga and Sisenye, the prevalence of hookworm ranged between 10.7% and 24.2%. Other clusters had prevalence below 10%. In addition, light *T. trichura* infestation was demonstrated in 6.2% (n=2054) of the mothers. Only 0.1% had moderate infestation. The prevalence of *W. bancrofti* antigen among 48 mothers sampled from 2 villages in Kikoneni (Kwale district) was 25.5%.

E. histolytica

For the 16 clusters whose sample size was adequate (n=28 to n=65), the prevalence of *E. histolytica* ranged between 7.1% in Njabini to 47.1% in Mwamosioma. In 12 clusters the proportion infected ranged between 16.3% and 37.5%. In the remaining 4 clusters the proportion infected ranged between 7.1% and 7.9%.

Red cell sickling:

In the lake basin and western highlands, the prevalence of sickling ranged between 1.2% in Birongo to 23.0% in Kandianga. In the coastal clusters, the prevalence ranged from 6.3% and 8.7%. Except clusters in Kitui district, with prevalences ranging between 0.5 and 1.4% sickling was not demonstrated in other places (Table 4.5).

Table 4.5 Prevalence of malaria parasitaemia, hookworm and schistosomiasis among mothers

Sub-region	Clusters	Malaria		Hookworm		*Schisto-somal*		Sickling		Temperature, °C	
		n	%	n	%	n	%	n	%	n	>37.5
Lake basin midlands	Osiri[1] (Ksm)	178	37.3	109	28.0	109	8.0	180	13.9	185	12.0
	Kandiang'a[1](Nyo)	174	28.0	114	60.0	100	20.0	174	23.0	180	11.7
	Sisenye[1] (Bus)	171	25.7	149	57.9	146	23.0	173	10.4	175	9.1
Western highlands	Nakhwana[1](Bus)	224	39.3	171	87.9	125	2.0	227	21.1	226	16.4
	Misikhu[2] (Bun)	166	26.5	12	74.0	113	1.0	174	11.0	171	9.9
	Mwamusioma[2] (Kis)	194	33.0	162	46.3	141	1.0	204	4.4	204	8.3
	Birongo[1] (Kis)	158	19.0	108	42.6	106	1.0	164	1.2	163	4.3
Central and mid west highlands	Sirwet[1] (Bar)	137	12.4	102	1.0	103	0	139	0	141	2.1
	Rurii[1] (Nya)	112	9.0	78	3.8	78	0	128	0	131	6.1
	Njabini[1] (Nya)	74	0	45	4.4	45	0	80	0	83	6.0
	Kibaranyaki[1] (Mer)	140	12.0	129	0	128	0	142	0	141	7.1
Dry humid and semi-arid midlands	Ng'aratuko[1] (Bar)	95	4.0	84	0	84	0	98	0	98	7.1
	Kibureni[1] (Mer)	156	8 .0	146	15.0	145	1.0	158	0	158	15.8
	Kyatune[1] (Kit)	182	1.1	119	16.0	169	4.0	183	0.5	181	3.3
	Wii[1] (Kit)	140	0	98	6.1	136	24.0	140	1.4	140	0
Coastal and semi arid lowlands	Elan[1] (Gar)	42	7.0	22	0	28	0	42	0	42	9.5
	Kikoneni[2] (Kwa)	174	30.0	172	57.0	194	14.0	211	7.1	220	2.3
	Kifyonzo[2] (Kwa)	107	20.0	144	41.7	151	28.0	172	8.7	176	4.0
	Miritini[2] (Msa)	139	18.0	115	30.0	129	9.0	144	6.3	145	5.5
	Utange[2] (Msa)	106	25.0	99	39.4	105	6.0	109	7.3	117	3.4
	Korkora (Gar)	99	11.0	57	0	33	3.0	98	0	98	9.2
All areas	Overall	2966	19.7	2344	35.3			3139	6.7	3174	7.5

For schistosomal, sample size was based on *S. mansoni* (1) or *S. haematobium* (2)

Table 4.6: Distribution of schistosomiasis infection intensity among mothers by cluster

Sub-region	Cluster/District	*S. mansoni*, epgf				*S. haematobium*, eggs/10 mL		
		n	<100	101-400	>400	n	≤ 50	>50
Lake basin midlands	Osiri (Ksm)	109	5.5	0.9	1.8	41	2.4	0
	Kandiang'a (Nyo)	100	13.0	6.0	2	0	0	0
	Sisenye (Bus)	146	10.3	11.0	2.7	0	0	0
Western highlands	Nakwana (Bun)	125	0	0	0	24	4.2	0
	Mwamosioma (Kis)	141	1.4	0	0	0	0	0
Dry humid and semi arid midlands	Kyatune (Kit)	161	0	0.6	2.5	169	4.1	0
	Wii (Kit)	136	1.5	8.8	13.2	0	0	0
Coastal and semi arid low lands	Kikoneni (Kwa)	172	0	0	0	197	12.7	1
	Kifyonzo (Kwa)	143	0	0	0	149	25.7	2
	Miritini (Msa)	115	0	0	0	128	9.4	0.8
	Utange (Msa)	98	0	0	0	105	5.7	0
	Korkora (Gar)	57	0	0	0	33	3	0

4.4.2. Illness, signs and symptoms among mothers

From medical history, febrile episodes were predominantly reported in the lake basin and western highlands and the coastal and semi-arid lowlands sub-regions. In these regions, the prevalence of current febrile episodes ranged between 12.1% and 49.2% (Table 4.7). In the other sub-regions, the proportion of mothers reporting febrile episodes ranged between 0 and 12.0%. Self diagnosed malaria was reported by between 47.3% and 90.3% of mothers in lake basin, between 1.2% and 74.6% of mothers in clusters in western highlands and between 2.8% and 32.3% in the coastal and semi-arid lowlands (Table 4.7). 27.3% (n=2633) of mothers reported that they had received treatment for perceived malaria infection during the preceding month.

Significant association in the distribution of all anemias and perceived episodes of malaria was evident in Wii (P=0.021) alone. The association between moderate to severe anemia

and perceived episodes of malaria were marginally significant in Kifyonzo (P=0.06), Osiri

(P=0.066) and Wii (P=0.06).

Coughs were reported by between 26.8% and 40.3% of the mothers in the lake basin clusters, between 27.5% and 61.4% of mothers in the western clusters. In the rest of the clusters reported coughs occurred between 11.1% and 39.8%.

The distribution of all anemias and coughing episodes were significantly associated only in Kyatune (P=0.02). Marginally significant associations were observed in Miritini (P=0.06) and Nakhwana (P=0.08). The distribution of current coughs and or those lasting 1 month was significantly associated with that of moderate to severe anemia in Kifyonzo (P=0.029), Kyatune (P=0.038), Utange (P=0.047) and Osiri (P=0.04). Diarrhea was predominantly reported in the lake basin and western highlands clusters. In other sub-regions diarrhea was reported by less than 10% of the mothers. The distribution of current diarrhea and that occurring during the previous month was significantly associated with moderate to severe anemia in Wii (P=0.000), Birongo (P=0.002) and Kandiang'a (P=0.031). Poor appetite was reported in all clusters. The lowest reporting rates of poor appetite were noted in Ng'aratuko and Misikhu clusters while the highest rates occurred in Kyatune (Table4.7).

4.5. Serum retinol status

The geometric mean s-retinol concentration in the lake basin, western highlands, and coastal and semi arid lowlands clusters reflected marginal deficiency states (Table 4.8). The lowest values were observed in Utange and Miritini in the coast sub-region. The prevalence of acute deficiency ranged between 0 and 50.8% (Table 4.8). While the central and mid west highlands and the midlands sub-regions were relatively free of acute s-retinol deficiency (0-3.8%), the coastal clusters followed by lake basin had significantly high levels of acute deficiency. The prevalence of marginal deficiency was more uniformly distributed and affected between 16.4% and 75.0% of mothers.

Severe to marginal s-retinol deficiency was associated with fever (>37°C) temperature (P=0.014). Similarly history of current or recent episodes of fever was associated with s-retinol (P<0.001 and P=0.003 respectively). S-retinol deficiency based on <20 µg/dL was associated with pooled anemia in the coastal clusters (P=0.017), semi-arid clusters (P<0.001), central highlands and Birongo (P=0.003). Overall the distribution of pooled anemia and marginal to severe s-retinol was significant (P<0.001).

Table 4.7: Prevalence of illness reported by mothers in different clusters

Sub-region	Clusters	n	Fever		Mala-ria	Resp. Tract disease cough	Diarrhea		Poor appetite
			Cur-rent	Past 1 month			Cur-rent	Past 1 month	
Lake basin midlands	Osiri (Ksm)	187	49.2	67.2	47.3	29.7	12.8	24.1	58.3
	Kandiang'a (Nyo)	183	39.3	36.6	63.9	26.8	13.1	18.0	67.2
	Sisenye (Bus)	176	14.8	53.3	90.3	40.3	6.3	14.9	60.8
Western highlands	Nakhwana (Bun)	204	43.6	8.6	13.2	53.6	11.4	4.1	14.1
	Misikhu (Bun)	171	29.8	3 .0	1.2	61.4	4.2	0.6	6.6
	Mwamosioma (Kis)	193	13.5	38.2	74.6	30.1	9.8	8.3	25.4
	Birongo (Kis)	167	15.6	3.6	50.9	27.5	4.8	0.6	23.4
Central and mid west highlands	Sirwet (Bar)	135	3.0	11.1	17.6	11.1	0.9	5.9	60.7
	Rurii (Nya)	133	7.5	15.8	18.8	39.8	4.5	14.3	72.2
	Njabini (Nya)	83	12.0	3.6	24.7	33.7	8.4	2.6	28.9
	Kibaranyaki (Mer)	141	0	0	11.3	24.1	0	1.4	66.7
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	96	3.2	1.1	25.3	32.3	0	5.3	6.4
	Kibureni (Mer)	158	2.5	7.6	39.2	38.6	1.3	3.2	66.2
	Kyatune (Kit)	180	7.2	15.6	25.0	13.3	4.4	3.3	79.4
	Wii (Kit)	140	0.7	17.7	28.4	19.9	2.2	4.3	56.0
Coastal and semi arid lowlands	Elan (Gar)	43	44.2	67.4	2.8	39.5	7.0	11.5	62.8
	Kikoneni (Kwa)	224	12.1	5 .0	5.4	21.4	1.3	0.4	12.1
	Kifyonzo (Kwa)	178	12.4	10.7	14.0	16.9	4.5	5.1	32.6
	Miritini (Msa)	146	20.5	2.7	25.5	18.5	3.4	0.8	13.0
	Utange (Msa)	116	20.2	5.2	20.7	14.7	4.4	1.0	30.1
	Korkora (Gar)	99	40.4	61.6	32.3	26.3	6.1	10.1	56.6
All areas	Overall	3169	18.5	19.5	32.6	29.7	5.5	6.6	41.5

Marginal to severe s-retinol deficiency was associated with both marginal deficiency of s-ferritin using <20µg/L cut-off (P=0.000) and sub-optimal s-ferritin levels using 40 µg/L cut-off (P=0.004). Among pregnant mothers, the prevalence of marginal and acutely low s-retinol increased with increasing gestation time as follows 46.4% (n=56) during first trimester 72.4% (n=69) during second trimester and 76.0% (n=79) during third trimester. The overall prevalence of low s-retinol among non-pregnant mothers was 47.5% (n=1342). Mean s-retinol concentration decreased by 0.0067 µg/L per month increase in gestation (P=0.004).

4.6 Serum zinc - Mothers

The mean s-zinc concentration among mothers sampled from the lake basin, western highlands and semi-arid midland clusters in Baringo were below the 65 µg/dL cut-off (Table 4.9). The central highlands, Garissa and Kwale clusters had significantly higher s-zinc concentration. The proportions of those at high risk of zinc deficiency ranged between 7.3 % and 76.5% in clusters in the central highlands and lake basin respectively. The proportions with excess s-zinc Nyandarua and Garissa were 1.6% and 2.6% respectively. The overall sample mean (n=602) was 63.6 $\pm$ 21.6 µg/dL (median 68.05 µg/dL) and proportion at risk of zinc deficiency was 52.2%.

From the pooled sample, the distribution of zinc risk was significantly associated with hookworm distribution (P=0.0006), s-retinol (P<0.001), current fever (P=0.015), respiratory morbidity (P=0.046), BMI (P=0.027) and history of perceived malaria (P=0.022). Malaria parasitaemia was only weakly associated with risk of zinc deficiency (P=0.072, n=563). The median s-zinc concentration among pregnant mothers was 54.8 µg/dL (mean 60.8 ± 18.4 µg/dL). These values were significantly lower than those of non-pregnant mothers (P<0.001). The s-zinc concentration decreased with increasing gestation age at rate of 1.97 µg/dL/month (P=0.008).

Table 4.8: Distribution of mean and categorized s-retinol status among mothers by cluster

Sub-region	Cluster	n	S-retinol concentration, µg/L and proportions, %				
			Mean	95% CI	. 10	10-20	>20
Lake basin midlands	Osiri (Ksm)	61	16.0	14.5-17.6	9.8	57.4	32.8
	Kandiang'a (Nyo)	72	15.9	14.5-18.1	19.4	41.7	38.9
	Sisenye (Bus)	102	18.9	17.2-20.4	6.9	52.0	41.2
Western highlands	Nakhwana (Bun)	86	18.1	15.6-20.4	12.8	45.3	41.9
	Misikhu (Bun)	83	18.1	16.8-19.9	7.2	54.2	38.6
	Mwamosioma (Kis)	88	20.4	18.9-21.9	4.5	40.9	54.5
	Birongo (Kis)	71	21.4	19.9-22.4	0	42.3	57.7
Central and mid west highlands	Sirwet (Bar)	60	21.9	19.9-24.7	3.3	36.7	60.0
	Rurii (Nya)	80	26.5	24.1-28.5	2.5	20.0	77.5
	Njabini (Nya)	56	23.5	21.9-25.9	0	30.4	69.6
	Kibaranyaki (Mer)	81	27.2	25.3-29.2	0	19.8	80.2
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	48	24.1	21.9-27.2	0	33.3	66.7
	Kibureni (Mer)	78	21.4	19.4-23.5	3.8	39.7	56.4
	Kyatune (Kit)	162	25.9	18.6-29.8	0	19.8	80.2
	Wii (Kit)	116	26.5	25.3-27.8	0	16.4	83.6
Coastal and semi arid low lands	Elan (Gar)	37	16.0	14.1-18.1	8.1	64.9	27.0
	Kikoneni (Kwa)	184	12.5	11.6-13.5	31.0	51.6	17.4
	Kifyonzo (Kwa)	51	18.1	16.8-19.9	3.9	51.0	45.1
	Miritini (Msa)	69	8.8	7.9-9.7	50.8	47.5	1.6
	Utange (Msa)	37	9.2	7.9-10.5	45.9	54.1	0
	Korkora (Gar)	60	14.1	12.8-15.2	11.7	75.0	13.3
All mothers (Overall)		1674	18.9	18.5-19.4	10.3	40.4	49.3

Table 4.9: Distribution of mean serum zinc concentration and prevalence of deficiency among mothers

Sub region	Cluster	n	s-zinc, µg/dL		Zinc deficiency risk category %	
			Mean	95% CI	High: <65µg/dL	Low: 65-150 µg/dL
Lake basin midlands	Osiri (Ksm)	25	62.1	57.9-68.1	56.0	44.0
	Kandiang'a (Nyo)	63	51.5	48.0-55.2	82.5	17.5
	Sisenye (Bus)	89	55.2	52.7-57.9	76.5	23.6
Western highlands	Nakhwana (Bun)	25	55.2	50.3-60.6	68.0	32.0
	Misikhu (Bun)	50	62.1	57.9-66.6	56.0	44.0
	Mwamosioma (Kis)	68	59.3	55.2-62.1	66.2	33.8
	Birongo (Kis)	54	63.6	60.7-68.2	51.9	48.1
Central/ mid west highlands	Sirwet (Bar)	45	66.6	62.1-71.4	44.4	55.6
	Rurii (Nya)	64	84.1	76.6-90.2	15.6	84.4
	Njabini (Nya)	41	88.1	82.2-94.5	7.3	92.7
	Kibaranyaki (Mer)	70	63.6	59.3-66.6	55.7	44.3
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	37	57.9	54.0-62.1	59.5	40.5
	Kibureni (Mer)	55	56.5	52.7-59.3	74.5	25.5
	Kyatune (Kit)	107	69.8	66.6-73.1	37.4	62.6
	Wii (Kit)	67	63.6	60.7-66.6	50.7	49.3
Coastal and semi-arid lowlands	Elan (Gar)	25	73.1	65.1-82.2	36.0	64.0
	Kikoneni (Kwa)	62	66.6	63.6-69.8	43.5	56.6
	Kifyonzo (Kwa)	37	74.9	68.2-80.3	32.4	67.6
	Miritini (Msa)	*53*	*52.7*	*49.1-56.5*	*73.6*	*26.4*
	Utange (Msa)	***18***	***57.9***	***50.3-66.6***	***12***	***6***
	Korkora (Gar)	38	76.6	68.2-86.1	28.9	71.1
All mothers (Overall)		1093	63.6	62.1-65.1	52.2	47.8

4.7. Menstrual losses

The occurrence of perceived heavy flow was observed in all clusters except Ng'aratuko. Over 10% of mothers in Osiri, Kandiang'a, Sisenye, Nakhwana, Rurii, Wii, Kikoneni and Kifyonzo reported heavy flow (Table 4.10). The proportion of amenorrheic mothers varied widely (2.2% to 43.6%). In 4 clusters the proportion in the latter category ranged between 23.6% and 43.6%. The distribution of all anemias was significantly associated with that of menstruation in Kibureni (P=0.017) and marginally significant in Ng'aratuko (P=0.05) and Njabini (P=0.07).

4.8. Maternal anthropometry among non-pregnant mothers

The mean BMI ranged between 18.1 $\pm$ 2.4 and 24.5 $\pm$ 3.6 kg/m^2. In four cluster namely Ng'aratuko, Elan, Korkora and Kifyonzo the BMI was either borderline or below the 18.5 kg/m^2 cut-off. The mean BMI in other clusters ranged between 20.4 $\pm$ 2.2 kg/m^2 and 24.5 $\pm$ 3.6 Kg/m^2. Several clusters in the central and western highlands and coastal sub-regions, namely Kibaranyaki, Njabini, Rurii, Birongo and Miritini had relatively higher mean BMIs (22.4 $\pm$ 4.3 kg/m^2 to 24.5 $\pm$ 3.6 kg/m^2). The prevalence of low BMI in clusters with borderline mean values ranged between 36.2% and 59.7% (Table 4.11). These clusters were located in the coastal and semi-arid lowlands and the dry humid and semi-arid midlands. In Nakhwana and Sirwet in the western and mid west highlands respectively, the proportion of mothers with low BMI was two-fold and over that observed in the other highlands clusters. The central highlands clusters had the lowest prevalence (1.5% to 9.7%). Significant association between BMI and all grades of anemia was observed only in Sisenye (P=0.007). Significant association between BMI and s-ferritin distribution based on the <20 µg/L cut-off was observed in Kandiang'a (P=0.003), Birongo (P=0.009) and central highlands clusters (P=0.014).

In general, 6.8% (n=2597) of mothers were <150 cm tall. The proportions affected by cluster ranged between 11.3% and 14.5% in clusters in Kwale and Kitui districts and Utange in Mombasa. In Miritini, Sirwet, Rurii, Kibureni and Mwamosioma, the proportions of short mothers ranged from 4.4% and 6.9%. From all other clusters, the proportion of short mothers was less than 4.4%.

Table 4.10: Perceived characteristics of latest menses

Sub-region	Clusters/District	n	Menstrual characteristics, %			Amenorrheic, %
			Normal	Light	Heavy	
Lake basin midlands	Osiri (Ksm)	76	47.4	14.5	14.5	23.6
	Kandiang'a (Nyo)	99	50.5	19.2	22.2	8.1
	Sisenye (Bus)	117	35.9	5.1	15.4	43.6
Western highlands	Nakhwana (Busia)		91	52.8	34.1	4.48.7
	Misikhu (Bun)	65	80.0	13.9	1.5	4.6
	Mwamosioma (Kis)	90	71.1	15.6	7.8	5.5
	Birongo (Kis)	96	90.6	1.0	4.2	4.2
Central and mid west highlands	Sirwet (Bar)	83	54.2	18.1	3.6	24.1
	Rurii (Nya)	94	66.0	14.9	12.8	6.3
	Njabini (Nya)	45	88.9	6.7	2.2	2.2
	Kibaranyaki (Mer)	113	78.8	2.7	0.9	17.6
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	43	60.5	2.3	0	37.2
	Kibureni (Mer)	96	75.0	2.1	4.2	18.7
	Kyatune (Kit)	112	75.9	7.1	8.0	9.0
	Wii (Kit)	81	70.4	6.2	12.3	11.1
Coastal and semi arid lowlands	Elan (Gar)	***10***	***2***	***2***	***1***	***5***
	Kikoneni (Kwa)	135	51.9	16.3	10.4	21.4
	Kifyonzo (Kwa)	66	50.0	10.6	31.8	7.6
	Utange (Msa)	96	78.1	10.4	8.3	3.2
	Korkora (Gar)	80	77.5	11.3	7.5	3.7

Table 4.11: Distribution of mean maternal body mass index and prevalence of malnutrition among non-pregnant mothers

Sub-region	Clusters	n	BMI, kg/m^2		% <18.5 kg/m^2
			Mean	SD	
Lake basin midlands	Osiri (Ksm)	-	-	-	-
	Kandiang'a (Nyo)	*22*	*20.4*	*2.2*	*22.7*
	Sisenye (Bus)	138	21.0	2.1	10.1
Western highlands	Nakhwana (Bun)	93	20.8	2.8	18.7
	Misikhu (Bun)	86	22.0	3.3	9.3
	Mwamosioma (Kis)	181	21.8	3.1	10.1
	Birongo (Kis)	150	22.5	3.4	6.0
Central and mid west highlands	Sirwet (Bar)	111	21.1	3.1	19.8
	Rurii (Nya)	116	22.7	3.5	6.9
	Njabini (Nya)	72	23.1	3.9	9.7
	Kibaranyaki (Mer)	135	24.5	3.6	1.5
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	83	19.0	2.9.0	51.9
	Kibureni (Mer)	137	21.7	3.4	11.7
	Kyatune (Kit)	165	21.1	2.8	15.7
	Wii (Kit)	121	20.9	2.6	19.5
Coastal and semi arid lowlands	Elan (Gar)	32	18.6	2.0	50.0
	Kikoneni (Kwa)	184	21	3.4	25.6
	Kifyonzo (Kwa)	141	19.3	2.1	36.2
	Miritini (Msa)	115	22.4	4.5	20.0
	Utange (Msa)	96	21.7	3.7	14.6
	Korkora (Gar)	87	18.1	2.4	59.7
All areas	Overall	2261	21.4	3.5	18.6

4.9. Geophagy and pregnancy

Overall 46.7% of mothers reported that they ate non-food items during the previous pregnancy (n=2905). In 13.2% and 12.6% of mothers, geophagy lasted the first and third trimester in that order. In 11 clusters, the dominant geophagus period was second trimester (Table 4.12).

With the exception of Korkora, Elan and Miritini where the response rate was very low, geophagy predominantly took place throughout pregnancy. Thus for the whole population, in 40.2% and 32.7% of mothers (n=1376) geophagy took place throughout pregnancy and during second trimester respectively. The most commonly consumed materials were soils (59.7%), soft stones (20.5%) and baked clay (7.6%). The materials were mainly obtained from a specific location in the surrounding (43.4%). 18.9% of mothers purchased the materials from the market or shop (n=1559). Marginal association was observed between distribution of history of geophagy and moderate to severe anemia (P=0.068).

The mean concentration of iron in 7 samples of soft stones and soils collected from the lake basin and coast sub regions and, Baringo and Garissa districts ranged between 1.3 $\pm$ 0.05 mg/g and 7.6 $\pm$ 0.96 mg/g. The zinc concentration ranged between 0.1 and 0.3 mg/g.

4.10. Illnesses during pregnancy and perception about anemia

The main illnesses that afflicted mothers during the previous pregnancy were perceived to be morning sickness (34.2%), malaria (11.8%), respiratory disease (10.3%) and backaches (6.4%). Anemia was cited by 2.3% (n=3008). Knowledge about anemia ranged between 5.7% and 98.9% (n=2950). High-level awareness was observed in Kifyonzo, Utange, Miritini and Korkora (79.3% to 98.9%). In 14 clusters, the level of awareness ranged between 10% and 32%. While 56.9% of mothers in Kibaranyaki were aware about anemia, only 5.0% and 5.7% of mothers in Kibureni and Ng'aratuko reported affirmatively. Overall, 34.6% of mothers were aware about anemia. The perceived leading causes of anemia included inadequate food, malaria and pregnancy (Table 4.13). The main sources of information about anemia were health workers (36.3%), friends and relatives (34.0%) and school (7.9%).

The highest response levels about locally used names or descriptions of anemia were observed in Kifyonzo (77.7%, n=184), Utange (82.4%, n=159), Miritini (95.1%, n=162) and Korkora (68.4%, n=38). Except Kibureni where no responses were recorded, the proportion of mothers who reported locally used name or description of anemia ranged between 5.9% and 37.3%. The commonly used names or descriptions are shown in Table 4.14.

Table 4.12: Geophagy practice and the gestation period within which it occurred

Sub-region	Cluster/District	n	Gestation period			
			Early phase	Mid phase	Late phase	Throughout
Lake basin midlands	Osiri (Ksm)	109	11.0	15.6	15.6	56.0
	Kandiang'a (Nyo)	112	4.5	14.3	13.4	67.9
	Sisenye (Bus)	72	13.9	36.1	20.8	27.8
Western highlands	Nakhwana (Bun)	80	23.8	23.8	18.8	28.8
	Misikhu (Bun)	126	7.9	37.3	7.9	45.2
	Mwamosioma (Kis)	88	17.0	44.3	12.5	25.0
	Birongo (Kis)	74	6.8	58.1	6.8	28.4
Central and mid west highlands	Sirwet (Bar)	79	6.3	32.9	10.1	50.6
	Rurii (Nya)	59	5.1	33.9	45.8	15.3
	Njabini (Nya)	24	8.3	75	4.2	12.5
	Kibaranyaki (Mer)	26	3.8	23.1	11.5	53.8
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	70	37.1	28.6	5.7	28.6
	Kibureni (Mer)	45	4.4	75.6	13.3	4.4
	Kyatune (Kit)	99	18.2	23.2	7.1	49.5
	Wii (Kit)	80	13.8	28.8	8.8	47.5
Coastal and semi-arid lowlands	Elan (Gar)	***3***	***1***	***2***	***0***	***0***
	Kikoneni (Kwa)	112	4.5	14.3	13.4	67.9
	Kifyonzo (Kwa)	71	15.5	33.8	8.5	39.4
	Miritini (Msa)	***2***	***1***	***0***	***0***	***1***
	Utange (Msa)	27	29.6	22.2	7.4	40.7
	Korkora (Gar)	***18***	***11***	***2***	***0***	***5***
All areas	Overall	*1376*	*13.2*	*32.7*	*12.6*	*40.2*

From 2027 respondents who attended AN clinics in public facilities, 25.1% reported that perceived hematinic were prescribed during every visit. 33.6% indicated that no hematinics were ever prescribed to them. In the former category prescriptions were given to respondents, 33.2% in the lake basin, 27.9% in the coast and 20% in the western highlands. For mothers attending private clinics (n=127), 22.8 % reported that humanities supplements were never prescribed while 40.2% reported receiving hematinics prescription at every visit. The corresponding rates among mission facilities (n=290) were 29.7% and 34.5% respectively.

Table 4.13: Distribution of perceived causes of anemia

Perceived cause	n	Proportion, %
Inadequate food	453	43.3
Malaria	64	6.1
Pregnancy	54	5.2
Over-working	27	2.6
Intestinal worms	24	2.3
Combinations	246	26.4
Don't know	148	14.1
Total	1046	100

The following price were paid for the hematinics by respondents <Ksh. 20, 48.3%, Ksh. 21-60 by 25.4% and >Ksh. 60 by 26.3%. In addition, among 1701 mothers who reported that they had received hematinics supplements, 42.4% indicated that they did not experience any side effects. The main complaints from the others were nausea (18.9%), bad taste (9.2%), generalized weaknesses (6.9%), combination of nausea with bad taste or generalized weakness (10.6%) and headaches (1.4%).

Table 4.14: Selected local descriptions or names for anemia

Sub-region/district	Name or description of anemia
Coast	*safura, furauende, nyongoo, guta, upungufu wa damu, kukosa milatso, anende mabaga madidi*
Kisumu/Nyando	*rarinu, segete, ledho, awira, akuodi, anemia*
Bungoma	*hua/khutamba kamafuki, lubuhunyu, khubumbelelwa, kamafuki, embaa ya kamafuki, khuchelelekha, khunyuna, khusiha*
Kisii	*esosera, ekeuno, enyamoreo, esiorora, oborwaire buranda/amanyinga*
Garissa	*dig yare*
Baringo	*kobok koroti, anemia*
Nyandarua/Meru	*ukosefu wa damu, macha, thiurura, kunyihia thakame, kuthirirwo, anemia*
Kitui	*muuku, ndetema, kyaathi, mulimbo, muumu, wasyuhi, malaria*

4.11. Utilization of maternity and maternity services

The proportion of mothers who sought antenatal (AN) care during the previous pregnancy ranged between 34.6% (n=26) in Korkora and 97.0% (n=165) in Utange. With the exception of Korkora and Elan, the proportion of mothers who utilized this service was over 72.0% in other clusters or on average 87.8% (n=3149). The following were the main providers of MCH services: public facilities 79.8%, private clinics and hospitals 7.4%, mission facilities 11.2% and out-reach clinics 1.7% (n=2746). Overall, 44.7% mothers reported that they were given supplements during the AN visit (n=1711). 28.6% (n=1520) reported that they were treated for malaria. For mothers who did not seek AN services, the following reasons were cited, no money 26.7%, too far 11.8%, not necessary 9.3%, too busy 8.2% and no reason 17.1% (n=475). Among pregnant mothers marginal association between prevalence of anemia and non-attendance of MCH clinic (58.0%, n=275) was observed (P=0.075). In this respect, marginal association between distribution of anemia and age of child that was attributable to lactating and or low HbC recovery among mothers of <6 month-olds was demonstrated (P=0.059).

The dominant place of delivery was home (61.1%) followed by public facilities (28.4%) (n=3168). The proportion of mothers who delivered at home ranged between 2.1% in Kibaranyaki and 88.4% in Kikoneni (Table 4.15). In Njabini and Misikhu, the proportion of mothers who used the mission facilities was more than those using the public facilities. The contribution of the private facilities was most marked (34.4%) in Njabini.

Table 4.15: Distribution of providers of maternity services used most recently

Sub-region	Cluster	n	Proportion, %			
			At home	GoK facility	Mission facility	Private facility
Lake basin midlands	Osiri (Ksm)	172	76.7	15.7	0.6	6.4
	Kandiang'a (Nyo)	180	59.4	28.3	3.9	8.3
	Sisenye (Bus)	173	71.2	27.2	1.2	0
Western highlands	Nakhwana (Bun)	241	81.7	8.7	9.1	0.4
	Misikhu (Bun)	205	72.2	8.8	14.6	4.4
	Mwamosioma (Kis)	196	67.8	29.6	1.5	1
	Birongo (Kis)	144	38.9	54.9	2.7	4.2
Central and mid west highlands	Sirwet (Bar)	137	34.2	65.7	0	0
	Rurii (Nya)	122	49.2	45.1	0	5.7
	Njabini (Nya)	64	5.3	23.4	35.9	34.4
	Kibaranyaki (Mer)	141	2.1	77.3	17	3.5
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	129	73.7	24.8	0.8	0.8
	Kibureni (Mer)	142	21.8	66.2	11.3	0.7
	Kyatune (Kit)	180	72.4	12.8	11.1	3.9
	Wii (Kit)	142	62.0	32.4	1.4	4.2
Coastal and semi-arid lowlands	Elan (Gar)	*3*	*3*	*0*	*0*	*0*
	Kikoneni (Kwa)	199	88.4	9.5	0.5	1.5
	Kifyonzo (Kwa)	221	88.3	11.3	0	0.5
	Miritini (Msa)	186	61.3	28.0	2.7	6.5
	Utange (Msa)	166	66.3	23.5	2.4	7.8
	Korkora (Gar)	26	96.2	3.8	0	0
Total	Overall	3168	61.1	28.4	5.2	3.9

4.12. Sub-regional distribution of anemia and median Hb shift

With regard to public health importance, anemia among mothers in the semi-arid lowlands (Garissa) was both severe and highly significant (Table 4.16). In the lake basin, western and coastal sub-regions, anemia among mothers was moderately severe and constituted moderate to high public health significance. In all central and mid west highlands and the dry humid and semi-arid midlands sub regions, anemia among mothers was mild and of moderate public health significance.

Table 4.16: Distribution of anemia by grade and its public health importance based on ranked scores for mothers

Sub-region	Grade of public/public health importance			
	Severe/highly significant [score 8-10]	Moderate/moderate to high significance [score 5-7]	Mild/moderately low significance [score 3- 4]	None/low significance [score <3]
Lake basin midlands	-	Kisumu - Osiri Nyando-Kandiang'a Busia - Sisenye	-	-
Western highlands	-	Kisii-Mwamusioma Bungoma-Nakhwana -Misikhu	Kisii - Birongo	-
Central and mid west highlands	-		Baringo - Sirwet Meru-Kibaranyaki Nyandarua-Njabini - Rurii	-
Dry humid and semi-arid midlands	-	-	Baringo-Ng'aratuko Meru - Kibureni Kitui - Kyatune - Wii	-
Coastal and semi arid lowlands	Garissa-Elan - Korkora	Mombasa -Utange -Miritini Kwale - Kikoneni - Kifyonzo	-	-

Using the ecological and relief features distribution, lines joining the clusters with comparable severity and public health importance of anemia (isoanaems) were constructed (Appendix 4.3). According to these estimates, the country is likely to fall into three anemia zones. Adjusting HbC cut-off using 1.0 g/dL per 1000m asl yielded a shift of all clusters under the mild/moderately low significance to moderate/moderate to high significance category except those in Nyandarua.

After adjusting HbC values for altitude using the 0.25 g/dL cut-off for mothers who were asymptomatic and had s-ferritin concentration between 50-150 g/dL, the median reference HbC was estimated to be 13.16 g/dL. The median HbC shift analysis yielded deficits ranging between 0.10 g/dL and 3.94 g/dL from the reference median in all but central highlands and parts of western highlands (Appendix 4.4). In the highlands, the medians were 0.021 g/dL to 0.83 g/dL above the reference median. Applying the survey estimated HbC altitude adjustment factor of 1.0 g/dL lowered the magnitude of deficits and surpluses (0 to 2.9 g/dL) with only one western highlands cluster having 0.01 g/dL more than the reference median (12.0 g/dL).

4.13 Risk factors associated with anemia, s-retinol, s-ferritin and s-zinc deficiency

The factors associated with anemia at univariate level are shown in Table 4.17. The results of the multivariate logistic model constructed using these factors are shown in Table 4.18. Except respiratory tract infection, the significantly associated factors carried comparable risk values. In the second model, all risk factors associated with anemia in the first model were included in the sub-sample with s-retinol data. Upon inclusion of s-retinol into the model, parasitaemia and respiratory tract infections were dropped (Table 4.18). Serum retinol deficiency was associated with a three-fold increase in the risk of anemia.

The risk factors associated with low s-retinol, s-ferritin and s-zinc are shown in Table 4.19. The dominant factor was low HbC. Other risk factors had comparable significance except current fever. Similarly, anemia was the principal risk factor for low s-ferritin and low s-zinc concentration. The contribution of hookworm infection and *S. mansoni* as significant risk factor only appeared after pooling both overt and marginal deficiencies.

4.14. Distribution of anemia, s-ferritin, s-retinol and s-zinc by health status

By desegregating mothers using both history and laboratory findings, it was observed that the prevalence of pooled anemia as well as moderate to severe among the ill was higher than that of the well mothers (53.5% *vs* 38.3% and 23.6% *vs* 13.9%; P<0.001). From Table 4.20, there were no significant differences in the distribution of s-ferritin among ill and well mothers. Among well mothers, the proportion with moderate to acute deficiency was smaller than that of ill mothers (38.7% *vs* 45.9%) but the difference was not statistically significant. A significant shift in s-retinol status was evident upon separation of mothers who were well from those who were ill (Table 4.20). Overall based on the sample of mothers, 38.7% of well mothers could have been either acutely or moderately s-retinol deficient. The tendency for toxic levels was evident in 0.2% of the mothers. Similarly, the proportion of well mothers who were at high risk of zinc deficiency was significantly lower than that of ill mothers (37.1% *vs* 47.6%, P=0.045). In addition, the mean zinc concentration was significantly lower among pooled ill mothers than well mothers (P=0.02) (Table 4.21).

Table 4.17: Distribution of commonly anemia associated factors

Sub-region	Cluster/Districts	Malaria parasitaemia	Hookworm	Under weight	Recent malaria episode	Recent diarrhea
Lake basin midlands	Osiri (Ksm)	√	√		√	
	Kandiang'a (Nyo)	√				√
	Sisenye (Bus)	√				
Western highlands	Nakhwana (Bun)	–				
	Misikhu (Bun)	√				
	Mwamosioma (Kis)	√				
	Birongo (Kis)					√
Central and mid west highlands	Sirwet (Bar)					
	Rurii (Nya)					
	Njabini (Nya)					
	Kibaranyaki (Mer)					
Dry humid and semi-arid midlands	Ng'aratuko* (Bar)					
	Kibureni (Mer)					
	Kyatune (Kit)					
	Wii (Kit)				√	√
Coastal and semi-arid lowlands	Elan (Gar)					
	Kikoneni (Kwa)					
	Kifyonzo (Kwa)		√		√	
	Miritini (Msa)			√		
	Utange (Msa)					
	Korkora*(Gar)					

* Constituted semi-arid sub-region

Table 4.18: Results from multivariate model risk factors for maternal anemia - odds ratios (OR) and 95% confidence intervals (95% CI)

Factor	OR	95% CI	P
Excluding s-retinol (n=2901) Current fever	1.68	1.37-2.05	0.001
Recurrent fever	1.87	1.52-2.28	<0.001
Perceived malaria	1.17	0.99-1.38	0.07
Respiratory tract infection	0.87	0.73-1.02	0.084
Parasitaemia	1.51	1.25-1.82	<0.001
Including s-retinol (n=1435) Current fever	1.64	1.19-2.23	0.002
Recurrent fever	1.97	1.46-2.65	<0.001
Perceived malaria	1.34	1.04-1.72	0.022
S-retinol	3.19	2.55-3.98	<0.001

Table 4.19: Results from multivariate model of risk factors for maternal s-retinol, s-ferritin and s-zinc deficiency

Factor	OR	95% CI	P
S-retinol <20 µg/dL (n=957)			
Recurrent fever	1.42	0.94-3.41	0.095
Body mass index	1.77	1.24-2.52	0.002
Parasitaemia	1.78	1.19-2.63	0.004
Hookworm	1.95	1.43-2.66	<0.001
HbC	2.78	2.11-3.67	<0.001
S-ferritin <20 µg/dL (n=766)# S-retinol	1.43	1.03-1.96	0.03
Respiratory tract infection	0.5	0.35-0.71	<0.001
HbC	3.23	2.36-4.48	<0.001
S-zinc <65 µg/dL (n=672) * Respiratory tract infection	1.64	1.15-2.26	0.005
HbC	2.11	1.56-2.86	<0.001

\# Using 40 µg/L cut-off point for hookworm and *S. mansoni* infections were included in the model with OR values of 1.34 and 1.73 respectively but associations were weak.

Hookworm and BMI were included in the model for s-zinc but were marginally significant with OR = 1.39 and 1.46 respectively.

Table 4.20: Distribution of S-ferritin status among mothers by presumed state of health

Health Status	n	s-ferritin categories (µg/l) and distribution (%)					
		< 12	12-20	>20-40	>40-160	>160-300	>300
All	968	28.6	14.3	27.7	26.7	2.4	0.4
Well^P	298	31.2	14.8	25.5	26.8	1.7	-
Ill	670	27.5	14.0	28.7	26.6	2.7	0.6

	n	s-retinol categories (µg/dl) and distribution (%)				
		<10	10-20	>20-50	>50-100	>100
All	1674	10.3	40.4	48.6	0.7	0.1
Well^P	505	10.1	33.3	55.0	1.2	0.2
Ill	1169	10.4	43.5	45.7	0.5	-

Table 4.21: Distribution of s-zinc and risk of deficiency

Group	n	Zinc deficiency risk category, %		
		High: <65 µg/dL	Low: 65-150 µg/dL	Excess: >150 µg/dL
All	1090	52.2	47.6	0.2
Well	385	44.5	52.3	0.1
Ill	705	54.5	45.1	0.2

4.15 S-ferritin and s-retinol distribution by anemia status

From Table 4.18, malaria parasitaemia was the most commonly associated factor with anemia. S-ferritin and recent history of morbid episodes were also associated with pooled anemia. There were no significant differences in the distribution of s-ferritin between well and ill mothers (Table 4.22). Overall, 41.9% of mothers were either acutely or marginally s-ferritin deficient. The tendency for excess s-ferritin was observed in about 0.5% of the mothers. Significant association between acute deficiency and severity of anemia was demonstrated, 29.7 % of the non-anemic mothers were either acutely or marginally deficient. Among those with moderate to severe anemia, 83.4% had low s-ferritin. The corresponding proportions for the mildly anemic and non-anemic mothers were 52.3% and 31.6% respectively. Thus the proportion of non-iron deficiency anemia was inferred in 47.7% and 16.6% of the mildly and moderately/severely anemia mothers respectively. Similarly, s-retinol deficiency occurred in 53.4% and 66.2% of the mildly and moderately/severely anemia mothers respectively. In this regard, the prevalence of acute and moderate s-retinol increased significantly with severity of anemia ($P<0.001$).

Significant correlation between severity of anemia and s-retinol status was evident in case of acute deficiency and an overall preponderance of moderate deficiency among anemic mothers. The proportion of mothers with acute s-ferritin deficiency increased with severity of anemia (Table 4.20).

Table 4.22: Distribution of S-ferritin and s-retinol status among mothers anemic by presumed state of health

Anemia Status	n	s-ferritin categories (µg/dL) and distribution (%)					
		< 12	12-20	>20-40	>40-160	>160-300	>300
Normal	190	15.3	16.3	28.4	38.9	1.1	
Mild	65	33.8	18.5	24.6	18.5	4.6	
Moderate + severe	54	76	7.4	7.4	7.4	1.9	
		s-retinol categories (µg/dL) and distribution (%)					
	n	<10	10-20	>20-50	>50-100	>100	
Normal	336	4.2	23.2	71.1	1.2	0.3	
Mild	118	13.6	39.8	46.6	-	-	
Moderate + severe	73	24.7	42.5	32.9	-	-	

4.16 Micronutrients overload

Among pregnant mothers, 7.2% (n=390) showed HbC overload tendency with a group mean of 14.4 ± 0.6 g/dL. S-ferritin data was available for only 8 mothers and concentration ranged between 12.6 µg/L and 53.7 µg/L. Among non-pregnant mothers, 11.7% (n=2735) showed increased tendency for HbC overloads and their mean HbC was 15.4 ± 0.7 µg/L. While the largest proportion of these mothers (45.9%) came from central highlands sub-region the lowest proportion (4.4%) came from the coastal and semi-arid lowlands sub-region. The mean s-ferritin concentration for 94 of these mothers was 50.7 ± 35.8 µg/L and only one case had marginal deficiency. Using HbC 12.2 g/dL among pregnant and 13.2 g/dL among non-pregnant mothers and adjusting for attitude, the tendency for hemoglobin overloads were 7.2% (14.4 ± 0.6 g/dL) and 11.7% (15.4 ± 0.7 g/dL) respectively. 45.9% of these mothers came from central highlands. 1.9% of all relatively well mothers had high s-ferritin concentration (161-300 µg/L) while 0.5% and 0.2% probably had excess zinc levels (>150 µg/dL) and s-retinol level (>100 µg/dL) respectively.

CHAPTER 5: HAEMOGLOBIN, S-RETINOL, S-FERRITIN, S-ZINC STATUS AND ASSOCIATED FACTORS AMONG ADULT MALES

5.1. Sample characteristics

The mean age of the fathers in different clusters ranged between 30.7 ± 5.4 years and 36.1± 7.1 years. The overall mean was 36.43 ± 10.28 years (n= 948). The age of the schoolboys ranged between 15 and 19 years (n=235). The pooled sample of fathers and schoolboys is subsequently referred to as adult males.

5.2. Distribution of anemia and its physical signs

5.2.1. Hemoglobin concentration and anemia

The mean HbC ranged between 12.2 ± 2.7g/dL and 16.7 ±1.3 g/dL (Table 5.1). In three coastal and semi-arid lowland sub-region clusters, (Kifyonzo, Korkora and Kikoneni) HbC were below altitude adjusted cutoffs. In addition, the lake basin sub-region and remaining clusters in the coast had borderline mean values (Appendix 5.1). The correlation between mean HbC and altitude was 0.88 ($p<0.0001$). The mean HbC increased with altitude by 1.19 g/dL per 1000 m rise *asl* (Appendix 5.2). In areas whose altitude was higher than 500 m *asl*, the mean HbC were above the adjusted cutoffs. In the central highlands, the mean HbC on average exceeded adjusted cut-off by between 1.0 and 2.0 g/dL.

The prevalence of all anemias ranged between 0% and 66.7%. Significant proportions of anemia were observed in the coastal and semi-arid lowlands, the lake basin and western highlands and midlands (Table 5.1). The central and mid west highlands were relatively free. It should be noted that the sample size in the central highlands clusters was relatively small. While mild grades of anemia were dominant in all affected clusters, moderate anemia was observed mainly in the lake basin, western highlands, and coastal and semi-arid lowlands sub-regions. Severe forms of anemia were observed in significant proportions (>5%) in Sisenye and Korkora in the lake basin and semi arid lowlands respectively. The overall 31.4% prevalence of anemia among pooled fathers and boys consisted of 26.2% mild and 5.1% moderate/ severe anemia respectively.

5.2.2. Palmar and nail bed pallor

Significant prevalence of palmar and nail bed pallor were predominantly observed in the lake basin and, coastal and semi-arid lowlands sub-regions (Table 5.2).

Table 5.1 Distribution of mean Hb concentration and prevalence of anaemia among adult males and boys based on altitude adjusted cut-offs (Bold - absolute numbers, [l]includes school boys)

Sub region	Cluster (district)	n	Hb conc. g/dL		% Anaemic			
			Mean	SD	All	Mild	Moderate	Severe
Lake basin midlands	Osiri (Ksm)	43	13.7	2.0	40.9	34.9	4.5	2.3
	Kandiang'a[l] (Nyo)	68	13.7	2.4	37.7	27.5	8.7	1.5
	Sisenye (Bus)	77	12.9	2.9	48.1	31.2	11.7	5.2
Western highlands	Nakhwana (Bun)	163	14.2	1.5	30.1	29.5	0.6	0
	Misikhu[l] (Bun)	47	14.5	2.2	21.3	17.0	2.1	2.1
	Mwamusioma[l](Kis)	95	14.5	1.8	24.3	23.2	1.1	0
	Birongo (Kis)	38	15.3	1.9	10.6	5.3	5.3	0
Central and mid west highlands	Sirwet (Bar)	49	15.1	1.1	2.1	2.1	0	0
	Rurii (Nya)	*23*	15.2	1.9	17.4	8.7	8.7	0
	Njabini (Nya)	***10***	16.7	1.3	**0**	**0**	**0**	**0**
	Kibaranyaki[l] (Mer)	69	15.6	1.7	13.0	11.6	1.4	0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	49	14.5	1	12.2	12.2	0	0
	Kibureni[l] (Mer)	70	14.3	2.2	20.0	14.3	4.3	1.3
	Kyatune[l] (Kit)	52	13.6	1.7	34.6	30.9	1.9	1.9
	Wii[l] (Kit)	50	14	1.5	30.2	28.3	2.0	0
Coastal and semi arid lowlands	Elan (Gar)	***6***	14.2	1.5	**1**	**1**	**0**	**0**
	Kikoneni (Kwa)	***27***	12.5	2.1	66.7	55.6	7.4	3.2
	Kifyonzo (Kwa)	66	13.0	1.9	52.2	46.3	4.5	1.5
	Miritini[l] (Msa)	40	13.3	2.2	40.0	35.0	2.5	2.5
	Utange[l] (Msa)	85	13.2	2.6	42.4	35.3	4.7	2.4
	Korkora[l] (Gar)	46	12.2	2.7	61.7	46.7	8.7	6.5
All areas	Overall	1183	14.0	2.22	31.4	26.2	3.7	1.4

Mwamosioma in western highlands had relatively high prevalence of palmar pallor. High prevalence of koilonynchia was observed in some clusters in lake basin and coastal and semi-arid lowlands. The distribution of all anemias and that of palmar pallor were significantly associated in Kikoneni (P=0.047), Sisenye (P=0.012), Misikhu (P=0.007), Birongo (P=0.003) and Korkora (P=0.036). Borderline significance was observed in Utange (P=0.08), Rurii (P=0.074) and Kyatune (P=0.062). When moderate to severe anemia distribution was considered, significant association with palmar pallor was evident in the following clusters, Sisenye (P=0.043), Misikhu (P=0.002), Wii (P=0.006), Kyatune (P<0.001) and Korkora (P=0.014). Overall palmar and nail bed pallor were significantly associated with pooled anemia's (P<0.001).

5.3. Serum ferritin concentration

The mean s-ferritin concentration in all clusters was within the ranges 0 ± 60 µg/L except for Korkora whose sample size was very small. (Table 5.3). In both coastal and semi arid lowlands and lake basin, marginal s-ferritin deficiency among fathers was evident. Pooled samples of fathers in the coastal clusters indicated that 31.2% were marginal to acutely deficient, 16.7% were borderline and 46.9% (n=96) were within the normal range. S-ferritin concentration in 3.3% of these fathers was >300 µg/L. Overall pooled s-ferritin samples indicated that 19.7% of the fathers were marginal to severely deficient. The proportion with excess s-ferritin beyond the normal was 3.7%. None of the cases with high s-ferritin levels (≥160 µg/L) had a HbC of >14.5 g/dL. Overall, significant association between pooled anemia and s-ferritin was evident at <20 µg/L (P=0.003) and <40 µg/L (P=0.001) cut-offs.

Table 5.2: Distribution of prevalence (%) of pallor and nail bed deformities among adult males boys in different clusters.

Sub-region	Clusters	n	Pallor(%)		
			Palms	Nail beds	Both
Lake basin midlands	Osiri (Ksm)	41	39.0	39.0	39.0
	Kandiang'a (Nyo)	53	30.2	34.0	30.2
	Sisenye (Bus)	76	23.7	38.2	19.7
Western highlands	Nakhwana (Bun)	136	4.4	4.4	3.7
	Misikhu (Bun)	44	9.1	6.8	7 .0
	Mwamosioma (Kis)	77	14.3	23.4	13.0
	Birongo (Kis)	38	2.6	15.8	2.6
Central and mid west highlands	Sirwet (Bar)	49	2.0	2.0	0
	Rurii (Nya)	*24*	*20.8*	*12.5*	*4.2*
	Njabini (Nya)	***10***	***0***	***0***	***0***
	Kibaranyaki (Mer)	68	2.9	4.4	1.5
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	46	21.7	4.3	4.8
	Kibureni (Mer)	66	9.1	9.1	3.0
	Kyatune (Kit)	57	15.8	3.8	3.5
	Wii (Kit)	54	11.1	3.8	3.7
Coastal and semi arid lowlands	Elan (Gar)	***6***	***0***	***1***	***0***
	Kikoneni (Kwa)	22	*22.7*	*0*	*0*
	Kifyonzo (Kwa)	66	19.7	21.2	16.7
	Miritini (Msa)	27	25.9	22.2	18.5
	Utange (Msa)	66	18.2	10.6	10.6
	Korkora (Gar)	46	22.2	35.7	13.3
All areas	Overall	1070	14.8	14.8	9.7

Table 5.3 Distribution of Geometric mean and status of s-ferritin concentration among fathers

Sub-region	Cluster	S-ferritin concentration µg/L and proportions, %								
		n	Mean	95% CI	<12	12-20	20.1-40	40.1-160	160.1-300	>300
Lake basin midlands	Osiri (Ksm)	2	86.1	66.6-111.2	0	0	0	2	0	0
	Kandiang'a (Nyo)	12	48.9	25.1-96.7	2	2	2	3	3	0
Western highlands	Birongo (Kis)	1	26.5	26.5-26.5	0	0	1	0	0	0
Central and mid west highlands	Sirwet (Bar)	21	84.1	55.2-128.8	0	9.5	14.3	52.4	4.8	19.0
	Rurii (Nya)	1	6.2	6.24-6.2	1	0	0	0	0	0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	27	96.7	73.1-124.9	0	3.7	3.7	66.7	25.9	0
	Kyatune (Kit)	13	66.6	40.7-108.7	0	1	1	10	0	1
	Wii (Kit)	14	78.4	55.2-111.2	0	0	2	9	3	0
Coastal and semi arid lowlands	Kikoneni (Kwa)	16	31.4	21.4-45.8	0	8	2	6	0	0
	Kifyonzo (Kwa)	19	45.8	32.1-65.1	2	0	3	14	0	0
	Miritini (Msa)	4	34.5	13.1-86.1	0	2	0	2	0	0
	Utange (Msa)	30	71.4	51.5-96.7	3.3	0	20.0	63.3	10.0	3.3
	Korkora (Gar)	4	12.9	9.1-18.2	2	2	0	0	0	0
All areas	Overall	164	60.7	52.7-69.8	4.9	11.0	12.8	57.3	10.4	3.7

5.4. Factors associated with anemia

5.4.1 Fever, sickling of red cells and parasitic diseases

Fever: The occurrence of elicitable fever among males ranged between 0% and 12.2%. Excepting clusters in western highlands and Korkora in the semi-arid lowlands, the prevalence of fever was less than 10% (Table 5.4). Acute febrile state was extremely rare among participating men (<0.5%). The association between distribution of moderate to severe anemia and fever was significant in Kandiang'a (P=0.003) and Korkora (P<0.001). Overall, elicitable fever was marginally associated with anemia (P=0.50).

Sickling: a significantly large proportion of sickling was evident in lake basin and western highlands except those in Kisii district (Table 5.4). Smaller proportions 0% to 17.9% were demonstrated in the clusters in the coastal clusters. The distributions of sickling and anaemia were significantly associated in Kikoneni (P=0.035) and only marginally in Osiri (P=0.068). The overall association between anaemia and sickling was not significant (P=0.63)

Malaria: Parasitaemia was demonstrated in practically all clusters except Elan (Table 5.4). The proportion affected ranged between 3.8% and 42.0%. Consistently large proportions were seen in the lake basin, western highlands and coastal and semi-arid lowlands sub-regions. Parasitaemia intensities were mainly of very light category in 50.6% of men (n=913). In 36.2% and 13.3%, the intensities were light and moderate respectively. Moderate to heavy parasitaemia was predominantly observed in the lake basin and western highlands and in Kibaranyaki and Kibureni clusters in the central highlands and midlands sub-regions in that order. Marginally significant association between malaria and all anemias was evident in Wii (P=0.052). Overall, malaria parasitaemia was significantly associated with pooled anemias (P=0.04)

Hookworm: The prevalence of hookworm ranged between 0% in the central and Midwest highlands to 80.0% in western highlands. With exception of the former and clusters in the semi-arid sub-regions, all other sub-regions had significant (≥15%) prevalence rates (Table 5.4). 90.4% (n=322) of the infected males had light infection (<1000 epgs). The remainder had moderate to heavy infection intensities. Borderline significance was observed between hookworm infection and anemia (P=0.053). Similarly significant association between moderate to severe anemia and hookworm intensity (P<0.001) was observed.

Schistosomiasis: *S. mansoni* and *haematobium* infections were mainly observed in the lake basin and coastal sub-regions respectively (Table 5.5). In Wii and Kyatune clusters in the midlands (Kitui district) significant levels of mixed *S. mansoni* and *S. haematobium* infections were observed (Table 5.5). In Osiri, 4.0% of the population had *S. haematobium* infestation. Schistosomal infection was significantly associated with pooled anemias (P=0.014). Significant association was observed between *S. mansoni* infection and all grades of anaemia in pooled midlands (Kyatune and Wii) clusters (P<0.001).

Other helminths and filariasis: Ascariasis was observed in 5.3% (n=780) of the men. Among the positive group, 80.5% had light infestation. Light infestation with *T. trichura* was observed in 6.1% of the population sample (n=799). Among 7 men screened for *W. bancrofti* antigen in Kikoneni in Kwale only one was positive.

E. histolytica: In 6 clusters whose sample sizes ranged between 26 and 88, the prevalence of *E. histolytica* ranged between 6.1% and 21.6%.

5.4.2. Illnesses, signs and symptoms

Fever was most commonly reported in the lake basin and western highland sub-regions followed by clusters in the coast and semiarid lowlands (Table 5.6). Significant association in the distributions of current or fever and pooled anemias was observed in Kandiang'a (P=0.038), Kibureni (P=0.031) and Rurii (P=0.008). Overall, both current and recent fevers were significantly associated with anaemia at P=0.002 and P=0.01 respectively. History of current fever was significantly associated with s-ferritin based on 20Fg/L cut-off (P=0.035).

Perceived episodes of malaria were reported in all sub-regions. The lake basin and western highlands had the highest rates (8.9 - 82.7%) followed by coastal and semi-arid midlands. In Kandiang'a, significant association in the distribution of both pooled anemias and perceived malaria episode was observed (P=0.014). Marginally significant associations were observed in Utange (P=0.055), Osiri (P=0.06), Birongo (P=0.068) and Mwamosioma (P=0.067). In 22.1% of responding households (n=2427), fathers were reported to have received treatment for malaria during the preceding quarter.

Table 5.4 Distribution of prevalence of elicitable fever, malaria parasitaemia, hookworm, schistosomiasis and sickling among males

Sub-region	Cluster	Malaria		Hookworm		*Schistosoma*		Sickling		Temperature °C	
		n	%	n	%	n	%	n	%	n	>37.5
Lake basin midlands	Osiri[1] (Ksm)	42	19.0	45	15.6	45	40.0	43	18.6	39	2.6
	Kandiang'a[1] (Nyo)	52	25.0	44	36.4	46	47.8	68	17.6	49	2.0
	Sisenye[1] (Bus)	72	20.8	70	26.0	75	41.3	73	16.4	74	6.8
Western highlands	Nakhwana[2] (Bun)	137	33.6	107	80.0	88	9.1	162	16.7	136	7.4
	Misikhu[1] (Bun)	46	30.4	45	61.0	43	2.3	47	23.4	43	7.0
	Mwamusioma[1] (Kis)	75	32 .0	71	33.8	64	3.1	95	2.1	75	6.7
	Birongo[1] (Kis)	37	10.8	35	5.7	35	0	38	0	38	5.3
Central and mid west highlands	Sirwet[1] (Bar)	73	4.1	40	0	41	0	48	2.1	47	4.3
	Rurii[1] (Nya)	***18***	***1***	***15***	***0***	***14***	***0***	***23***	***0***	***22***	***0***
	Njabini[1] (Nya)	***9***	***0.3***	***8***	***0***	***8***	***0***	***10***	***0***	***9***	***0***
	Kibaranyaki[1] (Mer)	28	10.7	32	0	32	0	69	0	67	4.5
Dry humid and semi-arid midlands	Ng'aratuko[1] (Bar)	48	4.2	33	0	33	0	49	0	46	6.5
	Kibureni[1] (Mer)	67	6.0	65	13.8	62	1.6	70	0	66	6.1
	Kyatune[2] (Kit)	52	3.8	40	12.5	57	50.9	55	0	55	5.5
	Wii[1] (Kit)	52	16.4	42	28.6	42	59.5	53	0	49	12.2
Coastal and semi arid lowlands	Elan[2] (Gar)	***5***	***0***	***5***	***0***	***5***	***0***	***6***	***0***	***6***	***0***
	Kikoneni [2] (Kwa)	***12***	***3***	***18***	***15***	***21***	***33.3***	***27***	***3.7***	***15***	***0***
	Kifyonzo[2] (Kwa)	68	16.2	100	43.0	97	24.7	67	17.9	64	3.1
	Miritini[2] (Msa)	66	23.7	52	28.8	53	11.3	40	12.5	25	4
	Utange[2] (Msa)	77	23.4	74	53.9	81	18.5	83	8.4	65	1.5
	Korkora[2] (Gar)	39	20.6	31	0	27	0	47	0	44	4.5
	Overall males	1047	18.7	972	32.9	964	19.6	1173	8.4	1033	5.0

For schistosoma infection the sample size is based on *S. mansoni* (1), and S. *haematobium* (2).

Table 5.5: Intensity of schistosoma infection among Adult males

Sub-region	Cluster	*S. mansoni*, epgs				*S. haematobium*, eggs/10 mL		
		n	#100	101-400	>400	n	≤ 50	>50
Lake basin midlands	Osiri (Ksm)	45	24.4	13.3	0	25	4	0
	Kandiang'a (Nyo)	46	30.4	15.2	0	12	0	0
	Sisenye (Bus)	74	17.6	10.8	12.2	-	-	-
Western highlands	Nakhwana (Bun)	-	-	-	-	83	3.6	0
	Misikhu (Bun)	43	2.3	0	0	-	-	-
	Mwamosioma (Kis)	62	3.1	0	0	-	-	-
Dry humid and semi-arid midlands	Kyatune (Kit)	53	30.2	0	1.9	50	48	2
	Wii (Kit)	42	2.4	9.5	45.2	45	2.2	0
Coastal and semi arid low lands	Kikoneni (Kwa)	15	3	0	0	17	29.4	0
	Kifyonzo (Kwa)	95	3.2	0	0	83	16.9	1.2
	Miritini (Msa)	-	-	-	-	44	9.1	0
	Utange (Msa)	-	-	-	-	90	11.1	4.4
	Elan (Gar)	-	-	-	-	-	-	-
	Korkora (Gar)	-	-	-	-	-	-	-

Respiratory tract infections in form of coughs was most commonly reported in the lake basin, and in western highlands sub regions. Significant association between episodes of cough and pooled anaemias was evident in Kandiang'a (P=0.029), Wii (P=0.027) and marginally in Miritini (P=0.056). Significant association in the distribution of moderate to severe anemia and coughing episodes was only evident in Kibureni (P=0.024). Similarly, diarrhea was reported mainly in lake basin and western highlands clusters. There was significant association between diarrheal episodes and moderate to severe anemia in Kandiang'a (P=0.031), Birongo (P=0.003) and Sisenye (P<0.001). Similarly, current and recent diarrhea was associated with pooled anemia (P<0.02). Poor appetite varied between 2.3% and 85.5% (Table 5.6). Poor appetite was significantly associated with moderate to severe anemia only in Kifyonzo (P=0.046).

5.5. Serum retinol status

The mean concentration of s-retinol was in the normal range except in the coastal and semi arid lowlands sub regions (Table 5.7). The prevalence of acute deficiency ranged between nil and 26.9%. While the central and mid west highlands and the semi-arid midlands sub-regions were relatively free of acute s-retinol deficiency (0%), high deficiency levels were observed in the coastal clusters followed by lake basin sub-regions. The prevalence of marginal deficiency was relatively more uniformly distributed across the clusters and affected between 1% and 54.1% of fathers. Among the schoolboys sampled in Utange, Miritini, Wii and Kyatune clusters, 3.7% and 43.1% (n=109) had acute and marginal deficiencies respectively. A significantly association was observed between pooled anemia and s-retinol based on 20 µg/dL cut-off (p=0.012). In addition, the distribution of s-ferritin at both <20 µg/L and <40 µg/L cut-offs were significant associated with that of s-retinol based on the 20 µg/L cut-off (P=0.033 and P=0.018).

Table 5.6 Distribution of perceived illness as reported by fathers in different clusters

Sub-region	Clusters	n	Fever		Mala-ria	Resp. Tract disease cough	Diarrhea		Poor appetite
			Cur-rent	Past 1 month			Cur-rent	Past 1 month	
Lake basin midlands	Osiri (Ksm)	40	47.5	67.5	50.0	37.5	17.5	32.5	67.5
	Kandiang'a (Nyo)	52	48.1	34.6	65.4	24.4	21.2	28.8	53.8
	Sisenye (Bus)	81	21.0	74.1	82.7	39.5	16.0	38.3	70.5
Western highlands	Nakhwana (Bun)	132	34.1	8.3	9.1	50.8	10.6	3.8	10.6
	Misikhu (Bun)	45	42.2	6.7	8.9	42.2	4.8	2.4	11.1
	Mwamosioma (Kis)	76	25.0	38.2	64.5	23.7	7.9	10.5	17.1
	Birongo (Kis)	32	40.6	18.8	46.9	31.3	9.4	0	28.1
Central and mid west highlands	Sirwet (Bar)	45	43.4	20.0	17.8	8.9	0	13.3	55.6
	Rurii (Nya)	***25***	***8.0***	***16.0***	***52.0***	***24.0***	***4.0***	***16.0***	***56.0***
	Njabini (Nya)	***9***	***2***	***2***	***4***	***0***	***1***	***0***	***2***
	Kibaranyaki (Mer)	61	11.5	8.1	21.0	30.6	1.6	4.8	25.8
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	44	2.3	4.8	4.5	13.6	2.3	4.7	2.3
	Kibureni (Mer)	53	13.2	15.1	49.1	50.9	1.9	5.7	52.8
	Kyatune (Kit)	52	3.8	16.4	19.6	12.7	5.5	2.0	85.5
	Wii (Kit)	52	7.7	3.9	26.9	23.1	1.9	6.0	36.5
Coastal and semi arid lowlands	Elan (Gar)	***4***	***4***	***4***	***1***	***2***	***2***	***0***	***1***
	Kikoneni (Kwa)	24	8.3	4.5	0	12.5	8.3	4.2	12.5
	Kifyonzo (Kwa)	66	24.2	25.8	27.7	15.2	1.6	15.4	30.8
	Miritini (Msa)	57	15.0	3.6	25.0	15.0	1.7	0	8.8
	Utange (Msa)	73	18.7	1.5	33.8	21.3	6.9	5.3	29.3
	Korkora (Gar)	44	34.1	47.7	40.5	25.0	9.1	22.7	52.3
All areas	Overall	1076	22.7	22.4	34.1	28.6	7.4	11.2	35.0

Table 5.7 Distribution of Geometric mean and status of s-retinol concentration among fathers

Sub-region	Cluster	n	S-retinol concentration µg/dL and proportions, %				
			Mean	95% CI	≤10	10 - 20	>20
Lake basin midlands	Osiri (Ksm)	***19***	19.0	13.8-25.3	**4**	**4**	**11**
	Kandiang'a (Nyo)	29	17.6	14.1-21.4	13.8	48.3	37.9
	Sisenye (Bus)	37	15.6	13.1-18.5	16.2	54.1	29.7
Western highlands	Nakhwana (Bun)	55	20.9	18.5-23.5	3.6	41.8	54.4
	Misikhu (Bun)	*20*	26.5	21.9-32.9	0	35.0	65.0
	Mwamosioma (Kis)	31	24.7	21.9-27.8	0	25.8	74.2
	Birongo (Kis)	*21*	29.2	24.1-34.5	*4.8*	*9.5*	*85.7*
Central and mid west highlands	Sirwet (Bar)	*41*	30.6	27.1-33.7	*0*	*14.6*	*85.4*
	Rurii (Nya)	***12***	27.2	24.1-31.4	***0***	***2***	***10***
	Njabini (Nya)	***5***	25.3	17.2-37.9	***0***	***1***	***4***
	Kibaranyaki (Mer)	33	26.5	23.5-29.9	0	21.2	78.8
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	39	27.2	25.7-29.9	0	15.4	84.6
	Kibureni (Mer)	34	23.0	20.4-26.5	0	35.3	64.7
	Kyatune (Kit)	53	24.1	22.4-25.9	0	30.2	69.8
	Wii (Kit)	49	25.3	23.0-27.8	2.0	20.4	77.6
Coastal and semi arid low lands	Elan (Gar)	***4***	***16.4***	***15.2-17.6***	***0***	***4***	***0***
	Kikoneni (Kwa)	36	12.5	9.7-15.6	26.9	53.8	19.2
	Kifyonzo (Kwa)	24	21.4	19.9-23.6	0	37.5	62.5
	Miritini (Msa)	*27*	*14.1*	*12.5-16.4*	*11.1*	*74.1*	*14.8*
	Utange (Msa)	47	14.1	12.5-16.0	8.5	78.7	12.8
	Korkora (Gar)	***12***	***17.2***	***14.8-20.4***	***1***	***7***	***4***
All adult male (Overall)		618	21.4	20.4-21.9	5.3	37.1	57.6

5.6 Serum zinc status

Six clusters in different sub regions had mean s-zinc concentration that was lower than the 65 µg/dL cut-off (Table 5.8). The mean concentration in all other clusters ranged between 65.1 µg/dL and 103.7 µg/dL. The proportion of individuals below 65 µg/dL cut-off was 36.5%. Low s-zinc concentration was significantly associated with *S. mansoni* (P=0.03) and s-retinol (P=0.015). Malaria parasitaemia was weakly associated with low zinc concentration (P=0.068).

5.7 Smoking

The overall proportion of households that reported smoking among fathers was 34.2% (n=2732). At cluster level, the proportion of households whose fathers smoked ranged between 8.9% in Kandiang'a and 59.7% in Wii. In coastal clusters the proportion of households with smoking fathers ranged between 25.0% (n=84) in Kifyonzo and 48.7% (n=187) in Kikoneni. In other sub regions, the proportion of households with smoking husbands were as follows; 8.9% (n= 179) in Kandiang'a to 45.7% (n=162) in Osiri in the lake basin, and 10.9% (n=137) in Birongo to 41.8% (n=182) in Mwamosioma in the western highlands, 29.4%(n=126) in Khyatune to 59.7% (n=119) in Wii n the midlands and, 36.4% (n=44) in Njabini to 42.7% (n=110) in Kibaranyaki in the central and mid west highlands. In general, with the exception of Kandiang'a and Birongo, the proportion of households with smoking fathers was 21.0% and over. The mean HbC among reported smoking and non smoking were 14.07 g/dL and 14.28 g/dL respectively (P=0.2). The proportion of anemic smoking fathers was significantly larger than that of non smokers (P=0.045).

Table 5.8: Distribution of Geometric mean serum zinc concentration and prevalence of deficiency among adult males

Sub region	Cluster	n	s-zinc, µg/dL		Deficiency risk category,%	
			Mean	95% CI	High: <65 µg/dL	Low: 65-150 µg/dL
Lake basin midlands	Osiri (Ksm)	12	66.6	57.9-76.6	6	6
	Kandiang'a (Nyo)	26	56.6	51.5-63.6	73.1	26.9
	Sisenye (Bus)	18	52.7	45.8-59.3	13	5
Western highlands	Nakwhana (Bun)	4	78.4	62.1-99.0	0	4
	Misikhu (Bun)	15	65.1	59.3-69.8	7	8
	Mwamosioma(Kis)	28	60.7	56.5-66.6	57.1	42.9
	Birongo (Kis)	16	66.6	59.3-74.9	10	6
Central/ mid west highlands	Sirwet (Bar)	27	76.6	73.1-80.3	14.8	85.2
	Rurii (Nya)	9	95.5	82.2-111.2	0	9
	Njabini (Nya)	6	103.7	88.1-122.0	0	6
	Kibaranyaki (Mer)	14	69.8	62.1-78.4	5	9
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	13	76.6	62.1-94.5	5	8
	Kibureni (Mer)	25	55.2	50.3-59.3	80.0	20.0
	Kyatune (Kit)	15	69.8	62.1-78.4	7	8
	Wii (Kit)	8	69.8	60.7-80.3	3	8
Coastal and semi arid lowlands	Elan (Gar)	3	71.4	42.7-116.5	2	1
	Kikoneni (Kwa)	16	68.2	60.7-74.9	5	11
	Kifyonzo (Kwa)	18	76.6	66.6-88.1	4	14
	Miritini (Msa)	28	63.6	59.3-68.2	42.9	57.1
	Utange (Msa)	35	60.6	55.2-66.6	57.1	42.9
	Korkora (Gar)	7	86.1	73.1-101.3	0	7
All adult male(Overall)		343	66.6	63.4-68.2	46.1	53.9

5.8. Sub-regional distribution of anemia and median Hb shift

Anemia of moderate severity and high public health significance was observed in Sisenye in the lake basin and the coastal and semi-arid lowlands sub-regions (Table 5.9). In the central highlands, anemia was practically insignificant. HbC and cut-offs indicate that in majority of clusters (9) mild anemia category was predominant. Construction of estimated isoanaems yielded three possible anemia zones (Appendix 5.3). Using HbC cut-off adjustment factor of 1.0 g/dL per 1000m asl yielded a shift of Osiri in Kisumu and Kyatune in Kitui from mild to moderate category. Mwamosioma in Kisii and Rurii in Nyandarua shifted from none/low significance to mild grade category (Table 5.9). The median HbC shift analysis showed marked deficits (1 to 2.28 g/dL) among males in the coastal and semi arid lowlands and lake basin (Appendix 5.4). The midlands and highlands appeared to be relatively stable within a range of -0.5 to 1.2 g/dL from the median.

Table 5.9 Distribution of clusters by severity of anemia and its public health importance among adult males

Sub-region	Grade of anaemia/public health importance			
	Severe/ highly significant [Score8-10]	Moderate/mode-rate to high significance [Score 5-7]	Mild/moderately low significance [Score 2-4)	None/low significance [Score <2]
Lake basin midlands	-	Busia - Sisenye	Kisumu - Osiri Nyando - Kandiang'a	-
Western highlands	-	-	Bungoma - Misikhu	Kisii - Mwamosioma - Birongo Bungoma-Nakhwana
Central and mid west highlands	-	-	Meru - Kibureni	Baringo - Sirwet Meru- Kibaranyaki Nyandarua - Rurii
Dry humid and semi-arid midlands	-	-	Kitui - Kyatune	Baringo - Ng'aratuko Kitui - Wii -
Coastal and semi arid lowlands	-	Garissa' -Korkora/ Elan Mombasa- Utange Kwale - Kifyonzo - Kikoneni	Mombasa - Miritini	-

' - Small number of observations made in Elan and Njabini

5.9 Distribution of anaemia, s-ferritin, s-retinol and s-zinc by health status

The prevalence of pooled anaemia among well males was significantly lower than that among ill ones (34.0% vs 26.4%, P=0.007). There was no significant difference in the distribution of moderate to severe forms (P=0.53). The distribution of various categories of s-ferritin status showed a higher proportion of s-ferritin deficient well than ill males (18.6% *vs* 11.2%). Furthermore, 20% of the well males had moderate to overt excess s-ferritin (Table 5.10). The distribution of s-retinol indicated that a relatively small proportion of males had acute deficiency (Table 5.10). In addition, dropping of the fathers who had parasitaemia or reported recent illnesses did not have profound effects on the distribution of s-retinol. Although not statistically significant, a larger proportion of ill than well adult males were deficient (33.0% *vs* 46.8%). The tendency for toxic concentrations was relatively low (0.6%). In both s-ferritin and s-retinol, the differences between ill and well males were mainly observed in the moderate category of deficiency. There was no significant difference in s-zinc distribution between ill and well adult males (Table 5.11).

Table 5.10: Distribution of s-ferritin and s-retinol status among adult males by presumed state of health

Health status	n	s-ferritin categories (μg/L) and distribution (%)					
		< 12	12-20	>20-40	>40-160	>160-300	> 300
All	164	4.9	11.0	12.8	57.3	10.4	3.7
Well	77	5.2	18.2	10.4	50.6	13.0	2.6
Ill	87	4.6	4.6	14.9	63.2	8.0	4.6
		s-retinol categories (μg/dL) and distribution (%)					
	n	<10	10-20	>20-50	>50-100	>100	
All	618	5.3	37.1	55.3	2.3	0	
Well	207	4.3	32.9	59.4	3.4	0	
Ill	411	5.8	39.2	53.3	1.7	0	

Table 5.11: Distribution of s-zinc status among adult males by presumed state of health

Health status	n	Zinc deficiency risk category, %	
		High: <65 μg/dL	Low: 65-150 μg/dL
All	343	46.1	53.9
Well	117	53.0	47.0
Ill	226	42.5	57.5

5.10 Factors associated with anaemia s-ferritin, s-retinol and s-zinc

The risk factors associated with anaemia are shown in (Table 5.12). There was consistency in the risk factors included in the first and second models. These factors included history of fever, respiratory tract illness and diarrhea and perceived malaria episode. Inclusion of s-retinol in the second model displaced diarrhoea. Marginal association between anemia and sickling was also observed. The significant factors that were associated with s-retinol status and s-ferritin status are shown in Table 5.13. The prominence of HbC is illustrated.

Table 5.12: Results from multivariate model of risk factors for anaemia among adult males

Factor	OR	95% CI	P
Excluding s-retinol (n=828) Recurrent fever	1.81	1.29 - 2.53	<0.001
Parasitaemia	1.53	1.06 - 2.19	0.023
Current diarrhoea	1.57	0.93 - 2.65	0.089
Including s-retinol (n=416) Recurrent fever	1.78	1.06 - 2.99	0.031
Parasitaemia	1.79	1.02 - 3.13	0.043
S-retinol	3.05	1.92 - 4.84	<0.001

5.11 Anaemia and s-ferritin, s-retinol

The proportion of pooled s-ferritin deficient adult males was significantly larger among anemic individuals than non-anemic ones (30.7% *vs* 21.2%). Majority of the anemic individuals (79.2%) had normal or moderate excess s-ferritin concentration. In addition, a larger proportion of non-anemic individuals had moderate to overt excess s-ferritin than anemic ones (22.8% *vs* 11.5%, Table 5.14). With regard to s-retinol, the proportion of deficient anaemic males was about two-fold that of non-anaemic males (56.1% *vs* 24.7%).

Table 5.13: Results from multivariate model of risk factors for s-retinol, s-ferritin and s-zinc deficiency

Factor **S-retinol <20 µg/dL (n=316)**	OR	95% CI	P
Fever	1.92	1.07 - 3.41	0.028
Diarrhoea	2.47	0.95 - 6.45	0.065
Parasitaemia	1.79	0.97 - 3.31	0.063
Hookworm	1.75	1.02 - 3.01	0.044
HbC	3.32	1.92 - 5.71	<0.001
S-ferritin <20 µg/dL (n=124) S-retinol	3.66	1.18 - 11.34	0.025
HbC	2.94	1.001 - 8.64	0.049
S-Zinc < 65 µg/dL (n=223) *S. mansoni*	2.68	1.04 - 6.91	0.042
S-retinol	2.0	1.15 - 3.50	0.015

5.12 Micronutrients overload

HbC overload was observed in 22.7% of adult men (n=1189). Their mean HbC was 16.5 ± 0.8 g/dL. Moderate excess and overt surplus s-ferritin were observed in 14.7% and 5.3% of the pooled sample respectively. The mean s-ferritin for cases with HbC overloads was 77.6 ± 51.9 µg/L (n=36). Only one case of marginal deficiency was observed from the semi arid lowland clusters.

Table 5.14: Distribution of s-retinol, s-ferritin and s-zinc among adult males by anemia status

	Anemia status					
	Normal		Mild		Moderate /Severe	
S-retinol µg/dL	Well n=119	Ill n=293	Well n=37	Ill n=95	Well n=8	Ill n=22
<10	1.7	4.1	5.4	5.3	12.5	31.8
10 - 20	25.2	32.4	48.6	54.7	50.0	59.1
>20 - 50	68.9	61.1	40.5	40.0	37.5	9.1
>50	4.2	2.4	5.4	0	0	0
S-ferritin µg/dL	n=45	n=63	n=15	n=23	-	-
<12	6.7	0	6.7	17.4	-	-
12 - 20	13.3	4.8	26.7	4.3	-	-
>20 - 40	6.7	12.7	6.7	21.7	-	-
>40 - 160	51.1	66.7	46.7	52.2	-	-
>160 - 300	17.8	9.5	13.3	4.3	-	-
>300	4.4	6.3	0	0	-	-
S-zinc µg/dL	n=68	n=162	n=26	n=48	-	n=14
<65	48.5	40.7	63.0	45.8	-	42.9
65 - 150	51.5	59.3	37.0	54.2	-	57.1

CHAPTER 6: HOUSEHOLD SOCIO-ECONOMIC FACTORS, ILLNESSES AND FOOD SECURITY

6.1 Socio-economic factors

6.1.1 Maternal education, family sizes and micronutrient status

Overall, 52.7% and 17% of mothers (n=2740) had obtained upper primary and secondary school education, respectively. Illiterate mothers and those with only lower primary education accounted for 15.2% and 12.7% respectively. Family size ranged between 3 ± 1 persons in Kibureni, (Meru district) to 7 ± 3 persons in Ng'aratuko (Baringo district). Excluding Elan (data not available), three quarters of clusters had an average of 3 to 5 persons per household. The HbC among mothers and children decreased by 0.085 g/dL (P<0.001) and 0.094 g/dL (P<0.001) respectively per additional family member. Similarly, s-retinol concentration among mothers decreased by 0.003 µg/dL (P=0.043) per every additional family member. For s-ferritin, a general decrease with increasing family size was observed but the rate was not significant. Among children, the concentration of s-retinol and s-ferritin also decreased with increasing family size but the rates did not attain statistical significance.

6.1.2. Settlement and assets

On average, land ownership was high in all clusters except those in urban areas, namely Miritini (19.3%) and Utange (34.8%) and clusters that were proximal to shopping centres such as Rurii (Table 6.1). In Korkora and Elan, (Garissa district) and Ng'aratuko (Baringo district) land ownership consideration was not applicable because demarcation is not an issue. In other clusters where land ownership was low, participating households were either renting houses or living on parental land.

In general, the proportions of the households living in own temporary, semi-permanent, permanent and rented residences were 37.7%, 28.1%, 18.9% and 5.3% in that order (n=3303). The proportions of households living in temporary structures ranged between 0.7% in Kibaranyaki and 72.6% in Kikoneni (Table 6.1). Temporary houses were dominant in some of the coastal, lake basin, western highlands and the semi-arid clusters. Kibaranyaki had the lowest number of temporary residences. Semi-permanent houses were more evenly distributed across the clusters. The largest proportions of permanent houses were observed mainly in the midlands and highland clusters and, urban coastal and lake basin clusters respectively.

The proportion of households with a radio ranged between 37.2% and 91.5% (Table 6.1). In addition, in 4 clusters (Kifyonzo, Ng'aratuko, Kyatune and Korkora), the proportion with a radio was less than 50%. In Njabini and Kibaranyaki three quarters and over had a radio. Overall, ownership of a radio was 60.4% (n=3303). Television (TV) ownership ranged between 0% in Korkora and Elan, and 37.3% in Kabaranyaki. The clusters with 10% and over of households owning a TV included Sirwet (11.2%), Utange (15.8%), Miritini (23.0%), Kibaranyaki (37.3%) and Njabini (33.8%). Overall, 8.9% of households owned a TV (n=3303).

6.1.3. Water sources and storage

During dry seasons the dominant source of water (83.6%, n=3174) were wells (25.2%), rivers and springs (23.7%), dam or lake (19.0%) and piped water 15.7%. The remainder sourced water from a combination of these source categories. Roof catchment accounted for only 0.8%. In wet seasons, four main sources of water were indicated, namely wells (14.6%), rivers or springs (11.9%), lake or dam (16.7%), piped water (15.3%) and roof catchment (14.4%). These sources accounted for 72.9%.

The main water storage containers were plastic ware (58.6%) followed by earthen ware jugs (14.1%), and metal drums (3.8%) (n=3208). Use of both earthenware jugs and plastic containers was reported by 14.4% while that of plastic containers and metal drums was reported by 3.6%. Thus, 7.4% of households were likely to store water in a metal drum.

6.2. Health promotive practices

6.2.1. Sanitation

The distribution of households without access to a latrine indicated unsatisfactory coverage in some coastal, semi-arid and lake basin clusters (Table 6.2). Overall, from a pool of 3150 responding households, 30.6% did not have access to a toilet or latrine. 3.5% had access to latrine or toilet but not on regular basis. The remainder 65.9% had regular access to these facilities. In the latter group, the main types of facilities were own pit latrine (87%) followed by communal latrines (11.5%). In addition, 73.4% of the latrine facilities were graded as satisfactorily hygienic (clean) and the remainder as unsatisfactory due to presence of flies filled up faecal matter and/or soiled floors. Furthermore, 11.5% (n=2027) of the households had faecal matter in the compound proximal to their latrine.

6.2.2. Feet protection

Overall, shoe wearing all the time was reported by 45.2% women and 49.0 % men. Wearing shoes all the time was reported by 80% and over of the mothers in only 3 clusters. In 12 clusters, less than 50% of the mothers wore shoes all the time. The proportion of mothers reporting affirmatively about wearing shoes all the time was lowest (7.9%) and highest (91.3%) in Rurii and Utange respectively.

Table 6.1 Distribution of ownership of selected assets by households in different clusters.

Sub-region	Clusters	n	Owned land, %	Te mporary house %	Owned radio	Owned TV
Lake basin midlands	Osiri (Ksm)	185	97.7	63.7	69.3	4.5
	Kandiang'a (Nyo)	187	93.5	24.1	71.3	6.8
	Sisenye (Bus)	188	74.7	71.8	59.8	4.9
Western highlands	Nakhwana (Bun)	251	98.4	57.4	57.6	3.3
	Misikhu (Bun)	207	97.1	48.8	74.9	9.2
	Mwamusioma (Kis)	200	99.0	25.6	64.1	6.6
	Birongo (Kis)	146	73.3	30.1	69.2	8.9
Central and mid west highlands	Sirwet (Bar)	144	92.8	34	65.0	11.2
	Rurii (Nya)	132	54.5	24.2	70.5	8.5
	Njabini (Nya)	84	79.2	7.1	91.5	33.8
	Kibaranyaki (Mer)	142	96.4	0.7	95.0	37.3
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	146	61.7	76	45.1	3.5
	Kibureni (Mer)	157	73.8	32.5	55.2	4.3
	Kyatune (Kit)	182	92.8	3.8	40.5	3.3
	Wii (Kit)	144	92.4	4.2	54.9	8.3
Coastal and semi arid lowlands	Elan (Gar)	***4***	***0***	***4***	***0***	***0***
	Kikoneni (Kwa)	201	91.5	72.6	59.5	6.0
	Kifyonzo (Kwa)	225	95.5	51.6	37.2	3.4
	Miritini (Msa)	187	19.3	27.8	70.4	23.0
	Utange (Msa)	183	34.8	15.9	62.0	15.8
	Korkora (Gar)	***22***	***1***	***10.0***	***2.0***	***0***
Total		**3317**	**80.0**	**46.4**	**60.4**	**8.9**

Others either did not wear shoes at all or wore them intermittently. Overall, 45.0 % (n=2225) of mothers reported that they wore shoes all the time. The proportion of fathers who wore shoes all the time ranged between 11.8% in Kifyonzo and 85.3% in Wii. Less than 50% of the fathers in 9 clusters either wore shoes intermittently or none at all. Overall 48.9% (n=2059) of fathers wore shoes all the time. Among children, the proportion of those wearing shoes all the time ranged between 3.8% and 52.2%. In 11 clusters the proportion in this category of children was 20% and below. Overall, 22.5% (n=2187) of children wore shoes all the time.

6.2.3. Availability and use of bed nets

Overall, 18.3% (n=3052) of households had one or more bed nets (Table 6.2). The proportion of households with bed nets ranged between 1.4% (n=140) in Sirwet and 56% in Miritini. At sub-regional level, the households with nets ranged from 14.6% to 56% (n=182) in the coastal clusters, 16.8% to 46.2% in the lake basin, 5.0% to 9.9% in the western highlands, 1.4% to 3.7% in the central and mid-west highlands and 2.8% to 12.9% in the dry humid and semi-arid midlands. 22 responding households in Garissa district indicated that they all had bed nets.

Among the households with bed nets 64.8% and 25.4% (n=559) had one and two bed nets respectively. The highest number of bed nets (6) in a household was recorded in Kikoneni cluster. 91.7% of bed nets had been purchased while the remainder had been donated or acquired as gifts. Kikoneni had the largest proportion of (26.7%) of donated bed nets (n=60). While 10.9% bed nets had been treated with insecticides at the time of acquisition, the proportion retreated during the preceding 6-12 months was 13.8%. The nets were mainly used by children alone or with mother (35.2%) by mother with or without father (17.2%) or by all three (28.1%).

6.3. Household illnesses and care seeking practices

6.3.1. Illnesses

Malaria was reported as the leading illness and perceived to be the greatest health concern by all the clusters except Njabini (27.8% n=36) and Sirwet (35.7%, n=56). In the former clusters, the proportion ranged between 61.5% and 95.2% of reporting households. In Njabini and Sirwet, respiratory tract diseases were cited as the main illness of concern by 33.3%. Overall, 83.3% of households were concerned with malaria (n=1984). Respiratory tract diseases (6.0%) and diarrheal diseases (3.8%) were second and third commonest concerns in that order.

Table 6.2: Distribution of availability of latrines and bed nets by clusters.

Sub-region	Clusters	Proportion without latrines		Proportion with bednet(s)	
		n	%	n	%
Lake basin midlands	Osiri (Ksm)	168	54.8	176	31.2
	Kandiang'a (Nyo)	175	3.4	182	46.2
	Sisenye (Bus)	166	65.7	173	16.8
Western highlands	Nakhwana (Bun)	243	22.6	245	6.1
	Misikhu (Bun)	203	2.0	201	5.0
	Mwamusioma (Kis)	195	4.6	194	7.2
	Birongo (Kis)	145	0.7	131	9.9
Central and mid west highlands	Sirwet (Bar)	136	38.2	140	1.4
	Rurii (Nya)	131	2.3	109	3.7
	Njabini (Nya)	72	0	***21***	***1.0***
	Kibaranyaki (Mer)	141	0	127	2.4
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	123	86.2	144	2.8
	Kibureni (Mer)	145	7.6	113	8.1
	Kyatune (Kit)	180	53.3	178	5.1
	Wii (Kit)	143	18.2	139	12.9
Coastal and semi arid lowlands	Elan (Gar)	***2***	***2.0***	***4***	***4.0***
	Kikoneni (Kwa)	201	55.2	201	29.9
	Kifyonzo (Kwa)	221	92.8	206	14.6
	Miritini (Msa)	179	14.5	182	56.0
	Utange (Msa)	163	19.0	168	55.2
	Korkora (Gar)	***18***	***18.0***	***18***	***18.0***
Total		3150	30.6	3052	18.3

6.3.2. Choice of health care providers

Shops and kiosks were the main source of first level health care provision for majority of households (50.8%, n=2631) followed by public facilities (30.4%). Private providers (clinics, nursing homes and pharmacies) and mission facilities accounted for 12.4% and

1.6% respectively. Community pharmacies and traditional healers were cited by 2.6% and 1% of households respectively. In the event of perceived non-recovery, the following providers were consulted, public facilities by 66.1%, private facilities (clinics, nursing homes and pharmacies) by 21.6%, mission facilities by 6.6% and traditional healers by 1.5%. The distance to the usual providers of formal health care was less than 2 km, 3-5 km and >5 km for 34.5%, 39.5% and 26% (n=3016) of the households in that order. Between 59.3% and 73.8% of residents in Kifyonzo, Ng'aratuko, Sisenye and Rurii traveled for more than 5 km to their usual health facility. In contrast, between 45.1% and 72.4% of households in Utange, Miritini, Osiri, Nakhwana, Sirwet and Mwamosioma traveled for less than 2 km to their usual health provider.

6.4. Food security and dietary practices

6.4.1. Sources of food

With exception of clusters in the lake basin, semi-arid areas (Ng'aratuko and Korkora) and the coastal (urban clusters), the dominant source of staple food was household's own farm (Table 6.3). In these clusters, food was mainly purchased from the shops and markets. With regard to sufficiency of farm yields, only Kibaranyaki (97%) and Njabini (92%) in the central highlands reported significant adequacy. All other clusters reported between 15% and 60% sufficiency levels of their farm yields.

The source of vegetables was mainly from own farm in majority of the households (Table 6.3). Overall, about one-third of households purchased vegetables and staple foods. The household's farm was the dominant source of fruits in the following clusters, Kifyonzo (69.3%), Kikoneni (93.7%), Osiri (61.8%), Misikhu (63.4%) and Nakhwana (79.5%). In other clusters fruits were mainly purchased by the following proportions Utange (78.9%), Miritini (100%), Kandiang'a (81.3%), Ng'aratuko (81.6%), Sisenye (81.9%), Rurii (82.0%), Njabini (63%), Wii (63.8%), Kyatune (73.9%), Birongo (87.1%), Mwamosioma (92.4%) and Korkora (7/9). In the remaining 3 clusters in Meru and Baringo districts, the ratios of households that obtained fruits from their farms to those purchasing were comparably the same.

6.4.2. Meal consumption patterns

Based on responses of whether breakfast or lunch or supper were always or sometimes available, variables describing stability were constructed. A stable household was considered to be one that reported to always consume the meals under consideration. Households where consumption of a given meal was reported to be 'sometimes' were classified as unstable. Furthermore, in case only lunch or supper was always consumed, these households were considered chronically unstable.

Table 6.3 Distribution of household's food sources and perceived sufficiency.

Sub region	Clusters	Staple food sources				Vegetable sources			
		n	Own farm	Buy	Farm + Buy	n	Farm %	Buy + farm %	Wild %
Lake basin midlands	Osiri (Ksm)	178	41.6	26.4	32.0	166	53.4	46.1	0.6
	Kandiang'a (Nyo)	183	24.0	76.0	0	179	24.0	76.0	0
	Sisenye (Bus)	168	54.8	36.9	8.3	170	22.4	74.1	3.6
Western highland s	Nakhwana (Bun)	244	69.3	10.2	20.5	241	72.2	26.9	0.8
	Misikhu (Bun)	201	80.1	5.0	14.9	200	79.0	20.5	0.5
	Mwamosioma (Kis)	200	66.5	16.5	17.0	198	39.9	60.1	0
	Birongo (Kis)	147	91.2	8.2	0.7	147	81.0	19.0	0
Central and mid west highland s	Sirwet (Bar)	134	72.4	21.6	6.0	132	35.6	61.4	3.0
	Rurii (Nya)	134	81.3	18.7	0	131	67.9	31.3	0.8
	Njabini (Nya)	70	78.6	14.3	7.1	60	75.7	24.2	0
	Kibaranyaki (Mer)	138	99.3	0.7	0	137	93.4	5.8	0.7
Dry humid and semi arid midlands	Ng'aratuko (Bar)	140	18.6	69.3	12.1	139	3.6	66.9	29.5
	Kibureni (Mer)	140	76.4	17.9	5.7	140	41.4	54.3	4.3
	Kyatune (Kit)	180	87.2	12.2	0.6	177	35.6	61.6	2.8
	Wii (Kit)	143	90.9	7.7	1.4	139	26.6	73.4	0
Coastal and semi arid low lands	Elan (Gar)	***4***	***2***	***2***	***0***	***4***	***0***	***4***	***0***
	Kikoneni (Kwa)	200	62.0	29.5	8.5	192	68.9	28.9	7.3
	Kifyonzo (Kwa)	89	55.1	12.4	32.6	90	68.9	28.9	2.2
	Miritini (Msa)	184	1.1	96.7	2.2	***7***	***1***	***6***	***0***
	Utange (Msa)	184	7.6	90.8	1.6	156	7.76	92.3	0
	Korkora (Gar)	33	6.1	93.9	0	26	11.5	84.6	3.8
Overall		3094	58.8	32.2	9	2853	49.8	38.3	2.8

Breakfast

Overall, 68.2% of households (n=2628) reported that they always had breakfast irrespective of the season. The distribution ranged between 100% in Korkora and Kibureni to 17.2% in Sisenye (Table 6.4). Among breakfast stable households, 78.5% (n=1751) were also stable with respect to consumption of lunch and supper.

Lunch and supper

Overall, 66% reporting households (n=2511) were stable with respect to availability of lunch and supper. 19% and 15% of the households were unstable and chronically unstable respectively (Table 6.4). Only Kibaranyaki in Meru indicated stability in all responding households (100%). Ng'aratuko in Baringo reported lowest stability (15.8%). It is note worthy that both Kikoneni, Kifyonzo and Korkora were receiving food aid for the more vulnerable households. In addition, key informants in Osiri and Misikhu reported unstable food availability in many homes at the time of the survey.

With regard to food security and childhood anaemia for those aged 4 months and above, anaemia was more likely to occur in households that were seasonally unstable (1) and those that were chronically unstable (2). Similarly, the likelihood of maternal anaemia was higher in seasonally unstable households (3) and chronically unstable households (OR=1.27, 95%CI:0. 99-1.63). There was no obvious association between food security status and anaemia among adult males.

Table 6.4. Household's food security based on meat availability

Sub region	Clusters	n	Lunch and supper			Breakfast		
			Stabl e	Unstabl e	Chroni-cally unstable	n	Stabl e	Unstabl e
Lake basin midlands	Osiri (Ksm)	157	40.1	28.0	31.8	178	60.7	39.3
	Kandiang'a (Nyo)	179	90.5	5.1	4.6	181	86.7	13.3
	Sisenye (Bus)	161	59.0	30.4	10.6	174	17.2	82.8
Western highland s	Nakhwana (Bun)	233	73.0	18.9	8.2	242	39.3	60.7
	Misikhu (Bun)	199	57.8	29.1	13.1	204	71.6	28.4
	Mwamosioma (Kis)	198	77.8	14.6	7.6	199	83.4	16.6
	Birongo (Kis)	142	72.5	16.2	11.3	145	74.5	25.5
Central and mid west highland s	Sirwet (Bar)	94	31.9	23.4	44.7	105	47.6	52.4
	Rurii (Nya)	118	78.8	13.6	7.6	124	72.6	27.4
	Njabini (Nya)	56	80.4	10.7	8.9	57	89.5	10.5
	Kibaranyaki (Mer)	140	100	0	0	140	100	0
Dry humid and semi arid midlands	Ng'aratuko (Bar)	101	15.8	36.6	47.5	119	20.2	79.8
	Kibureni (Mer)	138	86.2	2.9	10.9	143	97.2	2.8
	Kyatune (Kit)	173	59.5	32.9	7.5	181	72.4	27.6
	Wii (Kit)	138	82.6	8.7	8.7	140	85.7	14.3
Coastal and semi arid low lands	Elan (Gar)	**3**	**3**	**0**	**0**	**4**	**4**	**0**
	Kikoneni (Kwa)	194	49.5	26.3	24.2	195	75.9	24.1
	Kifyonzo (Kwa)	61	41.0	18.0	41.0	64	79.7	20.3
	Miritini (Msa)	NR	-	-	-	-	-	-
	Utange (Msa)	NR	-	-	-	-	-	-
	Korkora (Gar)	33	45.5	21.2	33.3	33	100	0
Overall		2518	66.0	19.0	15.0	2628	68.2	31.8

NR= No Response

6.4.3 24-hour dietary intake

Overall, 96.9% of households (n=327) in 11 districts had taken breakfast during the previous 24 hours (Table 6.5). Tea, porridge or both were consumed by 24%, 38.8% and 18.6% respectively. Milk was added to these drinks in about 50% of households. No milk consumption was reported in Kwale and Busia clusters. The following order of sources of milk was reported; cow (68.8%), goat (29.2%) and camel (2%). Sugar was added to breakfast drinks by between 28.6% and 95.2% of the households. Overall, 77.2% of households consumed sugar during breakfast.

Table 6.5: Frequency distribution of foods and beverages consumed during breakfast.

District	n	Proportion that had meal %	Types of foods and beverages, %						
			Cereals	Milk	Beverages		Sugar	Fruits	Tubers
					Tea	Others			
Mombasa	40	100	80.0	15.0	88.0	0	87.5	22.5	0
Kwale	24	92.9	100	0	46.0	0	28.6	23.1	0
Garissa	24	100	66.7	100	100	0	95.2	0	0
Kitui	40	90.0	83.3	30.6	42.0	5.6	76.9	2.8	0
Nyandarua	19	100	94.7	89.5	68.0	0	65.0	15.8	10.5
Meru	25	100	88.0	64.0	40.0	0	68.0	0	4.0
Baringo	45	97.8	84.1	56.8	48.0	0	86.7	0	4.5
Kisii	33	100	100	42.4	21.0	6.1	63.6	0	3.0
Kisumu	24	95.8	91.3	73.9	74.0	0	80.0	4.3	13.0
Bungoma	42	92.9	94.9	71.8	69.0	2.6	78.6	0	33.3
Busia*	21	100	100	0	9.5	0	90.5	38.1	19.0
Overall	327	96.9	88.3	49.8	56.0	1.6	77.2	7.9	8.2

* In Busia, lemons which were used for porridge preparation.

Supper was a slightly more common meal than lunch (88.1% *vs* 85.0%). With exception of Garissa and Kitui clusters 75% and over of the households in the other clusters had taken both lunch and supper (Table 6.6). In these meals, the main food types were cereals, vegetables and tubers. Maize was the principal staple (89.9%) followed by wheat (10.7%) sorghum (9.8%) and millet (6.4%).

Table 6.6: Distribution of meals and foods types consumed in a 24 hour-recall period from a sample of districts.

District / Meals	n	Propo r-tion that had meal (%)	Food types (%)								
			Cereals	Tubers	Animal flesh & products			Pulses/ legumes	Vegetables	Cook-ing fat	Fruits
					milk	meat	others				
Lunch											
Mombasa	40	95.0	84.2	18.4	0	13.2	23.7	5.3	65.8	52.6	21.1
Kwale	14	85.7	88.6	41.7	0	8.3	33.3	0	8.3	25.0	16.7
Garissa	24	66.7	87.7	0	84.2	52.6	0	21.1	0	47.7	5.3
Kitui	40	65.0	78.8	7.7	0	4.2	0	33.3	25.0	37.5	0
Nyandarua	19	94.7	100	88.9	88.9	5.6	5.6	55.6	77.8	72.2	16.7
Meru	25	92.0	87.0	87.0	0	4.8	0	52.4	66.7	52.4	33.3
Baringo	45	75.6	85.3	8.8	21.1	2.6	0	26.3	26.3	31.6	5.3
Kisii	33	87.9	100	0	41.4	13.8	3.4	34.5	100	89.7	10.3
Kisumu	24	91.7	90.9	13.6	21.1	10.5	42.1	31.6	73.7	78.9	10.5
Bungoma	42	95.2	92.5	47.5	70.0	7.5	22.5	77.5	60.0	65.0	5.0
Busia	21	95.2	96.4	70.0	5.0	0	90.0	0	10.0	0	0
Overall	327	85.0	92.1	32.0	30.6	10.4	18.0	33.1	50.0	51.8	10.8
Supper											
Mombasa	40	90.0	83.3	22.2	7.9	5.3	31.6	21.1	55.3	39.5	7.9
Kwale	14	92.9	90.7	46.2	0	7.7	7.7	7.7	0	7.7	0
Garissa	24	91.7	4.5	0	100	0	0	0	0	0	0
Kitui	40	85.0	82.4	11.8	0	2.7	0	51.4	43.2	51.4	8.1
Nyandarua	19	89.5	94.1	88.2	5.9	0	0	41.2	64.7	0	5.9
Meru	25	92.0	87.0	87.0	0	0	0	57.1	38.1	71.4	0
Baringo	45	91.1	82.9	14.6	7.9	18.4	7.9	2.6	55.3	42.1	7.9
Kisii	33	81.8	100	0	14.8	11.1	3.7	7.4	66.7	51.9	0
Kisumu	24	83.3	95.0	10.0	20.0	0	30	25	35.0	10.0	0
Bungoma	42	83.3	91.7	54.3	40.6	12.5	28.1	6.3	81.3	56.3	0
Busia	21	95.2	100	76.4	4.8	0	85.7	4.8	4.8	0	0
Overall	327	88.1	91.0	33.0	17.8	6.3	17.5	20.3	45.1	35.0	3.5

In Garissa sources of milk include: - goat milk (75%), cow (15%), and camel (10%). Variation in the consumption of vegetables and tubers across the country was evident. Overall, about half of the households had consumed vegetables once or twice during the preceding 24 hr-period. Kales (*sukumawiki*) (21.7%) followed by cabbages (7.3%) were the most commonly consumed vegetables. Overall, cooking fat/oils were consumed by between 8.0% and 51.8% (n=324) households during breakfast and supper respectively. The fruits mainly consumed included mangoes, oranges and bananas as reported in the coast and highlands, and lemons in the lake basin especially Busia.

Milk consumed during breakfast was the most common animal product (Table 6.7). Overall, red meats were mainly consumed in the highlands and midlands. Fish consumption was mainly reported in Busia, Kisumu, Kwale, Bungoma and Mombasa. While the highest intake of meat and milk were observed in Garissa the highest intake frequency of fish was observed in Busia.

Overall, 94.5% and 34.9% households consumed cereals and tubers respectively at least once (Table 6.7). 71.9% and 30.6% of households consumed sugar and cooking fats/oils at least once respectively. Animal flesh and fruits were consumed at relatively lower frequencies of 22.8% and 26.8% respectively.

Table 6.7: Frequency of intake of main food types consumed over a 24 hr period.

Frequency	Proportion of households (%) by food types (n = 327)									
	Cereals	Tubers	Animals products and produce			Pulses/ legumes	Vegeta -bles	Fruits	Sugar	Fats
			milk	meat	others *					
1	18.7	20.2	22	10.1	13.1	35.5	36.1	14.1	71.9	30.6
2	44.3	12.2	19.2	2.8	8.9	7.0	24.8	1.8	6.7	32.7
3	31.5	2.4	10.8	0	0	0	0	0.9	0.3	4.3
None	5.5	65.1	48.0	87.2	78.0	57.5	39.1	83.2	21.1	32.4

* This group consists include fish, chicken, and poultry products.

Based on available reference data the iron: calorie density ratios of millet and black night-shade *(Solinium nigrum)* are 6-fold and over those of the other reported foods (Table 6.8). In addition, the phytate: calorie density ratios are relatively uniform with exception of potatoes, mangoes and wheat. While the range of iron: calorie densities of animal products is comparable to that of commonly consumed cereals and markedly lower than that of pulses and legumes, their phytate: calorie density is nil.

Table 6.8: Distribution iron and phytate densities of commonly consumed foods stuffs.

Food types		Iron to calorie ratio[R] (x : 100)	Phytate to calorie ratio[R] (x: 100)
Cereals	Maize	1.1	6
	Millet	20.0	7
	Wheat	2.0	11
	Rice	0.5	2
Tubers	English potatoes	1.9	19
	Cassava	0.8	4
Animal products	Beef	1.6	0
	Fish	1.4	0
	Chicken	0.7	0
Vegetables	*Sukuma wiki*	3.5	1
	Cabbage	1.4	1
	B. night shade	23.0	7
Pulses	Beans	3.5	6
	Peas	3.3	8
Fruits	Mangoes	2.0	43
	Oranges	0.7	1
	Paw paw	0.4	3

□ **R** - reference values obtained from Sehmi et al- National food composition tables and planning of satisfactory diets in Kenya, MoH, 1993.

Iron and phytate intake: Among mothers, low intake based on the mean iron: calorie ratio for four districts was comparable. The ratio for Garissa was about half that of other sample districts (Table 6.9). The iron: phytate ratio ranged between 0.058 (5.8%) in Meru to 0.447 (44.7%) in Mombasa.

Table 6.9: Distribution of estimated 24- hour mean iron, vitamin C and protein intake, and corresponding iron and phytate densities

District/ Population group	n	Mean intake, mg			Nutrient and inhibitor densities	
		Iron	Vitamin C	Protein	Iron: calorie, %	Iron: phytate, %
Mothers Mombasa	38	31.2 (14.2)	94 (77)	298 (348)	1.7(0.8)	44.7 (72.4)
Kitui	38	46.2 (25.5)	74 (77)	60 (28)	1.5 (0.6)	24.7 (18)
Garissa	20	17.3 (15.2)	33 (95)	43 (23)	0.7 (0.4)	14.9 (10.1)
Meru	22	83.1 (60.1)	315 (262)	158 (69)	1.7 (0.8)	5.8 (7)
Baringo[1]	20	40.3 (48.9)	58 (92)	48 (28	1.9 (2.3)	25.5 (45.2)
Baringo[2]	21	21.0 (22.9)	69 (144)	95 (243)	1.7(3.9)	13.9 (13.9)
Fathers Mombasa	31	27.8 (16.4)	104 (194)	241 (394)	1.7 (0.8)	31 (25.6)
Kitui	32	30.3 (16.1)	71 (86)	43 (27)	1.4 (0.6)	23.6 (15.7)
Garissa	20	25.3 (12.1)	53 (102)	62 (37)	0.9 (0.5)	15.2 (9.5)
Meru	23	81.9 (75.0)	288 (224)	141 (79)	2.1 (2.1)	10 (15.2)
Baringo[1]	20	50.0 (77.6)	64 (112)	47 (30)	1.9 (2.2)	24.1 (34.3)
Baringo[2]	16	25.3 (15.5)	118 (130)	175 (65)	1.4 (1)	16.2 (32.6)
Children Mombasa	35	10.9 (8.3)	43 (85)	112 (194)	2 (1)	49 (74)
Kitui	37	20.1 (12.9)	31 (36)	24 (15)	2 (1)	25 (19)
Garissa	20	11.6 (14.4)	7 (15)	28 (24)	1 (0)	14 (10)
Meru	23	30.0 (25.6)	111 (124)	56 (38)	2 (1)	8 (9.4)
Baringo[1]	20	18.1 (24.8)	23 (36)	19 (13)	2 (2)	23 (32)
Baringo[2]	22	8.7 (10.4)	34 (65)	22 (19)	1 (2)	14 (12)

Baringo 1 - Sirwet; 2 - Ng'aratuko

The distribution of mean 24-hour intakes among fathers was similar to that of mothers. With regard to iron: calorie ratio, Meru had the highest (0.021) and Garissa the lowest (0.009). The lowest iron: phytate ratio was observed in Meru (0.1) and the highest in Mombasa (0.31). Large variation in mean potential vitamin C and protein intake was evident but the highest potential for sufficient intake was observed in Meru. Mombasa exhibited the widest scatter in protein consumption.

The mean iron intake based iron nutrient density was relatively uniform except for

Garissa and Baringo's Ng'aratuko cluster. The highest phytate inhibitor density observed in Meru was attributed to consumption of tubers (Table 6.5).

6.4.4. *Consumption of tea and coffee*

These beverages were taken predominantly at breakfast time (75.4% in Njabini to 95.9% in Kikoneni). The beverages were seldom taken along with or just after main meals by between 0% (n=201) in Kifyonzo and 16.5% (n=127) in Rurii clusters. In 14 clusters the proportion of households consuming tea or coffee along with meals ranged between 0.5% and 4.3%. Significant proportions of households consuming these beverages along with main meals were observed in the following clusters: Sirwet 5.2% (n=134), Mwamosioma (8.1%, n=198), Njabini (11.5%, n=69), Kibureni (13.7%, n=139) and Rurii (16.5%, n=127). There was no significant association between reported tea/coffee consumption with meals and occurrence of anemia.

6.5. Types of cooking pots

Use of aluminum, iron, copper and earthenware pots was reported across the sampled clusters. At a reporting level of 76.8% and over in all clusters, the dominant type of pot was aluminum (78.8% to 100%). In Nakhwana and Osiri, iron pots were reported by 14.2% (n=141) and 11.6% (n=146) respectively. In 6 other clusters, 1 to 2 households reported use of iron pots. Use of copper pots, was reported only in Nakhwana (4.3%). Earthenware pots were used by between 0.8% and 16.4% households in 9 clusters. While 7 clusters reported use of earthenware pots by 5.3% and below, Osiri and Wii clusters reported their use by 7.5% and 16.4% of the households respectively.

6.6. Intra-households nutrition and infection status

6.6.1 *Household anemia*

Anemia: Household HbC data representing at least 2 individuals per household was available in 3162 households. These consisted of 3118 mother-child pairs, 934 father-child pairs and 904 mother-father pairs.

The percentage co-occurrence of anemia among affected mothers-child pairs ranged between 9.7% in Njabini and 94.6% in Korkora (Table 6.10). The levels of co-occurrence among father-child pairs ranged between 0% and 54.2%, those of the mother-father pairs ranged between 0% and 49.1%. Overall the following percentage co-occurrence levels were observed: 51.2% (n=3118) for mother-child pairs, 31.2% (n=893) for father-child pairs and 59.5% (n=865) for mother-father pairs.

Table 6.10. Distribution of % co-occurrence within household's anemia by cluster.

Sub-region	Clusters	Mother - child		Mother - father	
		n	%	n	%
Lake basin	Osiri (Ksm)	174	67	31	45.2
	Kandiang'a (Nyo)	169	66.3	39	41.0
	Sisenye (Bus)	168	61.9	55	45.5
Western highlands	Nakhwana (Bun)	213	48.4	78	28.2
	Misikhu (Bun)	146	38.4	24	16.7
	Mwamosioma (Kis)	162	47.5	44	20.5
	Birongo (Kis)	92	19.8	***6***	***1***
Central and mid west highlands	Sirwet (Bar)	84	20.2	0	0
	Rurii (Nya)	47	10.6	0	0
	Njabini (Nya)	31	9.7	0	0
	Kibaranyaki (Mer)	65	16.9	0	0
Dry humid and semi-arid midlands	Ng'aratuko (Bar)	80	37.5	20	5
	Kibureni (Mer)	123	43.9	38	23.7
	Kyatune (Kit)	139	36.7	***6***	***2***
	Wii (Kit)	96	21.9	***0***	***0***
Coastal and semi arid lowlands	Elan (Gar)	41	78.1	***2***	***1 .0***
	Kikoneni (Kwa)	192	56.8	22	50.0
	Kifyonzo (Kwa)	160	65.0	53	49.1
	Miritini (Msa)	138	71.7	20	35.0
	Utange (Msa)	102	60.8	49	26.5
	Korkora (Gar)	93	94.61	***21***	***10 .0***

6.6.2 Maternal-child malnutrition

Findings on mother-child nutrition status were available for 2,551 households. Among mother-child pairs, the percentage co-occurrence of low BMI and stunting ranged between 4.6% and 23.0%. A marked increase in percentage co-occurrence was observed when underweight and low BMI were considered. In one third of clusters, malnutrition affected between 20.8 and 33.3% of mother-child pairs. Overall occurrence of wasting and low BMI had lower percentage co-occurrence than underweight.

6.6.3. *Malaria*

Malaria parasitaemia for paired household observations was available from 2978 households. The percentage co-occurrence between mother-child pairs ranged between 9.4% and 40.4%. With exception of Birongo, all clusters in the lake basin and western highlands had percentage co-occurrence of between 24.8% and 40.4%. The percentage co-occurrence levels for the father-child pairs ranged between 7.1% and 46.5%. Among mother-father pairs, percentage co-occurrence was relatively low.

6.6.4. *Hookworm*

The percentage co-occurrence between child-mother pairs infected with hookworm varied between 2.7% and 26.0%. Significant occurrence was observed in Nakhwana, Kifyonzo and Mwamosioma. Among father-child pairs, the percentage co-occurrence levels were relatively uncommon. Among mother-father pairs, percentage co-occurrence ranged between 28.1% and 75.9%. The overall percentage co-occurrence was among mother-child pairs, and mother-father pairs.

6.7 Factors associated with household anaemia

The final multivariate regression model for childhood anaemia (Table 6.11) included practically all independent variables that were included in the population specific analysis. Retention of household details, namely family size and food security in the dry season (without s-retinol) and maternal HbC status underlined their significance. A dominance of splenomegaly and comparable ratios of parasitaemia, household food availability and maternal anaemia were also significant. S-retinol was only retained in the model after removal of maternal HbC status.

Table 6.11: Results from multivariate model of risk factors for childhood anaemia

Factor	OR	95% CI	P
Without s-retinol <20Fg/dL (n=1340) Morbidity >4 episodes	2.31	1.53 - 3.47	<0.001
Malaria parasitaemia	2.27	1.68 - 3.07	<0.001
Splenomegaly	4.18	2.70 - 6.47	<0.001
Maternal anaemia	2.15	1.67 - 2.74	<0.001
Family size ≥ 6	1.59	1.19 - 2.09	0.001
Family size ≥ 4 - 5	1.4	1.03 - 1.88	0.03
Dry season: one meal/day	2.36	1.75 - 3.17	<0.001
Dry season: 1or 2 meal(s)/day	1.47	1.04 - 2.06	0.027
With s-retinol, (n = 447) Morbidity >4 episodes	3.27	1.61 - 6.58	0.001
Malaria parasitaemia	2.88	1.68 - 4.94	<0.001
Splenomegaly	6.35	2.85 - 14.14	<0.001
Maternal anaemia	2.64	1.66 - 4.21	<0.001

In the model for maternal anaemia, availability of meals during both wet and dry seasons was strongly associated with anaemia (Table 6.12). The inclusion of hookworm infection and dropping out of the effects of food availability in the wet season upon inclusion of s-retinol in model construction were observed.

Table 6.12: Results from multivariate model of risk factors for maternal anaemia

Factor	OR	95% CI	P
Without s-retinol (n = 1501) Morbidity >4 episodes	2.02	1.33 - 3.09	0.001
Malaria parasitaemia	1.31	1.05 - 1.64	<0.016
Hookworm	1.43	1.14 - 1.72	<0.001
Dry season - one meal/day	1.52	1.06 - 2.21	0.026
Wet season - one meal/day	1.59	1.07 - 2.38	0.025
With s-retinol (n = 784) Morbidity >4 episodes	2.15	1.14 - 4.75	0.018
Malaria parasitaemia	1.56	1.06 - 2.41	0.025
Hookworm	1.67	1.19 - 2.32	0.003
S- retinol	2.65	1.95 - 3.61	<0.001
Dry season one meal/day	1.59	1.10 - 2.03	0.015

Upon inclusion of household variables, H*ookworm* infection and availability of meals during the wet season were retained in the model for adult males (Table 6.13). Inclusion of s-retinol in model construction resulted in dropping of the other variables except morbidity >4 episodes.

Anaemia in mother-child and mother-father pairs

In the final household model for anaemia, the following factors were associated with mother-child anaemia (n=2762): family size ≥ 4 (OR=1.48, 95% CI: 1.11 - 1.96), consumption of only one meal per day during dry season (OR=1.73, 95% CI: 1.33 - 2.24) and weekly consumption of animal flesh (OR=0.61, 95% CI: 0.47 - 0.78). With regard to mother-child s-retinol status (n=694), deficiency associated factors were family size ≥4 (OR=1.68, 95% CI: 1.17 - 2.43) and weekly consumption of animal flesh (OR=0.58, 95% CI: 0.42 - 0.79). In the case of s-ferritin, only weekly consumption of animal flesh was retained but it was not statistically significant.

The % co-occurrence among mother-father pairs was as follows; anaemia 32.8 %, s-retinol deficiency 44.8%, s-ferritin deficiency (<40 μg/dL) 32.1%, hookworm infection 45.2% and malaria parasitaemia 19.3%. In the case of mother-father anaemia (n=824), significant association with consumption of only one meal per day during the dry season was evident (OR=1.69, 95% CI: 1.15 - 2.48). In the case of s-retinol deficiency, consumption of only one meal per day and weekly consumption of animal flesh were significantly associated. Only consumption of animal flesh (weekly) was retained in the model for s-ferritin deficiency but it was not statistically significant.

Table 6.13: Results from multivariate model of risk factors for adult male anaemia.

Factor without s-retinol (n=376)	OR	95% CI	P
Morbidity >4 episodes	5.04	2.68 - 9.49	<0.001
Hookworm	1.84	1.12 - 3.03	0.017
Wet season - one meal /day	1.7	1.09 - 2.64	0.018
With s-retinol (n = 190) Morbidity >4 episodes	5.02	1.93- 13.06	0.001
S - retinol	4.12	1.89 - 8.98	<0.001

CHAPTER 7: HEALTH SERVICE PROVISION

Anemia incidence and interventions

In this chapter, a review of annual workload statistics form the Health Information Systems of MoH during the period 1995 to 1999 and findings from a sample of districts that participated in the survey are presented.

7.1 Anemia in public facilities

Out patients: From averages of two to five years for 60 districts, the proportion of anemia diagnosis reported by public facilities in various districts ranged between 0.03% in Marakwet and 3.5% in Kwale. Districts in the North Eastern and the Coast provinces had the largest proportion of diagnosis (1.2% to 3.5%) while districts occupying the central and mid-west highlands had the lowest proportion of diagnosis (0.03 to 0.37%). The distribution of anemia incidence falls into three dominant regions and the rates decrease radially towards the central highlands (Appendix 7.1). This pattern was partly comparable to HbC distribution isoanaems derived from the survey findings of children and mothers.

In-patients: The numbers of districts reporting ranged between 22 and 42 over a four-year period. The incidence varied widely with Nairobi, Kiambu, Kwale, Taita Taveta, Embu, Kisumu, Bungoma, Busia and Kakamega reporting consistently between 502 and 1682 cases annually over a two to four years period. West Pokot and Kisii Districts reported 534 and 2631 cases respectively during 1999. The overall case fatality rate ranged between 15.7% in 1996 and 18.2% in 1999. During the period under review, the district case fatality rate ranged from 1.41% in Tana River to 55.3% in Kiambu. An upward trend case fatality rate was evident only in Nairobi.

7.2 Leading diagnoses in survey district facilities

In all 24 facilities that were drawn from 7 districts (Nyando, Bungoma, Kwale, Kitui, Meru and Garissa), malaria was the leading among the 5 top diagnoses. Upper respiratory tract infection was the second commonest diagnosis in all other districts excluding Nyando. Anemia was the second and third commonest diagnosis in Nyando, Kwale and Garissa respectively. In Kitui, anemia was the fifth commonest diagnosis. Intestinal worms and diarrhea were reported among the top 5 diagnoses in 6 and 2 districts respectively. Malnutrition was reported only in Nyando and Garissa districts.

Table 7.1: Distribution of age groups of outpatients attending health facilities by district

District/year	Age group	Proportion, %	
		Public	Private
Bungoma, 1997 n=82,038	<5 years	17.6	-
	Women	45.3	-
	Men	42.1	-
Baringo, 1998 n=7,193	<5 years	-	39
	Women	-	35.9
	Men	-	25.1
Kwale, 1997 n=31,718	<5 years	17.5	-
	Women	48.5	-
	Men	33.4	-
Garissa, 1998 n=10,677	<5 years	19.4	-
	Women	56.6	-
	Men	24.1	-
Kitui, 1998 n=84,974	<5 years	8.8	-
	Women	40.9	-
	Men	50.3	-

From workload analysis of the sample facilities in 5 districts (Bungoma, Baringo, Kwale, Garissa and Meru) the contribution of malaria ranged between 19.7% (n=81,947) in Kwale and 54.6% (n=377,121) in Meru. The proportion of reported anemia among outpatients ranged between 0.2% in Kitui (n=55,285) and 4.2% (n=12,735) in Baringo. In the other districts the proportions were in the order of 1.5% to 1.7%. Intestinal worms were indicated in between 2.1% of patients in Bungoma and 26.4% of patients in Meru. In the other districts, the proportion ranged between 1.2% and 5.2%.

From a sample of facilities, the proportion of anemic inpatients ranged between 3.7% and 20.4% (Table 7.2).

Table 7.2. Distribution of proportions of patients admitted with anemia by facility

Facility	1997		1998	
	Inpatients	% Anemic	Inpatients	% Anemic
Bungoma District Hospital	-	-	6035	11.3
Busia Sub District Hospital	1911	20.4	1882	13.1
Garissa District Hospital				
Garissa Health Center	160	8.8	85	10.6
Kitui District Hospital	-	-	6785	6.3
Kitui Mission Hospital	6924	3.7	5481	7.4
Kwale District Hospital	3961	11.4	3536	7.5

7.3. Control and prevention of anemia

7.3.1 Availability of hematinics, antimalarial and deworming drugs

From sample of 5 districts, the volume of ferrous sulphate and folic acid tablets received during calendar year 1997 and 1998 are shown in Table 7.3. The volumes recorded showed significant variations during the two-year under review with majority of the facilities (12/17) recording a reduction in the volume of ferrous sulphate during 1998. In the case of folic acid, a decrease in volume supplied was evident in 6/17 facilities. The other facilities either received a greater volume or there was minimal change in the volume of folic acid received during the two years. The ratio of the volumes of ferrous sulphate to folic acid ranged between 53:1 and 1:10 in 1997 and 6:1 to 1:12 in 1998 (Table 7.3).

The stock out periods ranged from nil to 12 months in public facilities and nil to 11 months in mission hospitals (Table 7.3). The average stock out period in the facilities for folic acid was 2.3 months and 4.5 months during 1997 and 1998 respectively. The corresponding averages for ferrous sulphate were 2.9 months and 4.5 months during 1997 and 1998 respectively.

The stock out periods for Chloroquine ranged between 1 and 8 months. The deficit was predominantly observed in facilities situated in Garissa and Kitui districts. From 14 reporting facilities, stock out period for Fansidar™ in 1997 was nil in 3 facilities and between 2 and 12 months in the remaining facilities. In 1998 only one of the 14 facilities had a nil stock out period. The remainder had periods ranging between 2 and 8 months. The overall average stock out periods for the public facilities was 8 months and 3.9 months in 1997 and 1998 respectively.

Mebendazole™ was the main antihelminthic supplied to the facilities in 4 of the 17 facilities, Niclosomide or Levamisole™ were also reported to have been supplied. The range of stock out periods was 1 to 11 months. The average stock out periods for the public facilities was 2.7 months and 3.0 months in 1997 and 1998 respectively.

7.3.2. Prescription of hematinics, antimalarials and deworming

Among the 12 hospitals, 4 facilities reported prescription of hematinics (iron and folate) to all antenatal mothers throughout pregnancy. The respondents' dominant reason for this decision was to raise hemoglobin level. Similarly, four facilities dewormed both children and antenatal mothers regularly. The commonly used drugs were Albedazole™, Nichosamide™ and Ketrax™. Malaria prophylaxis during pregnancy was also reported by four facilities and the drugs mentioned included Chloroquine™, Fansidar™ or Metakelfin™ and Amodiaquin™.

In the peripheral facilities category (health centers and dispensaries), 2-reported prescription of hematinics for antenatal mothers at all times to correct anemia caused by malaria. Two facilities also reported that they give antimalarial prophylaxis. The antimalarial of choice was Chloroquine. Fansidar was mentioned in 3 facilities only. Deworming of antenatal mothers and young children was not reported in these facilities.

7.3.3. Transfusion

Data on incidences of transfusion was not immediately available from the district facilities. From household interviews, 1.59% of the responding families (n=331) reported transfusion either the mother or father or a child during the proceeding 3 months. 43.4% of the transfused were children and 37.7% were mothers. The leading clusters were Mwamosioma in Kisii 15% and Kandiang'a in Nyando (13%). Correspondingly, it was noted from discussion with health personnel in Kisii district that up to 40 transfusions took place per day at the peak malaria annual epidemic. Comparable rate were reported in Osiri (Kisumu), Nakhwana (Bungoma), Kinango (Kwale) and Kibureni (Meru). These clusters are in the malaria endemic areas.

Table 7.3. Hematinic supplies and stock out periods for sample facilities in 1997 and 1998.

District	Facility type	Volumes supplied, tablets				Estimated Ferrous sulphate to Folic acid ratio		Stock out period, months			
		Ferrous sulphate		Folic acid				Ferrous Sulphate		Folic acid	
		1997	1998	1997	1998	1997	1998	1997	1998	1997	1998
3aringo	Mission hospital	100,521	95,044	23,635	22,488	4 : 1	4 : 1	0	0	0	0
	Health center	72,000	47,000	47,000	94,000	2 : 1	1 : 2	0	0	0	0
	Health center	22,400	22,150	10,220	10,181	2 : 1	2 : 1	0	0	0	0
3ungoma	District hospital	84,000	3,300	1,600	38,000	53 : 1	1 : 12	3	7	0	2
	Mission hospital	55,000	65,000	46,000	56,000	2 : 1	1 : 1	0	0	0	0
	Dispensary	29,000	0	8,000	0	4 : 1	-	3	0	4	0
	S/D hospital	36,000	2,000	15,000	3,000	12 : 5	1 : 2	3	10	3	8
3usia	S/D hospital	23,000	50,000	15,000	9,000	2 : 1	6 : 1	6	4	5	7
Garissa	District hospital	143,000	25,100	5,800	46,000	25 : 1	1 : 8	4	3	0	3
	Health center	43,000	22,000	10,000	18,000	4: 1	1 : 1	0	0	2	6
	Dispensary	1,000	0	1,000	15,000	1 : 1	-	11	12	11	9
;itui	District hospital	93,010	0	5,100	0	18 : 2	-	0	12	0	12
	Mission hospital	12,500	9,000	29,500	4,000	1 : 2	2 : 1	6	8	2	11
	Dispensary	8,000	11,000	15,000	34,000	1 : 2	1 : 3	5	5	3	2
;wale	District hospital	8,000	5,000	800	15,000	1 : 10	1: 3	2	5	2	5
	S/D hospital	74,000	30,000	36,000	8,000	2: 1	4: 1	3	10	3	8
	Health centre	20,000	24,000	8,000	7,000	5: 2	3: 1	3	0	4	3
leru	Dispensary	12,000	13,000	12,000	12,000	1: 1	1: 1	1	0	0	0

'D hospital - Sub district hospital

7.3.4. Hemoglobin estimation services

In 9 facilities where method of HbC estimation was reported, dilution and color matching (Sahli's method) and/or photo calorimetric methods based on cyanomethahemoglobin or oxyhemoglobin was used. Sahli's method was mainly reported in health Centers. Only one facility reported use of direct reading haemoglobinometer. PCV estimation was carried out as an adjunct test in Kwale and Kitui district hospitals.

7.3.5 Personnel

Excluding nursing staff, the dominant cadres in the sample health facilities were laboratory staff, public health technicians, nutritionists and health educators in that order. The technicians were available at all levels of public health facilities while laboratory personnel were available up to health center level. Nutrition personnel were mainly found in the hospitals and two health centers in Garissa, Busia and Meru districts. Health educators were also distributed in both hospitals and some health centers but their numbers were restricted to 1 or 2 individuals.

7.4 Utilization of immunization and anatenatal services

Utilization of immunization and antenatal services provides unique opportunity to reach out to the vulnerable children and pregnant mothers. The results are based on a sample of 19 public facilities that were drawn from districts that participated in the survey. Excepting Bungoma where the annual workload doubled, variations in other facilities ranged between 0.5% and 13% during 1997 and 1998 calendar years. The overall monthly rates in 1997 and 1998 were 922 and 726 respectively. The monthly means varied widely with the ratio of new to revisits ranging between 1:1 and 1:6. The overall ratios of new to revisits were 5:12 during both 1997 and 1998.

Similarly, antenatal service utilization varied widely between the districts and also during the two years. The overall monthly rates in 1997 and 1998 were 393 and 280 cases respectively. The ratio of new to revisits ranged between 1:1 and 1:4. A reverse order (2:1) was observed in Garissa district during 1998. The overall ratios of new to revisits were 1:2 during 1997 and 1998 respectively.

CHAPTER 8: DISCUSSION

The key findings in Chapter 3 to 7 are synthesized and possible interpretations relevant to the objectives of the survey are presented. The discussion covers principal concerns of the survey namely; prevalence and severity of anemia based on HbC, s-ferritin, s-retinol, and s-zinc and associated risk factors at population group, household and sub-region levels. Similarly, health care services relevant in the control of anemia and relevance to NHSSP are also discussed.

8.1 Anemia and iron deficiency

8.1.1 Children

The findings of this survey conformed with previous observations that as a population group preschool aged children are likely to bear the largest burden of anemia (4,47,48). The distribution of HbC among the under 6 month-olds showed an overall decrease with age and practically all the infants in this category had values below the recommended altitude adjusted cut-offs (36). These observations were in agreement with those reported by Mbuthia (9) in which HbC decreased from a mean of 16.2 g/dL at birth to 10.3 g/dL two months later. Of significance is the rate of clearance of fetal Hb, inadequate depot iron at birth and low intake (2,3,9). Among the 6 month-olds and over, a mean increase in HbC by 0.041 g/dL per month increase in age was comparable to that observed following re-analysis of data from previous studies in Nairobi (10,49). Thus among the under 5 year-olds, age adjustments of HbC cut-off by 0.5 g/dL per year for 6 month-olds and over is required in determining low HbC defined anemia. In this regard, the appropriate cut-offs used in NHANES would merit review before application in the Kenyan setting. Furthermore, while HbC response to altitude related hypoxia at 0.25 g/dL/1000 m rise *asl* has been recommended (36), the findings of this survey suggest that under the prevailing conditions a four- to five-fold increase would be more appropriate. Consequently, the profound effects of altitude on the mean HbC across the country must be factored in decision on cut-off point for anemia. Excepting children residing at 1900 m *asl* and higher, the overall mean HbC among children was below the altitude adjusted cut-off by significant margins even when the lower adjustment factor was applied.

The peak prevalence of all anaemias and moderate to severe anemia in majority of clusters was observed among 6-12 months-olds. However, it would appear that the risk of being anemic was uniformly distributed among the 6 - 60 months-olds in the semi-arid lowland clusters in Garissa and lake basin. In contrast, the pattern of distribution of anemia in other areas and especially the highlands decreased with increasing age. Overall, the following weighted age wise distribution of the burden of anemia was estimated: <6 months 19.1 %, 6 - 11.9 months 16.1%, 12 - 17.9 months 15.6 %, 18 - 23.9 months 13.4%, 24 - 29.9 months 13.1 %, 30-35.9 months 11.9 % and ≥36 months 10.3 %. The inverse relationship between prevalence and age was observed in all clusters except those in the semi arid lowlands and the lake basin where rates remained relatively unchanged until after 36 months of age. This is a clear reflection of significant reduction in background risk and vulnerability to other risk factors among older children. In the multivariate model, the dependent variables that must be addressed include splenomegaly, malaria parasitaemia, current fever; inadequate intake inferred from underweight and wasting, s-retinol and perceived malaria infection by mothers.

In relation to nutrient intake, underweight and wasting rates were significantly associated with anemia in more than half of the clusters signifying recent inadequate food intake. Thus recent food and nutrition insecurity due to reduced food intake and or nutrient wastage invariably increased the risk of anemia. It is interesting to note the differences in the pattern of decay of anemia with increasing age in semi-arid midlands (Baringo district) and semi-arid lowland (Garissa district), (Appendix 3.3a). These features underlined potential differences in the extent of exposure to risk factors among pastoral communities in midland and lowland semi-arid areas (Baringo *vs* Garissa districts). Since both districts had experienced prolonged drought, these differences probably indicate variations in social-cultural dietary practices and the extent of sedentism (50). Potential effects of sedentism on dietary shifts from milk to starch and sugar and less sharing of milk among kin in nomadic pastoral groups is believed to be the main explanation for better HbC among children of fully nomadic families than those from sedentate ones (11.03 g/dL *vs* 9.47 g/dL).

Although children in lake basin and western highlands clusters had on average potential for higher HbC by at least 0.3 to 0.43 g/dL than those from the coast due to altitude effects, this was not the case. The lower HbC among lake basin children and corresponding higher prevalence of anemia than coastal children conformed with previously observed differentials in areas of high and low seasonal malaria transmission pressure in Kenya and Tanzania (51). Furthermore, moderate grades of splenomegaly that was likely due to repeated malaria infection affected between 10% and 71% of the children. The variations in splenomegaly rates were probably a reflection of transmission pressure related morbidity (51,52). The strong association between splenomegaly and anemia was consistent with reported association with accelerated hemolysis (53). Although sensitivity for anemia was low (14.8 to 72.2%), the high specificity (66.2% to 91.7% %) underscored its potential utility in raising the index of suspicion for childhood anemia among mothers living in areas with high rates of splenomegaly. Anecdotal evidence suggests that mothers are aware of splenic enlargements, which they elicit when bathing their children but its importance is oblivious to the majority. It is interesting to note that in Kisii district mothers described anemia using a local name for splenomegaly.

The prevalence of HbAS among the coastal and lake basin communities was within ranges (20 to 30%) reported nearly four decades ago (8). Failure to demonstrate significant association between sickling and anaemia was possibly due to grafting of malaria on to other anaemias. In addition, lack of significant association conformed to possible dominance of the HbAS and its attendant protective benefits, among them lower parasite densities and lower likelihood of moderate to severe anaemia among child populations (8,22). Determination of the proportion of HbSS among the sicklers was not considered in the survey.

In general, from the findings of 1964 survey (5), it would appear that HbC and prevalence of anemia in among coastal and central highlands communities remained relatively unchanged or had marginally improved. In contrast, in the lake basin clusters lower mean HbC and two-fold increase in anaemia was evident (Annex 1.1). In general, this survey suggests a high likelihood of a larger burden of anaemia among pre-school age children than at the advent of independence. Thus, in conformity with recent KDHS (13) those overall temporal trends in childhood nutrition and health status in the country during the nineties are likely to have declined.

The pooled s-ferritin results of well children indicated that over two fifths (44.8%) of the children were either acutely or moderate iron deficient. In addition, marginal s-ferritin deficiency (21- 40µg/L) among nearly one third of the children was also observed. It would appear therefore, that about 74% of the sample of relatively well children had either depleted depot iron or were at a high risk of developing functional iron deficiency. The significantly larger proportion of low HbC anemic children with acute or marginal s-ferritin deficiency compared to non-anemic well children (48.7% *vs* 35.4%) was consistent with dominant late stage iron depletion and high prevalence of early to intermediate iron deficiencies (Appendix 2.1). These rates are within the range reported among children attending outpatient clinics in Dagoreti (38.5%) and Kibera (31.2%) communities in Nairobi (10,49). A higher deficiency rate (50%) has been estimated among anemic children in Kisumu. However, given that these studies did not discount for acute phase response and chronic disease, rigorous comparisons are not feasible. In this regard, desegregation based on reported illness and laboratory observations caused considerable shift in the proportion with acutely low s-ferritin deficiency (41.6% for well *vs* 28.5% for ill children) using <20 µg/L cut-off. The limitations of this desegregation strategy with respect to precision on the magnitude of the response and likelihood of underestimating the low s-ferritin must be borne in mind. However, despite absence of sTfR, and or ACT and AGP findings, objective desegregation s-ferritin results of well from ill children suggest that for every case of IDA detected there is high likelihood of finding another case of iron deficiency without anaemia in the same population. The contribution of frank hemolytic, and other hematinic deficiencies should account for the remaining proportion. Given the dominance of vegetarian diets across the country and widespread iron deficiency, it is certain that there is co-occurrence of risk factors. It is useful to note that B_{12} deficiency with and without ID has been shown to account for over 36% of early childhood anaemia (54). In the model for s-ferritin deficiency, s-retinol, stunting and splenomegaly were retained but none was significantly associated.

The findings of this survey underline the need for actions to cause increased post-neonatal intake of iron containing hematinics and prevention of their wastage among middle to low socio-economic groups. The former should go on through out early childhood in regions where anaemia is either a severe or moderately severe public health problem (Appendix 3.3b). The central highlands and some semi-arid midland areas should also be targeted especially during the first 24 months of life and food lean periods. Prevention of wastage should be addressed through reduced exposure to infections especially malaria. Prevention of the latter through chemoprophylaxis has been shown to be more effective in reduction of incidence of severe childhood anaemia than iron supplementation alone (55). Similarly, the effectiveness of ITNs in reducing malarial anemia during early childhood has also been well characterized. In high transmission settings however, both protective strategies are likely to leave children at greater risk of complicated malaria upon withdrawal of intervention or later childhood (55,56). Nevertheless, the higher likelihood of intermittent exposure associated with ITNs and moreover, their broader utility for example partial protection for those within the vicinity (57) and prevention of filariasis renders their application more attractive than chemoprophylaxis.

8.1.2 Mothers

The distribution of mean HbC and prevalence of anaemia among non-pregnant mothers followed a pattern similar to that of children. The increase in HbC per 1000 m rise *asl* was over four-fold that recommended previously (36). The largest burden of anaemia was borne by the semi-arid clusters in Garissa district. The coastal and the lake basin sub-regions followed with more than two thirds of mothers being anemic. In the western highland clusters and some of dry humid to semi-arid midland clusters, nearly half (41-50%) of the mothers were anemic. The largest burdens of moderate and severe grades of anaemia were observed in clusters in Garissa district (63% to 86%) followed by the urban coastal clusters (41% to 51%). The rural coastal and lake basin clusters had between 20% and 30% prevalence of moderate and severe anaemia. These findings were comparable to rates (26%) reported in Bagamoyo (4). It should be noted that despite relatively comparable agro-ecological, pastoral activities and maternal anthropometric characteristics, the prevalence and severity of anaemia were worse in the semi arid low lands in Garissa than the semi-arid midlands in Baringo. In addition to possible variations in the extent of sedentism, the 24-hour dietary recall findings indicated a two-fold iron: calorie intake and accompanying potential for higher vitamin C and protein intake in Baringo than Garissa districts. In this regard, anecdotal evidence suggest that dietary practices associated with high level of sedentism in Korkora (Garissa district) could have significantly contributed to higher prevalence of anaemia when compared Elan in the same district where the indigents are wholly nomadic.

Among the pooled sample of pregnant mothers, a dominance of moderate to severe anaemia (two fold and over) was consistent with rates reported among coastal mothers in Kilifi and Bagamoyo (4,58). Higher prevalences in the later are likely to be due to the large fraction of primigravidae as well as all mothers being drawn from the coastal communities. The fundamental concern is that more than half of mothers enter pregnancy with mild anaemia and about one fifth with moderate to severe anaemia. The observed increase in severity should be in response to fetal demands and a reflection of the inadequacy of existing strategies control anaemia among pregnant mothers. In this respect, it is significant to note that there was no obvious association between reported service utilization by pregnant mothers and the prevalence of anaemia.

Based on s-ferritin levels, nearly two fifths of mothers (43.4%) had either acute or moderate iron deficiency. Furthermore, 27.2% had marginal iron deficiency. It should be noted that unlike among children, excluding ill mothers resulted in relatively small changes in the distribution of the s-ferritin status suggest unremarkable response to illnesses captured in during the survey. In addition, it would appear that the proportion of well anemic mothers had either moderate or acute s-ferritin deficiency (66.4%) which was two-fold that of non-anemic mothers. The proportion of acutely s-ferritin deficient mothers increased with severity of anaemia. Among pregnant mothers, the proportion of s-ferritin deficient mothers increased two-fold and over during the second trimester but unlike HbC did not change significantly during the third trimester. Overall, despite weak statistical significance, s-ferritin concentration decrease by 4.39 µg/L per month increase in gestation age should be noted.

The most commonly associated aetiologic factors for anaemia were malaria parasitaemia, current respiratory morbidity and diarrhoeal episodes. It was interesting to note that despite marked prevalence of *S. haematobium* among mothers in coastal clusters, there was no obvious relationship with occurrence of anaemia. Since these mothers were indigents, it is possible that low intensity and partial immunity to *S. haematobium* could partly explain absence of association with anaemia.

Association between household consumption of animal products and anaemia was mainly evident in the semi-arid clusters and only marginal in some clusters in western highlands and coastal sub-regions. In addition, it was interesting to note that anaemia among non-pregnant mothers was marginally associated with geophagus history during past pregnancy. Given the higher likelihood of moderate and severe anaemia among the pregnant mothers it was surprising that no obvious association could be demonstrated between geophagy and anaemia among them. Whilst this is possibly due to design limitations, it is noteworthy that preceding studies have also shown association between anaemia and geophagy among school children but only s-ferritin was retained as a dependent factor (59). However, weak association between anaemia and geophagy history among nonpregnant mothers could be considered an indication of overall high predisposition to anaemia. Furthermore, the significant associations between marginal and acutely low s-ferritin concentration with geophagy underlined this possibility.

In contrast to children, explicit association between anaemia and maternal malnutrition was only significant in Sisenye (Busia). The difference was possibly due to quantity of depot iron in the two groups. With regard to menstrual loss, perceived heavy loss was significantly associated with anaemia in only three clusters. It is possible that these variations emanated from phrasing of the questions. From the multivariate model, the main dependent factors were s-retinol, current and recurrent fevers and perceived malaria infection. Malaria parasitaemia was retained only after excluding s-retinol. The factors that were significantly associated with s-ferritin were anaemia and s-retinol.

Mother's knowledge and perceptions: The highest awareness about anaemia was observed in coastal and Garissa district clusters. The description given in all clusters referred to domains that describe perceived causes, blood loss or presentation following blood loss or actual blood insufficiency. The most explicit descriptions were noted in the coastal clusters. In the latter communities anaemia was described in one word *safura* or as a direct translation *upungufu wa damu* and *kukosa milatso*. In addition, anaemia was also described in relation to hookworm as *nyongoo*. Severe anaemia was described from both presentation of oedema and expected fatal consequences as *fura uende*. The literal translation of this phrase is swell and go. Among inland communities, anaemia was described as direct translation of insufficient blood in Bungoma, the central highlands and in Garissa district. Other common perceptions and views, shared descriptions of dizziness, malaria, fever, splenomegaly, wasting/AIDS and abdominal diseases. These observations underlined some awareness among community about causes and presentation of anaemia. The extent to which this knowledge could trigger a decisive household action against anaemia is unclear. It is noteworthy that good knowledge levels about causation and presentation among mothers in Bungoma has previously been observed but paradoxically knowledge on prevention including possible suitable diets and high-risk situations was low (60).

8.1.3 Adult males

In general, the pattern of distribution by altitude was similar to that of mothers and children. In addition, the mean cluster HbC was greater than the cut-off in all clusters whose altitude was above 500 m *asl*. Excepting Sisenye (Busia district), Korkora, Kikoneni and Kifyonzo (Kwale and Garissa districts) all mean HbC values were above the expected levels. In this respect while the prevalence of pooled anaemia among adult males in general ranged between 0 and 60.9%, mild forms were dominant. The prevalence of moderate anaemia was markedly lower than those observed among mothers and children and mainly found in the lake basin, coast and semi-arid lowland sub-regions. In Korkora and Sisenye, a tendency for severe anaemia was evident. The only factor that was consistently associated with anaemia was current fever. From the final models, current fever, schistosomiasis and history of current diarrhea and s-retinol concentration were associated with anaemia.

The results of s-ferritin analysis among relatively well fathers indicated that the prevalence of acute and moderate deficiencies was about 5.1%. In addition, 8.6% of the fathers had sub-optimal s-ferritin concentration. In contrast to mothers, the possibility of higher level of acute s-ferritin deficiency among ill compared to well fathers (3.4% *vs* 17.1%) should be noted, albeit small number of observations. In this regard, s-ferritin deficiency was relatively uncommon among non-anemic fathers. In the pooled sample about one third of the fathers had acute to marginal s-ferritin deficiency.

From a public health view point, excepting clusters in the central highlands, effort to minimize further downward shifts of HbC among adult males are necessary. These observations underscore limitations in using adult males as the reference population in the Kenyan setting. The main dependent variables in the adult male anaemia were s-retinol, recurrent fever and malaria parasitaemia. The dependent variables for low s-ferritin were anaemia and s-retinol.

8.1.4 Older children and the elderly

The mean HbC of older children including adolescents are consistent with the altitude related distribution presented for other population groups. The reported mean HbC values are relatively close to the expected levels. In conformity, mild anaemia is likely to vary widely across the regions. The pattern of anaemia distribution is probably comparable to that observed among adult males in corresponding sub-regions.

From reported deficiency levels, coast leads followed by the lake basin. The likely morbidity determinants appear to be parasitic infections, including hookworm and schistosomiasis, with hepato-splenomegaly being associated with higher prevalence and severe forms of anaemia. The role of malaria seems less clear. Studies in western Kenya (11) and midlands (43) indicate relatively comparable increases in HbC following iron containing micronutrient supplementation, and chemotherapy for helminths and schistosoma infections. These findings and results of other intervention studies suggest a possible dominance of iron deficiency and significant wastage resulting from the two parasitic infections. As in the case of men population, these findings underline possibility of dietary deficiency of iron among other hematinics. Furthermore, among the elderly, the two reviews that were based on highland populations suggest that prevalence of mild anaemia in the order of 20% and over could be expected. The principal risk factor is likely to be diet, aggravated by loss of teeth and intestinal parasites (45,46).

Concerning older children, little information is available about their s-retinol status. The prevalence of marginal s-retinol deficiency reported in western Kenya (34) was within the range of 3.7% to 41% observed in the present survey. It seems probable that distribution of deficiency would follow similar pattern with that of other population groups included in this survey.

8.1.5 Anaemia in the household and sub region levels

With exception of highland and some midlands clusters where relatively low prevalence of anaemia was observed between one third and two thirds of the households had mother-child pair affected in all but three clusters. In the coastal, lake basin and some clusters in the western highlands and semi-arid sub-regions, comparatively lower proportions of anemia in the father-child and mother-father pairs was evident. These findings suggested ubiquitous existence of risk factors for anaemia at household level in most parts of the country.

From weighted distribution of the share of the burden of anaemia per unit of the surveyed population, the following proportions were estimated; lake basin 25.9 %, the Coastal and semi-arid lowlands 24.4 %, the western highlands 20.7 %, dry humid and semi-arid midlands 18.1 %, and the central and midwest highlands 10.9 %. Furthermore, among mothers, the following sub regional distribution of the share of burden of anaemia per unit of the surveyed population was estimated: coastal and semi-arid lowlands 31.5 %, the lake basin 29.3 %, the western highlands 17.3 %, the dry humid and semi arid midlands 16.1 % and the central and midwest highlands 5.8 %. In the case of men the following distribution was estimated; coastal and semi-arid lowlands 32.9 %, the lake basin 28.2 %, the western highlands 16.6 %, the dry humid and semi arid midlands 16.1 % and the central and midwest highlands 6.2 %. In terms of population density based on the 1999 census, the distribution of the national share of the burden of the western highlands and central highlands increases significantly.

8.1.6 Anaemia among patients

Anaemia was among the top five outpatient diagnoses in the sampled facilities. Malaria was leading in all facilities and the likelihood of a high attributable fraction to reported anaemia is plausible. Among in-patients, rates ranging between 3.7% and 20.4% of patients were estimated. This observation was in agreement with HIS statistics for the period 1995 -1999 among others. In Kisii district where anaemia was not as prevalent as the rest of the region, recent surveys indicate that it is the 2nd or 3rd commonest cause of hospitalization (61). This impression is likely to hold true in the entire western highlands and the lake basin. Although data on transfusion was not immediately available from the facilities, the prevalence of moderate and severe anaemia in malarious areas suggested high rates of transfusion. The risks and life long impediments associated with transfusion and moreover, the cost-effectiveness of preventing anaemia are sufficient to stimulate integration of anemia control activities in all community based primary health care initiatives.

8.2 Serum retinol status

Children: The mean s-retinol concentration confirmed previous findings that low vitamin A status attributable to actual and or apparent deficiency due to hepatic sequestration was a public health concern. In this respect, the proportion of acute s-retinol deficiency among ill children was three fold that found among well children. However, according to the WHO recommended cut-off, prevalence of acutely low s-retinol among well children still constituted a public health problem (62). The distribution of acute deficiencies was strongly associated with malaria parasitaemia and by extension, malaria endemic coast and western regions had the highest rates of deficiencies. In the overall model, the dominant risk factors were parasitaemia with fever and stunting retained but weakly significant. Within the limits of this survey, the prevalence of excess s-retinol was about 0.2% indicating relatively low risk of overloading with s-retinol.

In view of differences in sample sizes, sampling strategy and possible variations in seasonality during the VAD (23) and the present surveys, strict comparisons are not feasible. However, pooled district prevalence of acute deficiency in Kisii, Baringo and Kitui were comparable to those reported from the VAD survey (23). However, the rates reported for Kisumu, Bungoma, Garissa and coastal districts were considerably higher than those reported from the VAD survey. With regard to marginal deficiency (10-20 µg/dL), rates comparable to those reported from the VAD survey were observed in Kisumu, Bungoma and Garissa. In the remaining districts, the rates were two-fold those reported during the VAD survey. HbC was the only significant dependent factor in the s-retinol model.

Mothers: The low mean s-retinol concentration and the high prevalence of acutely and or moderately low s-retinol implied that VAD among mothers was widespread across the country. Only one cluster in Kitui district (Wii) where the prevalence of moderate s-retinol deficiency did not attain the recommended 15% cut off (63). Upon desegregation of well mothers and ill mothers, the proportion of acutely deficient ill mothers was twice that of well mothers. However, among well mothers the public health importance of VAD as seen from both acutely low (6.2%) and moderately low (33.7%) s-retinol concentration was sustained.

The prevalence of acute s-retinol deficiency was closely comparable to that observed during the VAD survey in Kitui, Baringo, Kisii, Kwale, Bungoma and Garissa. However, the prevalence of moderate deficiency was two fold and over in all districts. The pattern was closely comparable to that of children. In the final model, the dependent variables for low s-retinol were parasitaemia, hookworm infection, body mass index and anaemia.

The deterioration of s-retinol status with increasing gestation age was consistent with expected pregnancy associated shifts and underlined inadequate intake of vitamin A or pro-vitamin A rich foods. The prevalence of s-retinol deficiency among nearly half of non-pregnant mothers and comparable proportion among mothers in their first trimester (46.4%) implied that majority of mothers entered pregnancy in marginal s-retinol status. In this respect, the observed mean s-retinol concentration indicated either overt deficiency or marginal status in practically all clusters. It was therefore not surprising that only <0.5% of mothers presented with tendency for high or excessive s-retinol concentration. These observations point towards two important concerns in the current post partum large dose vitamin A supplementation strategy. Firstly, the dose regime is most likely inadequate to meet deficits for majority of mothers and by extension unlikely to prospectively satiate the needs of lactating mothers and their breast-feeding infants. Secondly, the strategy does not cater for the larger proportion of mothers. In conformity with evidence adduced from other studies, the survey findings underscore the need to consider upward revision of the current post-partum dose (64). Interim findings of an ongoing field study in western Kenya using 400,000 IU indicate such revisions are possible. Among pregnant mothers, the possibility of introducing low dose supplementation strategy during the second and third trimesters should be considered along with dietary IEC.

Men: Despite relatively small sample sizes, median s-retinol concentration and the prevalence of marginal deficiency in most clusters underlined the possibility of widespread marginal VAD but did not constitute a serious a public health concern. The exception includes central highlands and the midlands clusters where deficiency appeared to be relatively uncommon. Discounting for possible effects of illnesses confirmed the low likelihood of acute VAD but significant marginal deficiency among well adult males. In this regard, given the low prevalence of high s-retinol concentration (<4%) and excessive concentration (<1%), the risk for overload could be relatively low. In the model for s-retinol, the significantly associated factors were anaemia, hookworm infection and current fever.

Overall, these findings underline the possible household risk of apparent as well as true VAD. It is noteworthy that on average the prevalence of low s-retinol among mothers and children marked possibly significant deterioration of the VAD status in the country. Given that the standard sample collection, storage (-20EC to -70EC) and analysis had been adhered to, it is unlikely that the deficiencies are overestimated. In this regard, close to 30 years ago it was shown that about half of a sample of male prisoners (46%, n=118) whose mean jail stay was 15.4 months had acute to moderate s-retinol deficiency (65). The findings of this natural experiment demonstrated the likelihood that depot vitamin A could be depleted within a relatively short period of dietary incarceration. Furthermore, prisoners from pastoral communities remained significantly better of than those from agricultural communities (34.6 " 20.2 µg/dL *vs* 23 " 19 µg/dL). Already, this was a pointer to the possibility that majority of Kenyans have marginal storage of vitamin A. The findings of this survey indicate changes that are consistent with prolonged drought, food insecurity and deteriorating poverty across the country. Moreover, the findings of this survey implied that national wide VAD interventions initiated about one year before had not attained sufficient momentum to cause discernable change in s-retinol status in the population. In the sampled districts, comprehensive coverage for childhood vitamin A supplementation was possibly realized only during national immunization days. Finally, the contribution of the expanding malaria zone to the highlands cannot be ignored.

8.3 Serum zinc status

Among the three population groups, the mean s-zinc concentration and distribution based on the <65 µg/dL cut-off indicated high risk of deficiency in all clusters except those in Nyandarua where the proportions affected were considerably lower. In this respect, excepting Nyandarua, the median concentration in all clusters was lower than those reported for a reference American population (21). The high risk of deficiency should largely be attributable to inadequate intake and repeated infections. It was interesting to note that mothers in the semi-arid clusters in Garissa district were less severely affected than the ones in Baringo. This was contrary to expectation given comparable maternal malnutrition rates and lower rates of other deficiencies in Baringo than in Garissa district clusters. It is useful to note that in a separate investigation, the mean s-zinc concentration in a sample of 16 individuals in Wajir district with suspected debilitating micronutrient deficiencies were recently reported as 76.44 µg/dL. Similarly, he proportion of mothers at risk in Kwale district clusters were considerably lower than vould be expected when trend in other deficiencies is considered. In view of the likely ɔwer caloric intake in the Garissa district clusters and possibly fewer episodes of nfection in Baringo district, the observed differences could result from variations in zinc ;ontents of their diets (66). However, the likely contribution by tissue wasting to these lifferences makes interpretation of observed risk of deficiency in affected clusters elatively difficult. However, the comparable s-zinc concentration and proportions at risk n the three population groups across the country suggest that nutrition deficiencies are a ɔrimary factor. The dependent variables in the model for s-zinc were anaemia, ıookworm and diarrhoea but at marginal significance excepting diarrhoea. Schistosoma nfections and s-retinol were significant dependent variables in the s-zinc model among nen. Among mothers, anaemia and respiratory tract illness were significant dependent ′ariables in s-zinc deficiency model. Hookworm infection and low BMI were also retained n the s-zinc model but at marginal significance.

₹.4 Risk factors for anemia, ferritin s-retinol and s-zinc

₹.4.1 *Malaria infections*

The prevalence of parasitaemia among children in malaria endemic areas underlined ɔossibility of significant disparities in the transmission pressure between the lake basin ;lusters. Similarly, distinct differences were observed between the coastal rural and ırban clusters. The range of rates observed were comparable to those documented rom previous studies but two to three fold those reported by Levy (5). For example, in Asembo bay, (along northern shores of Lake Victoria) monthly prevalence of 83% among I - 4 year-olds, 73% among 6-11 month-olds and 42% among <6 month-olds have been eported (52). Further west in Usigu and in the southern shores (Migori district), ɔarasitaemia rates of 70% and 65% respectively were reported among under 5-year-olds 34, Care Kenya-ECD survey). In comparison to the VAD survey, the rates of ɔarasitaemia were either lower or at par. The exception was Meru district area, in which ıigher rates of parasitaemia than those reported in the VAD survey were reported. While he possibility of congenital malaria could not be ruled out, it is significant to note that ɔarasitaemia was evident as early as 2 months of age and peaked during late infancy. 3y extension, it seems probable that inter-cluster and age-wise variations in malaria ɜndemic sub-regions could be partly attributed to differences in transmission pressure in lifferent clusters. An additional concern was the apparent invasion of central highlands ɔy malaria. Its implications in the control and prevention of anaemia must be factored in ıealth programmes at the earliest opportunity.

Nith exception of Meru, Garissa and Baringo clusters, the prevalence of parasitaemia ɪmong mothers was relatively comparable with the pooled district area findings of the /AD survey (21). It is possible that the observed higher prevalences were due to rains hat preceded the survey by several weeks in both Baringo and Meru. The reasons for

0% parasitaemia in Garissa during the VAD survey was not immediately clear. Parasitaemia rates among adult males were in general comparable to those of mothers with respect to both magnitude and distribution. It is possible that the rates observed in non-malaria areas in the midlands and highlands clusters were a reflection of imported malaria.

The leading prevalence of mother-child parasitaemia was observed in the western highlands followed by the lake basin. Among coastal clusters, the rates were relatively low except in Kikoneni (Kwale). This distribution pattern was also evident among father-child pairs. It seems probable that high co-occurrence of child-parent parasitaemia was due to higher mid-year malaria transmission in the western highlands. In the lake basin considerable rates of parent-child parasitaemia conformed to perennial transmission. While confirming ubiquitous distribution of parasitaemia, these findings suggest significant intra-household malaria transmission in western Kenya. The significance of the sub-regional variations in parasitaemia rates in the inter-cluster differences in anaemia rates is not clear.

8.4.2 Hookworm infection

The findings on hookworm prevalence in western and coastal sub-regions confirmed setting-in of the infection in early childhood. However, in keeping with recent studies, there was no obvious association between hookworm infection and childhood anaemia in most clusters when both prevalence and intensity were considered (67) except in Sisenye in Busia. Therefore, contrary to expectation it would appear that early setting in of light hookworm infection among <5 year-olds did not have an obvious effect on anaemia. However, in the absence of details on species of hookworm (*A duodenale vs N americanus*) and their prevalence (68), it is not possible to rule out its importance in childhood anaemia predisposition at community level. Furthermore, its role in wastage of other nutrients cannot be ignored as evidenced by risk consideration at population level.

Among mothers and adult males, the effects of hookworm infection were observed s-retinol and s-zinc deficiency. In addition, hookworm infection was retained in the s-ferritin model for mothers but it did not attain statistical significance. At household level, the occurrence of hookworm infection was most conspicuous among mother-father pairs in the coastal and western highlands. Among mother-child pairs, marked rates of infection were evident in the coastal clusters and the lower altitude western highlands. The low occurrence of infected mother-child pairs cast doubt on the wisdom of using mothers as proxies for childhood hookworm infection.

The lack of significant association between latrine coverage and prevalence of hookworm infection indicated exposure of children to highly infective grounds and dominance of favorable climatic and ecological factors in the transmission pressure. This survey confirmed that hookworm infection is unlikely to be a major concern in the highlands and semi-arid to arid sub-regions (68). In addition, it seems probable that the prevalence of hookworm infection across the population groups considered were on average higher than those reported by Levy (5).

8.4.3 Schistosoma infections

Early infection with both *S. mansoni* in the lake basin and *S. haematobium* in coastal clusters indicated ubiquitous dispersion of vectors in the proximity of homes. Although no significant association with anaemia could be demonstrated, our findings confirm the possibility that these infections are important public health concerns in the areas that were sampled, but probably for the older children (34). In this respect, *S. mansoni* was included in the s-ferritin deficiency model but the association was not statistically significant.

8.4.4 HIV infection

HIV infection is known to affect iron metabolism during early and late stages. Unfortunately, HIV screening during this survey was not possible because of inadequacy of available logistical support. Furthermore, efforts to elicit clinical manifestations did not yield data that would implicitly suggest established HIV disease. Nevertheless, there is enough evidence to conclude that asymptomatic HIV infection lowers HbC among women with or without depleted depot iron. These effects have been shown among asymptomatic antenatal mothers in Burkina Faso and Zimbabwe where the prevalence of HIV was 9.7% and 31.5% respectively (69,70). These rates are within the range reported from antenatal clinics across the country (Annex 1.2, NASCOP). In Burkina Faso, HIV sero-positive status has been associated to about 14% higher anaemia rates than sero-negative status (69). Reporting from Zimbabwe, Friis et al (70) associated a drop in mean HbC of 1.29 (95% CI 0.89-1.68) g/dL with sero-positive HIV status. Thus, the effects of HIV infection on anaemia prevalence and other micronutrient deficiencies are not a matter of probability but a question of its contribution in the explanatory model.

Other illnesses that were associated with anaemia, *inter alia*, febrile episodes, diarrhea and coughing are expected to give rise to nutrient wastage or anorexic tendencies.

8.4.5 Food Security

The main source of food corresponded to the agro-ecology of the cluster and the main socio-economic activities. Miritini and Utange in Mombasa district, the semi-arid lowland and midland clusters of Garissa and Baringo, and the lake basin clusters of Sisenye and Kandiang'a mainly purchased food from other sub-regions. All other clusters relied mainly on home grown food. Only six clusters reported 75% and over availability of midday and evening meals irrespective of the season.

The dominant staple foods were cereals (maize followed by millet and sorghum), tubers (potatoes and cassava), and beans and pulses. These foods are classified as low iron bioavailability because of the high phytate content (71). The lower iron density ratios Garissa and Baringo semi-arid areas were possibly a reflection of relatively low calo intake from staples at the time of the survey due to a long drought period. Assuming dose response relationship between iron absorption and phytates, the estimated inhibit densities suggested relatively low absorption of iron, which was possibly mo unfavourable in Meru. The high phytate density was attributed to consumption of tuber Finally, consumption of phenols (also iron absorption inhibitors) in the form of beverage (tea or coffee) with meals in the highlands (5.2% - 16.5%) is worth noting. Overall, wi exception of Garissa and Ng'aratuko in Baringo, children had slightly better iron intak than parents. Whilst phytates are expected to similarly inhibit zinc absorption, the pauci of data on zinc nutrient values of Kenyan staple foods bottlenecks detailed discussion It is however, established that variations in plant food content exceeding ten-fold ca occur.

The frequency of intake of animal flesh was largely weekly or less frequent irrespective c the season. The low frequency of vegetable and fruit consumption intake and, moreove long cooking of vegetables and potatoes confirmed a low potential for adequate vitami C intake. Interestingly, Meru presented with the highest potential for vitamin C intake a community level. The reasons for inconsistency in the association between anaemia a well as selected micronutrients and intake of animal flesh were not immediately clea However, while evidence about their nutrient value is indisputable, the frequency an quantities likely to be consumed precludes the need for emphasis on their consumptio presently.

The findings of this survey indicated that children and mothers were most vulnerable to family size attributable household resource pressure. However, the risk was only significant among children. It is probable that this underlined inadequate nutrient intake was due to reduced access and childcare practices due to demands placed on mothers in such circumstances.

8.4.6 Culinary practices and choice of cooking pots

Extra-food sources of iron have significant potential to influence the iron intake. For example, use of iron pots has been associated with lower rates of anaemia and improved growth of children in Eriteria (72). In the current survey, the dominant cooking pot material was aluminum. Except Nakhwana in Bungoma, the proportion of households using iron/steel pots was small. Therefore, although iron aluminum pots are overwhelmingly popular, the growing evidence about the potential of iron pots to mitigate against iron deficiency calls for urgent consideration of strategies to increase their use across the country. Finally, it was disappointing to note that simple methods that can be used for freeing iron and zinc in staple cereals such as sprouting and fermentation are uncommon.

8.5 Health services

8.5.1 Diagnosis of anaemia

In majority of clusters where large proportions of mothers and children had low HbC, specificity for pallor (>81%) was satisfactorily. However, erratic and overall low sensitivity (22.2% to 63.6%) underlined the inadequacy of applying physical signs alone in community screening. Against this background, it is commonly agreed that clinical staff are likely to be more motivated to prescribe iron/folate supplements if the risk of low HbC is expressed using quantitative objective measurement and similarly monitor progress the of effects intervention (73). Moreover, since many Kenyans are likely to associate laboratory investigations with better quality health service (7), objective assessments of HbC has potential of enhancing compliance among antenatal mothers to demand and use hematinic supplements. Nevertheless, while use of photometers provided a stable alternative, their price and possible instability under tropical humid climates (74) casts doubt on their suitability and sustainability for routine application.

From the sample facilities, services for objective estimation of HbC in public dispensaries were not available. Moreover, whilst dilution and color matching method (Sahli) and photo calorimetric methods were dominant in higher level facilities, issues relating to standardization remain a major challenge. In this regard, recent semi- quantitative approaches based on a simple and low cost Hb Color Scale (75) should be considered as an adjunct tool in confirming low HbC especially in MCH settings. It should be noted that, in view of the relatively low sensitivity and specificity above 10 g/dL HbC, its potential for application in general surveys is limited. Irrespective of the method chosen, objective assessment of HbC merits significant attention in follow-up action to control anaemia among mothers and children. However, apprehension to the finger stick procedure indicates need for an objective non-invasive and relatively simple HbC assessment.

8.5.2 *Supply and use of hematinics*

The dominant hematinics supplied were iron and folate as separate preparations. Large variations in the volume supplied between facilities as well as from year to year suggested inadequate coordination of the ordering and or procurement and or distribution and or prescriptions. Along with estimated stock out time, these variations also indicate possible underestimation of facility needs among public facilities. Overall, the sample facilities showed that at best, the supplies provided lasted between half and three-quarters of a year. The supply of antimalarials varied more widely and greater deficits seem probable. In contrast, the stock out periods for antihelminthic preparations was considerably shorter.

8.5.3 *Personnel and service utilization*

The main cadres in all facilities were nursing staff followed by laboratory personnel. While both cadres provide front line service in clinical care, the wider deployment of nursing personnel and their primary duties lenders them key in anaemia control efforts. Given the low reporting rates in hyper endemic areas, it is possible that a low index of suspicion for mild and moderate anaemia among clinical personnel and the community exists. In addition, inadequate supply of hematinics and non-observance of guidelines partly explain the observed prevalence of anaemia among pregnant mothers and lack of association between the anaemia status and attendance to antenatal clinics. There is a likelihood that cost implications may have reduced access to hematinic supplements. However, the low demand for iron and folate tablets from community pharmacies under the Bamako Initiative (75) suggest inadequate knowledge on value of supplements. This argument should hold true in the case of children.

Available data on immunization coverage suggest a possible decline in health service utilization. This trend along the findings from sample facilities underscores the need to go beyond immunization and antenatal clinics in the control of anaemia.

8.5.4. *Households practices*

The findings of this survey confirmed that shops and kiosks are the first source of treatment sought by the majority of households (7,76). In addition, the main second referral level for providers was public facilities. Given the high likelihood of managing fever and perceived malaria at home and the attendant risk such as partial treatment, health-seeking behavior among high-risk communities and population groups must be factored in strategies to contain anaemia.

With regard to bed nets, significant variations in bed net coverage was evident in malaria endemic areas in Western and Coastal regions. While specific explanations for these disparities were outside the scope of this survey, it would appear that clusters that had benefited from the Bamako Initiative projects or were in the catchment of such project areas had higher coverage than others. In Sisenye in Busia and the western highlands clusters in Bungoma and Kisii districts where BI projects had never been launched, a conspicuously low bed net coverage was observed. Similarly, Kibureni in Meru had also a relatively low coverage despite obvious endemic malaria. In addition, the low overall re-treatment of nets with insecticides (13.8%) reflected inadequacies in the bed net strategy of malaria control. Since all children in the country have a background risk of nutritional anaemia, it is considered that the excess anaemia observed in malaria endemic regions was due to repeated exposure to malaria. The findings of this survey and the established benefits of ITNs (57,77) should give additional impetus to social marketing efforts within the NMCP and other partners whose focus is to improve acquisition and use of ITNs.

With regard to pregnant mothers available evidence indicates that ITNs alone are unlikely to yield significant reduction of anaemia (78). Thus while promotion of ITNs use among pregnant mothers to reduce maternal morbidity should continue, specific activities to increase use of haematinics and appropriate chemotherapy will be pivotal in the control of maternal anaemia (79,80).

8.6 Linkage with NHSSP

To conceptualize opportunities to address the demonstrated public health concerns due to anaemia, and deficiencies of iron, vitamin A and zinc, fine-tuning of interphasing themes and activities within the NHSSP is required. The prevalence of deficiencies, severity and dispersion especially among children and mothers legitimizes special emphasis to contain them within the high priority national public health packages under malaria prevention and treatment, reproductive health, IMCI, EPI and HIV/AIDS/TB prevention and management (19). Furthermore, the proximity of helminthic and Schistosoma infections in control and prevention of anemia and its cost-effectiveness justifies elevation of their priority rating from low to moderate or high for regions that are affected. Thus, the findings of this survey should influence specific objectives that are guiding implementation of the NHSSP.

A critical review of supporting activities, targets and indicators chosen for the plan period suggest need for some adjustments. Priorities include integration of childhood and non-pregnant mothers anaemia, and strategies to contain anaemia risk factors among the rest of the population among key packages. In addition, the control of vitamin A deficiency among mothers especially during pregnancy should be reflected in the plan. In this respect, under malaria prevention and treatment, and IMCI, the proximity of malarial anaemia and its exacerbating effect on childhood and maternal background nutritional anemia should be explicitly included. Moreover, splenomegaly and pallor rates among children in malaria endemic areas require recognition as impact indicators. The dominance of home management of illnesses underscored the importance placed on improving household and community skills. Furthermore, rational use of over the counter drugs from the viewpoint of outlets and manufacturers should be visibly reflected in the NHSSP.

Under the IMCI package, elimination of VAD among <5 year-olds by 2005 using strategies of EPI and NIDs strategies is not in full tandem with the dynamics of depletion of vitamin A. A guaranteed continuous intake at RNIs level through fortification of nationally consumed and centrally processed foods along with these strategies should enhance the chance of success. In addition, upward adjustment of the post-partum mega-dose, and initiation of the supplementation at third or fourth month during immunization present high potential entry points towards realization of this objective.

Under reproductive health, the bold statement about reduction of IDA among antenatal mothers by 30% translates into reduction of burden of anaemia by about 15%. Clearly, the magnitude of the problem, and moreover, the feasibility and cost-effectiveness of prevention necessitate upward revision of this target. Under malaria prevention and treatment the target to reduce malaria morbidity and mortality by 30% is a useful entry but recognition of consequence of asymptomatic parasitaemia on true and apparent micronutrients deficiency is desirable. Furthermore, while cognisance of need to increase proportion of household and people using ITNs is valuable in reduction of possible intra-household transmission, specialization to target <5 year-olds and mothers requires clear emphasis.

In the control and prevention of major environmental health related communicable disease, a basic education objective addresses teaching of basic health intervention and enhancing personal hygiene in schools. The treatment of biology and comprehensive health education as optional subjects in the current syllabi precludes the chances of realizing this objective at national level among future adults. In the absence of a comprehensive school health programme, it is clear that a unique opportunity to reduce the burden of helminthic and schistosoma infections in the community, and moreover, essential preparation of adolescents especially girls for adulthood demands is lost.

8.7 Limitations of survey

With exception of clusters in Meru and Bungoma districts, the desired response rates were considered too low to permit pooling of the data at district areas. However, except Elan Miritini and Utange, the cluster response rate of 75% and over was considered adequate for satisfactory representation of the actual situation at cluster level. In addition, based on HbC determinations for children and mothers an overall project implementation efficiency of 91.7 % was considered satisfactory for the national perspective using agro-ecological and altitude zoning. This was not the case for adult males in general. The reason for poor response included fear for HIV testing. For this group, at best the survey findings could give some insight into the situation among males. It is expected that the sampling and mobilization procedures considerably reduced selection bias especially for individuals coming for free medicine. However, a caveat in the interpretation of the survey findings in relation to estimated intra- zonal variations. These should be considered depicted in the *isoanaems* is required. The estimates generated by this survey should be considered provisional in the construction of comprehensive national anaemia profiles. Higher precision will only be achieved through increasing of the number clusters. Such shortcomings should be overcome when anaemia and micronutrients deficiencies are tackled at district level.

While HbC analysis was comprehensive, other key variables such as s-retinol and s-ferritin were by design captured in a sub-sample of the individuals. In addition, because of the logistics it was not possible to attain as high a coverage for parasitic diseases and household interviews. Invariably the resulting gaps reduced the number of cases for detailed statistical analysis. Therefore, while it is possible that sequential sampling could have minimized sampling biases, generalization of interpretations of the findings must take into account possible variations at household, population, cluster and sub-regional levels. In this regard the pooling of data at sub-regional or national level was based on assumed similarity and not absence of statistical significance. It is expected that supplementation of the survey findings with secondary data permitted more realistic interpretations. However, a clear limitation in this survey was its failure to capture details on HIV status of the participants. The latter is a key predictor of anaemia and micronutrients status, and available secondary data may not be sufficient to account for the contribution of HIV/AIDS to the overall burden of deficiencies with certitude.

In the morbidity questions, the duration of recall ranged between presently and last one month as opposed to the more common two-weekly recall. While noting the limitations associated with recalls, this survey assumed that significant illness occurring within a period of one month would easily be remembered by the respondents. In contrast, the more common fortnightly recall was considered a useful cut-off when tracking all morbid events. There is no clear-cut solution for such biases.

Despite earlier standardization of physical examination protocols and client interview, it is possible that variations arising from survey implementation by two teams could have occurred. Furthermore, the involvement of local health cadres at district level and translation of the questions into local languages could also have caused variations. For laboratory investigations paired observations and periodic independent re-examinations was carried out. It is expected that the close supervision maintained through out the survey, and the choice of motivated local health cadres significantly reduced variations attributable to these shortcomings.

The clusters sampled in this survey were predominantly rural. However, the fact that nearly 80% of the population is rural and the dominance of peri-urban and low-economic settlements among urban populations suggest that the survey findings should be a reasonably good reflection of the situation for majority in the country. The higher socio-economic urban groups may have been missed out in this survey and are may be an exception to some extent.

In the absence of data on acute phase response and chronic disease, it is possible that the desegregation between apparent and true deficiencies of s-ferritin, s-zinc and s-retinol especially in the malaria endemic areas was not as objective as that obtained using specific markers. However, given the relationship between biochemical and clinical findings to acute and chronic illnesses, desegregated distribution of findings of the three biochemical variables should be a reasonable estimate of the true situation. Furthermore, unsatisfactory response from providers limited analysis to a sub-sample of districts. However, workload statistics from HIS over a period of 4 to 5 years should have improved representativeness of the national distribution of anaemia burden. While findings on availability of haematinics among providers were limited, the prevailing economic trends suggest that the observed pattern is a useful pointer to the actual situation.

The findings of this cross-sectional survey provide a snapshot view of anemia and selected micronutrients status of the population under the prevailing environmental, health economic and food security conditions. It is not possible to establish temporal relationship between exposure dynamics and the scenarios captured by the survey. Furthermore, in computation of odds ratios, prevalence of relevant dependent variables was treated as incidence. However, characterization of anaemia and related deficiencies, along with delineation of the risk factors form a sound base for reviewing strategies outlined in the NHSSP and evaluation of ongoing activities from a more comprehensive perspective.

CHAPTER 9: CONCLUSIONS, RECOMMENDATIONS AND IMPLEMENTATION STRATEGIES

9.1 Conclusions

Within the context of the findings of this survey, the following conclusions are advanced:

9.1.1 Burden of anaemia, IDA and ID

Low HbC defined anaemia is a national public health problem. Anaemia prevention and control must therefore, be accorded high priority status. Across the country the largest burden of anaemia is borne by preschool age children and the lowest by men, older children and the elderly. Discounting for older children and the elderly, provisional *isoanaems* indicate that the distribution of the burden of anaemia is heavily skewed with the low altitude semi-arid to arid north and the lake basin sub-regions bearing the larger share of moderate and severe forms of the estimated national burden. Among pre-school age children, seven out of every ten children are likely to be anaemic. 35.2 % and 76.5 % of this burden is borne by infants and children aged below 30 months respectively. Moderate to severe anaemia is more common than mild grades. Among mothers, on average one out of every two is affected irrespective of pregnancy status. Consequently, moderate to severe grades of anaemia are dominant among pregnant mothers. This underpinned the fact that over half of mothers probably entered pregnancy in anemic state. Older children, adult men and the elderly bear lower but significant burden of mild anaemia that is estimated at one or more in every five individuals in these population groups. Correspondingly, an upward shift in median haemoglobin concentration would be required for all except men in the central highlands and part of the midlands. In this consideration, an adjustment factor of anaemia cut-off point in the HbC by 1 g/dL per 1000 m *asl* instead of 0.25 g/dL would be appropriate.

With regard to distribution of burden of anaemia per unit of surveyed population, the lake basin and coastal and northern semi-arid lowlands lead. The western highlands and midlands follow in that order. The central and mid west highlands sub-region has lowest anaemia burden per unit population but weighting for population density yields a large burden of predominantly mild anaemia. Under field conditions, it would appear that both a median HbC shift and response among the central highlands residents would constitute useful references for national interventions against nutrition anaemia.

It was estimated that 43.2 %, 42.9 % and 15.9% of pre-school children, mothers and adult males in that order were iron deficient. Including those at high risk of slipping into deficiency status raised the proportion of affected children and mothers to over 70 %. For adult males the estimate was 26 %. Iron deficiency is likely to account for about one-half, two-thirds and less than one-third of burden of anaemia among children, mothers and adult males in that order. Overall, for every observed case of IDA, there will be at least 2 cases of ID among young children, mother and adult males. It is possible that storage iron and subsequent desegregation of ill from well children may have underestimated prevalence of iron deficiency due to pooling of apparent and true s-ferritin deficiencies. Despite presence of sickling, s-transferrin receptor alone or with s-ferritin should be

considered in future. Chronic and acute anaemia should also be desegregated in futu[r]
assessments. Whilst decreasing oxygen tension with increasing altitude sufficient explains the higher HbC in the highlands, its relationship with bioavailability of hematinic could not be clarified. Furthermore, low s-ferritin among non-anemic individuals wa[s] evident especially among children. This is considered be a statistical effect given th[e] definition of anaemia based on low HbC. Non-iron deficiency anaemia due t[o] inadequacy of other hematinics and hemolytic losses should account for the remainin[g] proportions.

Aetiologies of anaemia

The staple diets are primarily of low iron bioavailability potential category. Reduced foo[d] security during the dry season and malaria parasitaemia were each associated wit[h] nearly two-fold increase in risk for child and maternal anaemia. Similarly, diarrhoea, maternal anaemia and family size were each associated with a two-fold increase in the risk of childhood anaemia. Splenomegaly was most graphic with a five-fold increase in the risk of childhood anaemia. The significance of wastage due to hookworm and Schistosoma infections was seen in mothers and adult males respectively. Vitamin A deficiency was associated with a three-fold increase in the risk of both maternal and adult male anaemia. Reported febrile episodes were also included in anaemia models of the three groups. Thus, the models largely conform with the conceptual framework adapted for anaemia (Appendix 1.1) and reflected important regional and by extension household characteristic exposure to risk factors. The reverse response to reported weekly flesh consumption was unclear but could in part be related to consumption of small quantities.

9.1.2 Vitamin A deficiency (VAD)

The prevalence of VAD remains a significant public health problem in Kenya. The inferred prevalence of VAD based on s-retinol deficiency among preschoolers (14.7 % for acute and 61.2% for moderate grades) was nearly twice that reported in the 1994 survey. The rates remained relatively unchanged in some district areas while others possibly deteriorated. The prevalence of acute and moderate VAD among mothers were 9.1 % and 29.6% respectively. The trend and distribution pattern were similar to those seen among children. Malaria parasitaemia, hookworm infection and malnutrition were each associated with a two-fold increase in the risk of VAD. The rates of VAD among adult males were two to three percentage points below those of mothers. Positive history of recurrent fever and hookworm infection were each associated with nearly two-fold increase in risk of VAD. Anaemia was associated with a three-fold increase in the risk of VAD among mothers and adult males.

The inferred trend is most likely a product of drought associated *La Nina* phenomenon and increasing poverty. Absence of major improvement s among mothers and young children was likely due to low coverage at the time of the survey. Furthermore, the pattern was in tandem with deteriorating health indices reported in recent Demographic Health Surveys as indicated in the background. The trend calls for improvement in the quality of VAD elimination activities and identification of novel approaches to increase community access and intake of vitamin A or effective pro-vitamin A. Furthermore, twining anaemia control with ongoing VAD interventions should be most prudent.

9.1.3. Zinc deficiency

High risk for hypozincaemia is likely to occur in about half of the population. Among children, diarrhoea, hookworm and anaemia were the main risk factors for hypozincaemia. Among mothers, anaemia and respiratory tract illnesses were each associated with nearly two-fold increase in risk of hypozincaemia. Hookworm and maternal malnutrition are also likely to be significant factors. Pregnancy further exacerbated the risk of deficiency. In the case of men, Schistosoma infections and VAD were each associated with a two-fold increase in the risk of hypozincaemia. Overall, distribution of zinc level and deficiency, and association with anaemia strongly indicates the need to consider coupling zinc supplementation with that of iron.

9.1.4. Parasitic and other infections

Malaria: Parasitaemia rates especially among pre-schoolers, and acquisition of infection by nearly half and one-third of the children below 6 months of age in western Kenya (lake basin and western highlands) and the coast respectively is significant. The burden of parasitaemia in midland areas in Meru and possibility of invasion of lower grounds in the central highlands also merits decisive action. In addition, low household bed net coverage and dismally performing pre-purchase and post-purchase insecticide treatment showed saturation of common predictors of net acquisition. The need to initiate novel approaches to improve household acquisition propensity and treatment especially as part of the ante- and post-natal care package requires emphasis.

Hookworm and Schistosoma infections: The findings confirmed the century old observations on regional distribution of hookworm infections and the need to extend the high transmission zone to cover the entire western highlands. The transmission patterns implied the likely dominance of behavioural factors, infectiveness of soil and tropical climates in hookworm infection rates. The distribution of schistosoma infections confirmed previous reports. The low intensity in both infections and probably less aggressive hookworm species could explain strengths of associations with anaemia and merits follow up investigations.

Other illnesses: Perceived febrile episodes, respiratory morbidity and diarrhoeal disease were reported by relatively large proportions of mothers, children and adult males. From available literature HIV infection significantly increases the burden of anaemia. The relationship between observed morbidity and depressed coping mechanisms in the communities is unclear. Nevertheless, they portrayed a significant burden of unmet households health needs.

While recent findings do not support increased helminthic infection rates or increased risk of clinical malaria attacks among individuals receiving iron supplementation, there are strong indications that excess iron and zinc exacerbates progression of HIV and tuberculosis. Should this concern gain foothold, then with the reported prevalence of HIV infection and the observed occurrence of anaemia a major public health dilemma especially among antenatal mothers is in the offing.

9.1.5. Health services provision and use

The district anaemia workload pattern was largely comparable to the distribution projected from survey *isoanaems*. It would appear that for every anaemia case detected at facility level several hundred anaemic persons remain in the community oblivious of their anaemic status, its cause and consequences. In this regard, the level of concrete awareness in majority of mothers is low and motivation for individual or household preventive action seems limited. Outside health workers and inferred peer gossip, little information seems to reach the communities about anaemia from other sources.

The GoK followed by missions and private clinics are the main providers of formal health care. Iron and folic acid supplements were available in most facilities but amounts supplied were on average inadequate and unbalanced. Moreover, routine prescription of hematinics even to antenatal mothers as per guidelines was not universally observed. Close to three out of five mothers deliver at home and could miss the recommended post-partum vitamin A supplementation. In addition to side effects reported by some mothers, varying pricing of hematinics could inhibit access and use by vulnerable groups. There were no obvious facility or community based hematinic supplementation to control anaemia among children. The few fortified foods are mainly found in city supermarkets and invariably inaccessible to the vulnerable majority.

High sensitivity but low specificity of pallor and splenomegaly for moderate and severe anaemia emphasised need for increasing access to basic laboratory support service. These services were not available at dispensary level despite being the most accessible source of care. Against expectation, the private providers did not perform better in terms of supplementation for pregnant mothers. Early childhood malnutrition confirmed precipitous loss in growth momentum during the first half of infancy and worrying trends in breast-feeding practices in parts of central highlands and semi-arid communities. Of significance is care practices and performance growth monitoring support services. For the older children, there was no scaled up school or community based hookworm or Schistosoma or micronutrients control programme.

9.2 Recommendations

Within the limits of interpretation of the survey findings, anaemia was a product of multiple factors, in which dietary incarceration was dominant and other factors were grafted on. In malaria hyperendemic areas it is highly probable that malaria attributable fraction of anaemia is significantly larger than that due to dietary inadequacies. Thus, the burden of infections and, inadequate household and facility coping mechanism exacerbated the burden of anaemia. These aspects lucidly interface anaemia and micronutrients deficiencies with the national poverty reduction plan. Furthermore, elicited relationships between anaemia and various risk factors demonstrated the contribution of immediate, underlying and basic causes to the magnitude of anaemia and micronutrients deficiencies. The need to combine interim expedient interventions to protect children and mothers and primary prevention targeting the general population is therefore explicit. Consequently, the following recommendations are advanced.

a. The government (GoK) and development partners in health and related sectors recognize consequences of anaemia and priority micronutrients deficiencies to the socio-economic development of Kenya. A national wide advocacy initiative to expose cost-effective risk reduction approaches to contain the problem and maximize accruable benefits be mounted without delay.

b. Specific preventive measures targeting anaemia and hematinic deficiencies as the principal problem among 2 to 30 month-olds, antenatal and lactating mothers be visibly integrated into MCH and child survival programmes at national level. For the lake basin and northern arid to semi-arid zones, these efforts should target all under 5 year-olds.

c. The magnitude of deficiencies shown by this survey strongly indicates that micronutrients supplements should be accorded the status of public health goods. Arising from this, mechanisms should be established to ensure that they are readily accessible to the poorest and most vulnerable. The NHSSP projected reduction target of 30 % of iron deficiency anaemia should be adjusted upwards and include other hematinics.

d. The preventive and promotive care capacity of the GoK providers should be strengthened in terms of provision of diagnostic and prophylactic services for anaemia and other micronutrients deficiencies as well as infections associated with their development. The capacity of the private providers should also be tapped and the necessary support provided to enhance effective provision of anaemia and micronutrients deficiency preventive care.

e. To increase access to hematinics for the general population, the capacity of district PHC set-ups should be strengthened to accommodate anaemia and micronutrients deficiencies prevention.

f. Nation wide efforts towards increasing micronutrients density through, among others increasing bioavailability and food fortification of commonly consumed foodstuffs and condiments is required. Dietary diversification should also be included in this framework.

g. In order to optimize efficient and cost-effective innovative interventions, the existing operations research, monitoring and evaluation capacity should be strengthened.

9.3 Strategies

a. The GoK facilitate the design of strategies to raise awareness among stake holders including the community

The government should formulate policies to stimulate concerted multi sectoral efforts by public and non-governmental development partners in the control of anaemia and hidden hunger nutrients in general. Within the health sector, fine tuning of policies to facilitate expedient interventions to protect mothers and children through improved access to micronutrients supplements and parasitic diseases control are required. This should be achieved through review of packages proposed in the NHSSP and strengthening the health and nutrition IEC packages. The capacity of the micronutrients committee should be strengthened to catalyze this process through development of a comprehensive policy for micronutrients deficiency control in Kenya.

b. Integration of specific anaemia and micronutrients deficiencies control

Integration of anaemia and micronutrients deficiency control with proximal on-going national or regional health programmes provides the way forward. The on-going child focused priority preventive interventions including those of VAD should be reviewed to identify relatively straightforward responsibilities that can be transferred to the community and households. Infant supplementation with mega dose vitamin A should be brought forward possibly to the third month. In case of mothers, these interventions must be extended to lactating ones and non-pregnant mothers in general. The current mega-dose vitamin A regime for post-partum mothers should be revised upwards and made accessible to those delivering at home. Furthermore, a multi-micronutrients package should be made available to all mothers and adolescent girls through outlets such as family planning and youth clinics respectively. Activities targeting maternal knowledge on childcare practices should lean heavily on anaemia and micronutrients deficiency as verifiable indicators. An objective HbC assessment should be made available at dispensary and outreach levels.

c. Improved access to supplements and parasite control measures

To improve overall population access, the price of micronutrients supplements should become significantly lower if they are placed under zero rate duty category. In the worst case scenario, the GoK should consider duty waiver within context of increasing human productivity aspect of the national poverty reduction plan. Similar treatment should be accorded to the crusade against malaria by improve bed net coverage and insecticides for mothers and infants living in malaria endemic areas. Finally, effective and affordable treatment for malaria, hookworm and schistosoma infections should be accessible in endemic areas. Activities leading to modification of health seeking behaviour for perceived malaria infection and mothers index of suspicion for anaemia based on pallor and splenomegaly should be included in the community package. At sub-regional or regional levels, strategies for reducing wastage due to filariasis and leishmaniasis could also be indicated.

l. **Partnerships in reaching out to entire community**

To achieve **b** and **c** above, capacitation of the inter-phase personnel such as Traditional Birth Attendants, Community Health Workers and schoolteachers should be factored in the process. School health and nutrition programmes should be scaled up and optimized to benefit use of educational opportunities and meet increased needs all children, especially adolescents. Community action programmes among them Early Childhood Education and Development programme (ECD) and Community Based Nutrition Programme (CBNP) should be used in reaching out to pre-schoolars and non-school going children.

- **Increasing nutrient density and primary household prevention**

For effective primary prevention, there is need to increase bioavailability of micronutrients in particular iron and zinc from staple foods. Dietary improvement aimed at increasing intake of vitamin C, vitamin A and pro-vitamin A is required. Mineral releasing processes such as fermentation and sprouting should be re-examined and promoted appropriately. Use of iron pots is feasible and cost-effective and should be promoted. For these concepts to gain local acceptance development of social marketing strategies is requisite.

Food fortification and diversification of food crops

Stakeholders should provide support for feasibility studies and preparation of GoK policy to enable industries fortify selected foods and condiments. The GoK should define specific incentives to stimulate an active and sustained fortification programme by the industries as a public health measure. High on the list are centrally processed sugar, flour, oils and salt. Lessons learned from salt iodization programme in the country should be utilized. The feasibility of introducing high nutrient density varieties of staple food crops such as genetically modified cereals and tubers and rich indigenous plants should be accorded high priority status. Similarly, activities to increase consumption of micronutrients rich indigenous plants merits attention.

- **Support for operations research and an effective monitoring and evaluation system.**

Available capacity in local research institutes and universities should be strengthened to effectively support policy decisions and programme activities. Top on the agenda should be operations research towards optimizing strategies in the control of anemia and micronutrients deficiencies at national and specific sub-regions, the role of other hematinics in different types of anaemia, interactions between HIV and TB with iron, zinc and vitamin A and their implications, zinc and growth velocity and speciation of hookworm in endemic areas. In addition, food-health policy research especially in relation promotion of genetically modified varieties of food crops and indigenous plants that are known to be very rich in the key micronutrients, fish consumption quarters and approaches in social marketing of nutrient dense foods. Furthermore, the micronutrients committee and researchers should review the cutoff points for anaemia in different regions as well as preparations of supplements available in the market.

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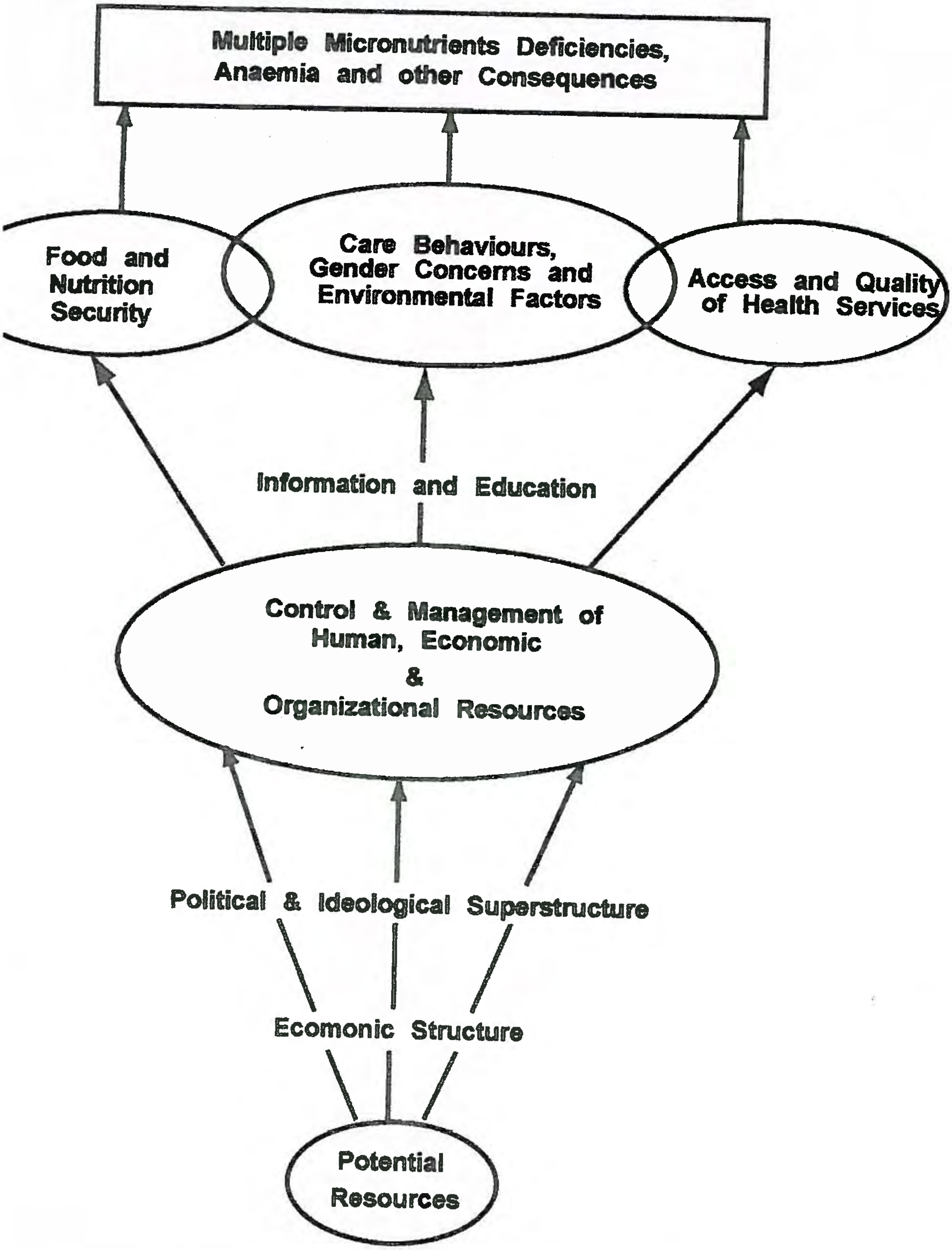
APPENDICES

pendix 1.1 Simplified conceptual framework for micro-nutrient deficiencies and anaemia



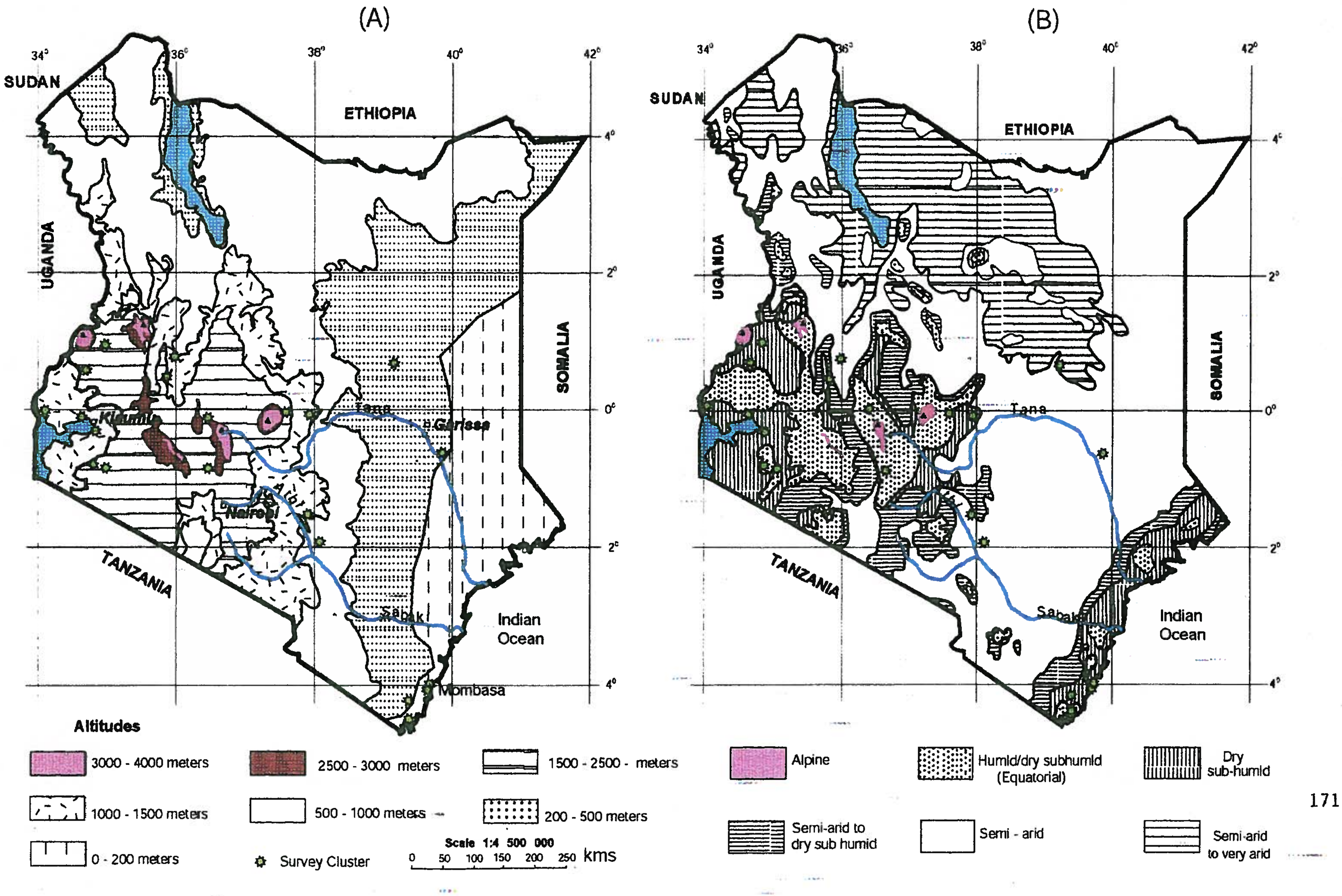
Appendix 2.1: Biochemical indicators of progressive development of iron deficiency anaemia.

Indices of iron status	**Early stage:** Depleted iron stores	**Intermediate stage:** Iron-deficiency without anemia	**Late stage:** Iron-deficiency anaemia
↓ Serum ferritin	— — —	— — —	— — →
↓ Transferrin saturation		— — — —	— — — →
↑ Transferrin receptor		— — — —	— — — →
↑ Erythrocyte protophorphyrin		— — —	— — — →
↓ Hemoglobin			— — — →
↓ Mean corpuscular volume			— — →

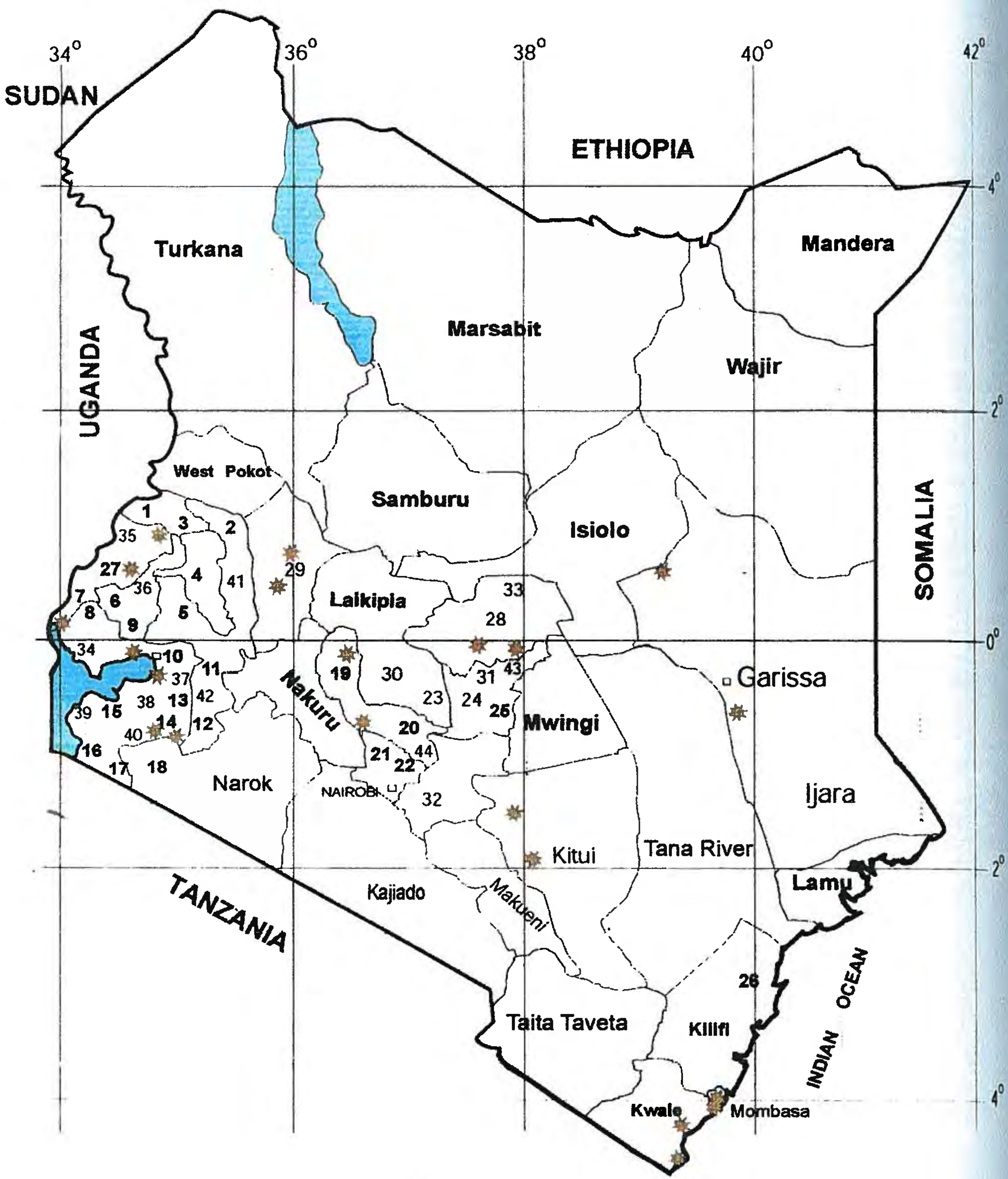
↑ Elevated

↓ Depressed

Appendix 2.2 : Distribution of relief features (A), ecological zones (B) and location of survey clusters



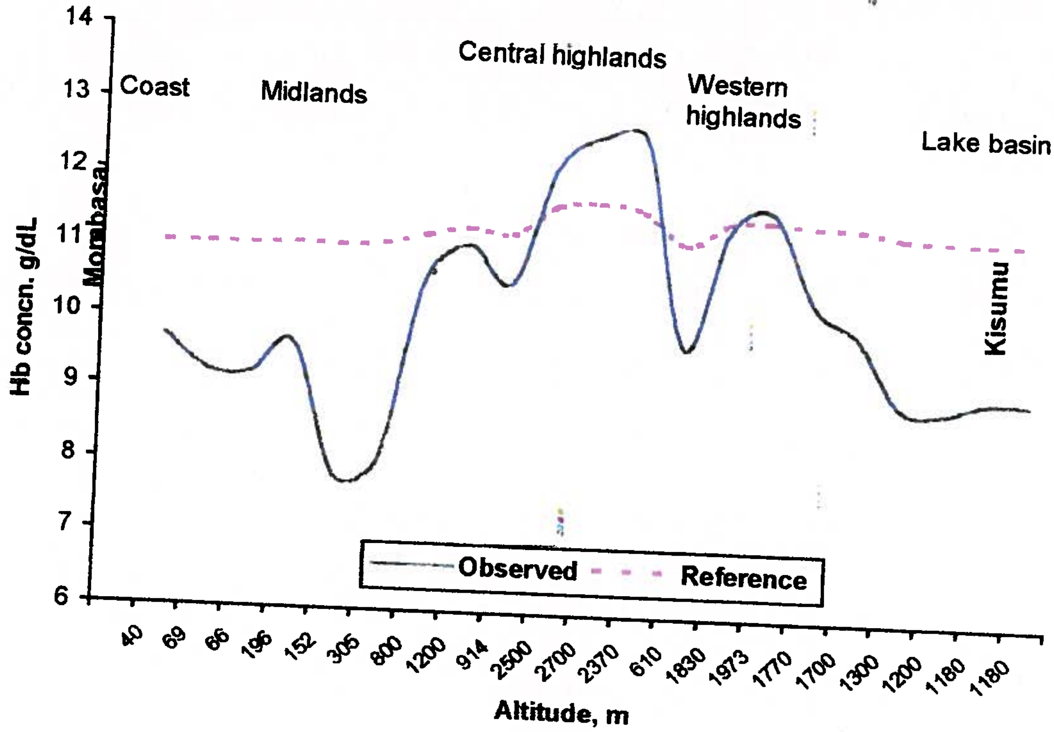
Appendix 2.3: Districts in Kenya



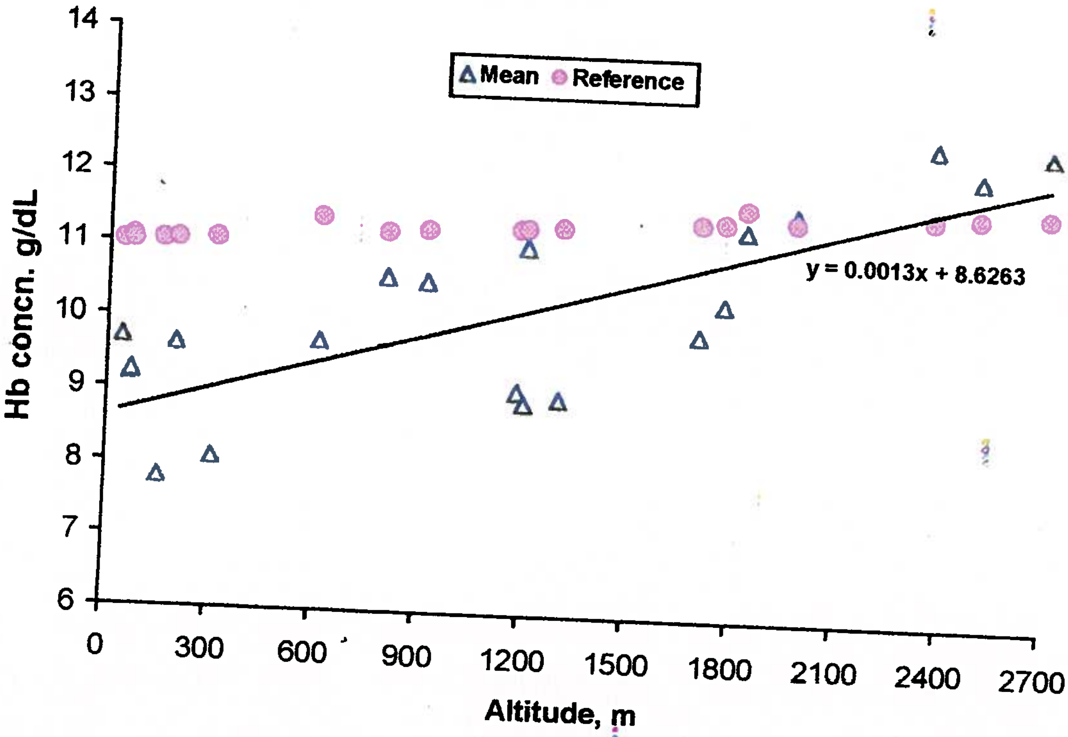
1 - Mt. Elgon	7 - Busia	13 - Nyamira	19 - Nyandarua	25 - Mbeere	31 - Nithi	37 - Nyando	44 - Maragua
2 - Marakwet	8 - Siaya	14 - Kisii	20 - Murang'a	26 - Malindi	32 - Machakos	38 - Rachuonyo	43 - Tharaka
3 - Trans Nzoia	9 - Vihiga	15 - Homa Bay	21 - Kiambu	27 - Bungoma	33 - Nyambene	39 - Suba	
4 - Uasin Gishu	10 - Kisumu	16 - Migori	22 - Thika	28 - Meru	34 - Bondo	40 - Gucha	
5 - Nandi	11 - Kericho	17 - Kuria	23 - Kirinyaga	29 - Baringo	35 - Teso	41 - Keiyo	
6 - Kakamega	12 - Bomet	18 - Trans Mara	24 - Embu	30 - Nyeri	36 - Butere Mumisa	42 - Buret	

Scale 1:4 500 000

Appendix 3.1: **Distribution of mean Hb concentration among 6-72 months old children**

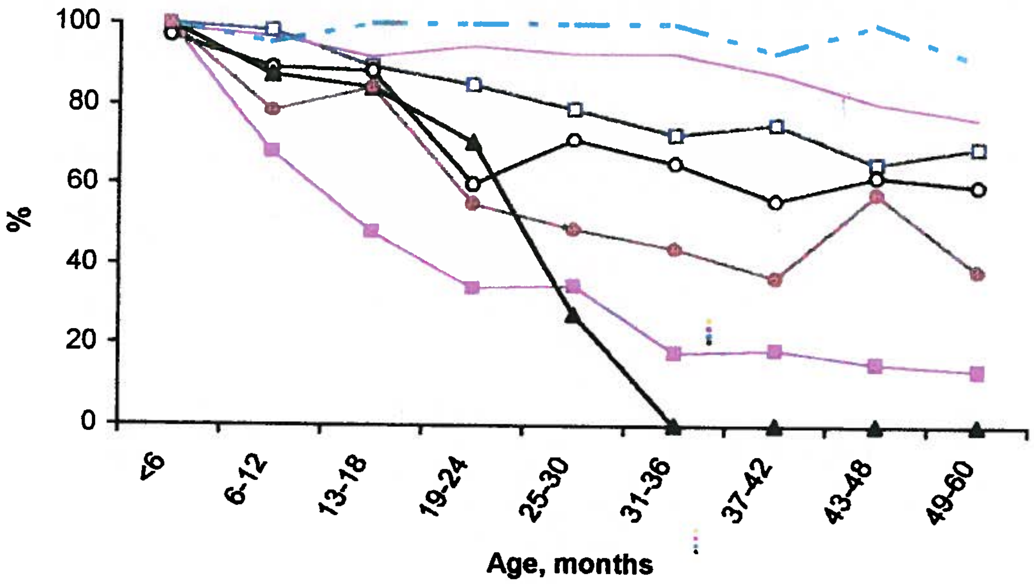


Appendix 3.2: **Variations in mean Hb concentration with altitude among 6-72 months –old children**

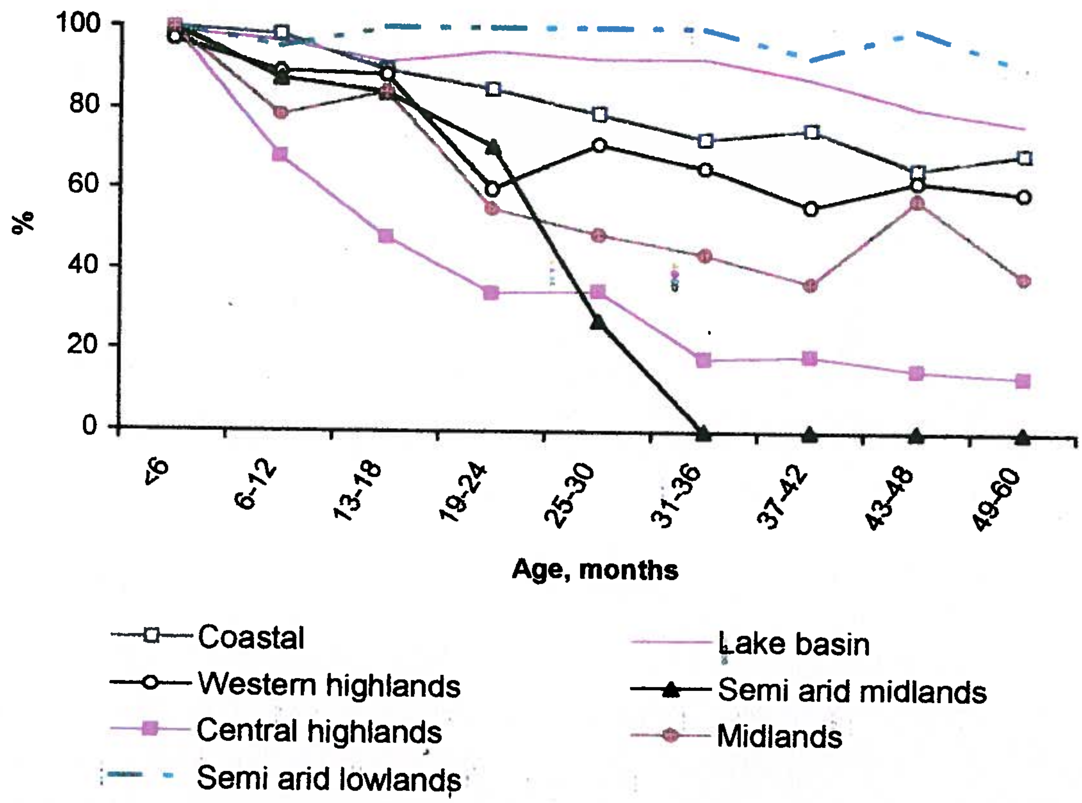


Appendix 3.3: Distribution of pooled anemia (A) and moderate to severe anemia (B) in different sub-regions.

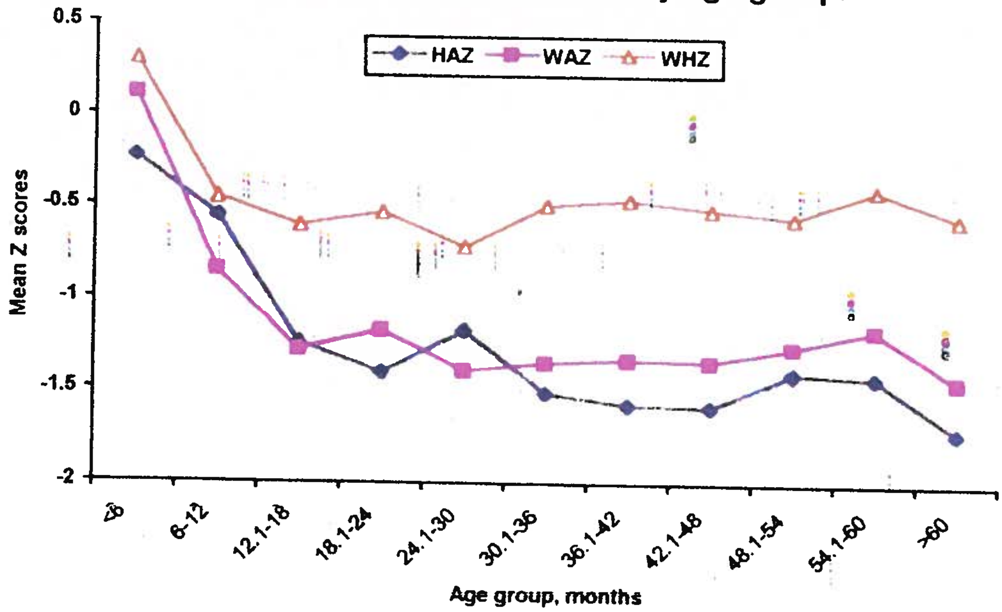
(A)



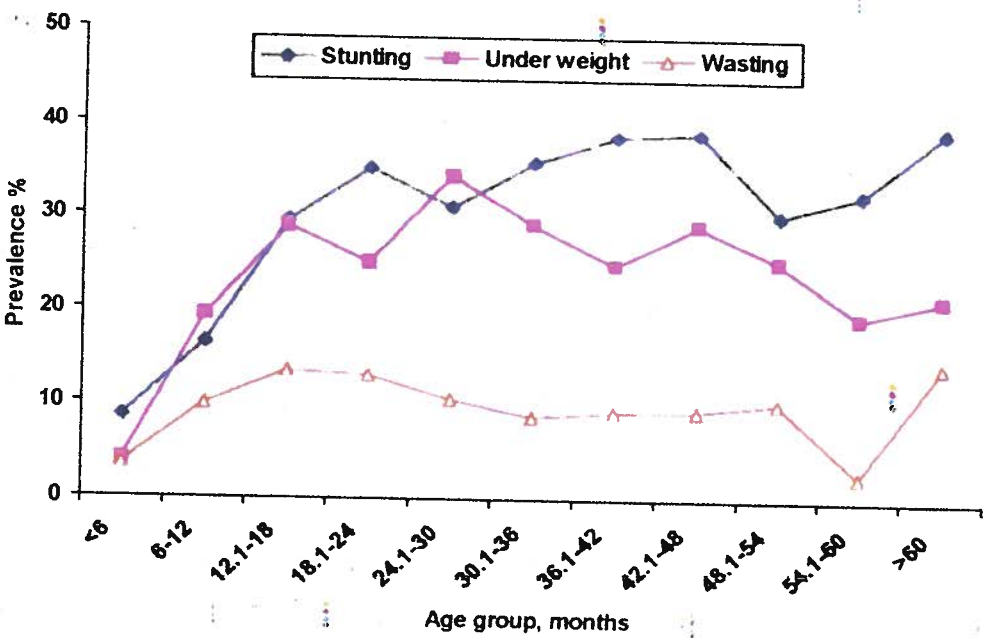
(B)



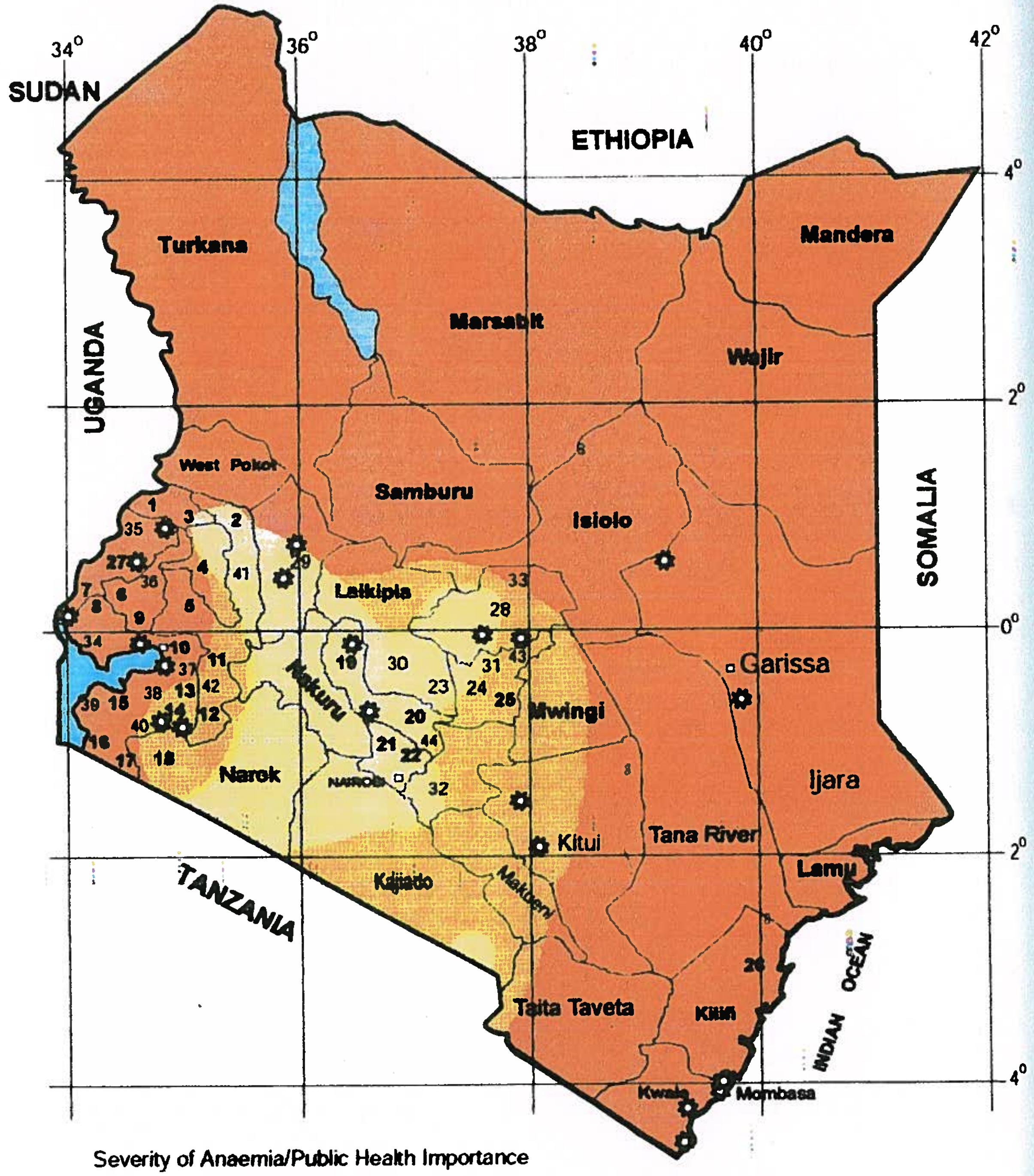
Appendix 3.4: **Changes in mean height-for-age, weight-for-age and weight-for-height Z scores by age group.**



Appendix 3.5: **Prevalence of stunting, underweight and wasting by age group.**



Appendix 3.6: Estimated isoanaems for children



Severity of Anaemia/Public Health Importance

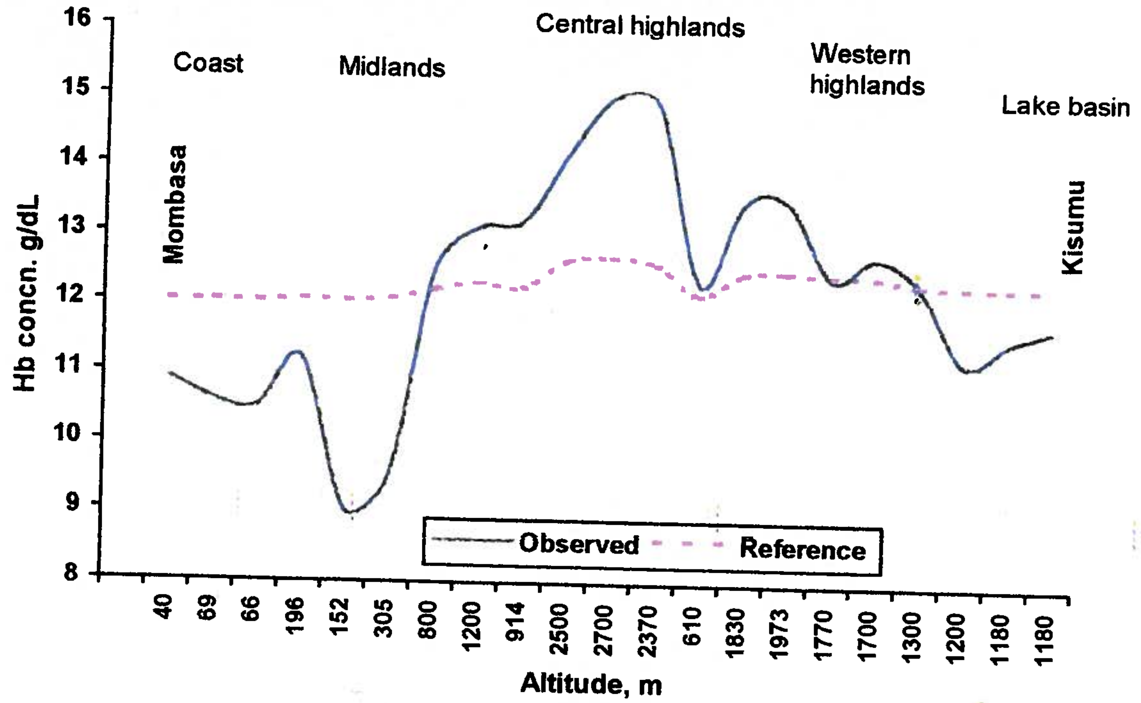
- Severe/highly significant problem
- Moderate/moderate to highly significant problem
- Mild/moderately significant problem

1 - Mt. Elgon	7 - Busia	13 Nyamira	19 Nyandarua	25 Mbeere	31 Nithi	37 Nyando	44 Maragua
2 Marakwet	8 - Siaya	14 - Kisii	20 Murang'a	26 - Malindi	32 Machakos	38 Rachuonyo	43 - Tharaka
3 - Trans Nzoia	9 - Vihiga	15 - Homa Bay	21 - Kiambu	27 - Bungoma	33 Nyambene	39 - Suba	
4 - Uasin Gishu	10 - Kisumu	16 - Migori	22 Thika	28 - Meru	34 Bondo	40 Gucha	
5 Nandi	11 - Kericho	17 - Kuria	23 Kirinyaga	29 - Baringo	35 Teso	41 Keiyo	
6 - Kakamega	12 Bomet	18 Trans Mara	24 - Embu	30 - Nyeri	36 - Butere Mumisa	42 - Buret	

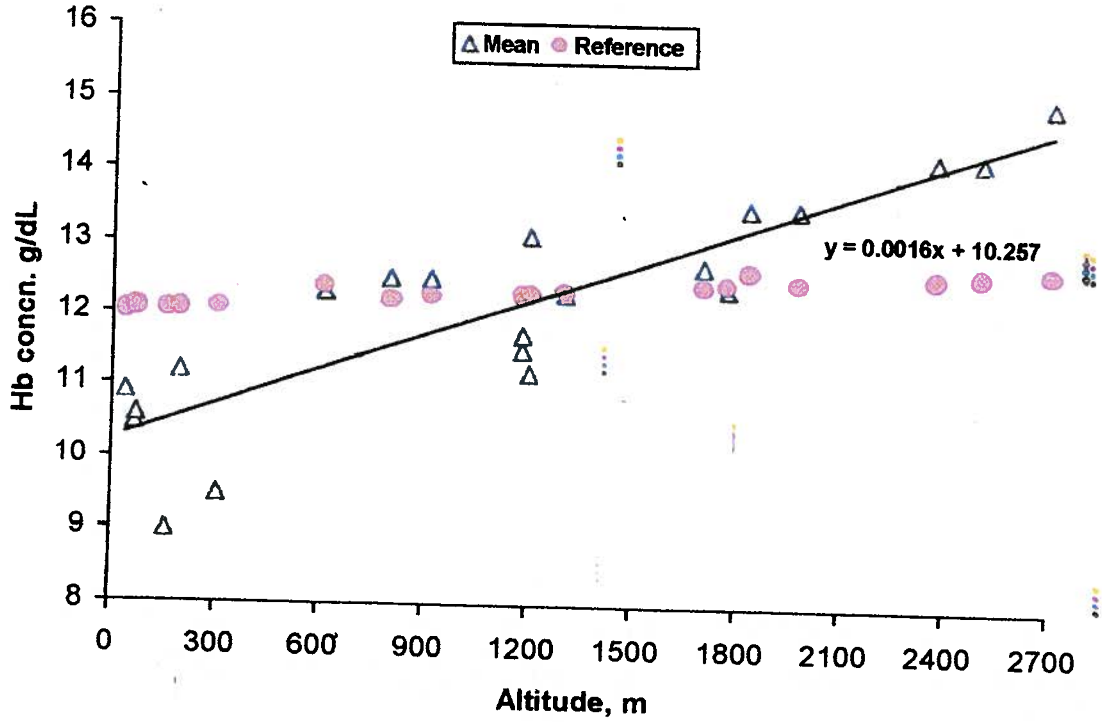
✲ Survey Cluster

Scale 1:4 500 000
0 50 100 150 200 250 Kms

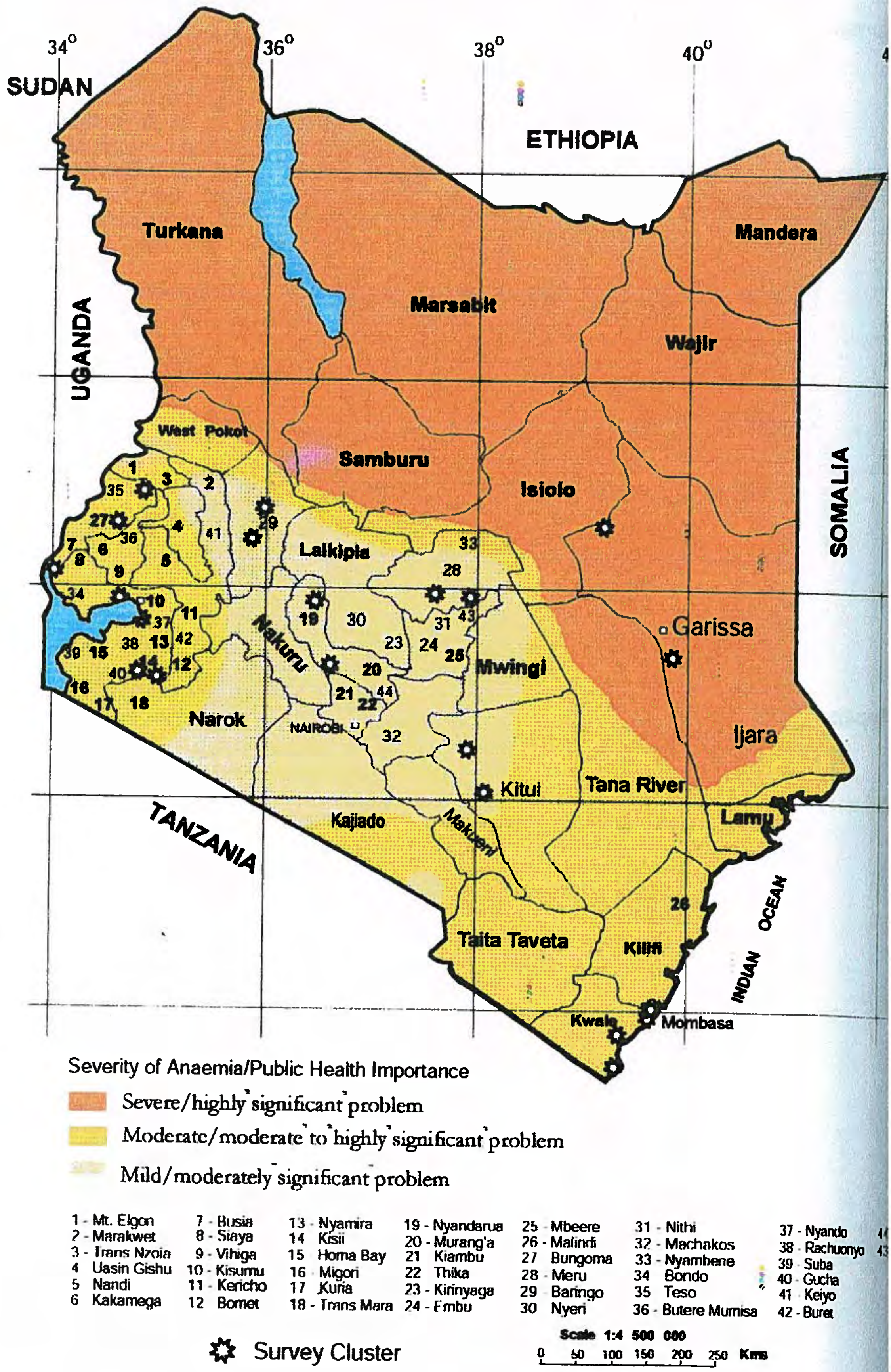
Appendix 4.1: **Distribution of mean Hb concentration among non pregnant mothers**



Appendix 4.2: **Variations in mean Hb concentration with altitude among non pregnant mothers**



Appendix 4.3: Estimated isoanaems for mothers



pendix 4.4: **Distribution of difference between altitude adjusted median and reference HbC by cluster.**

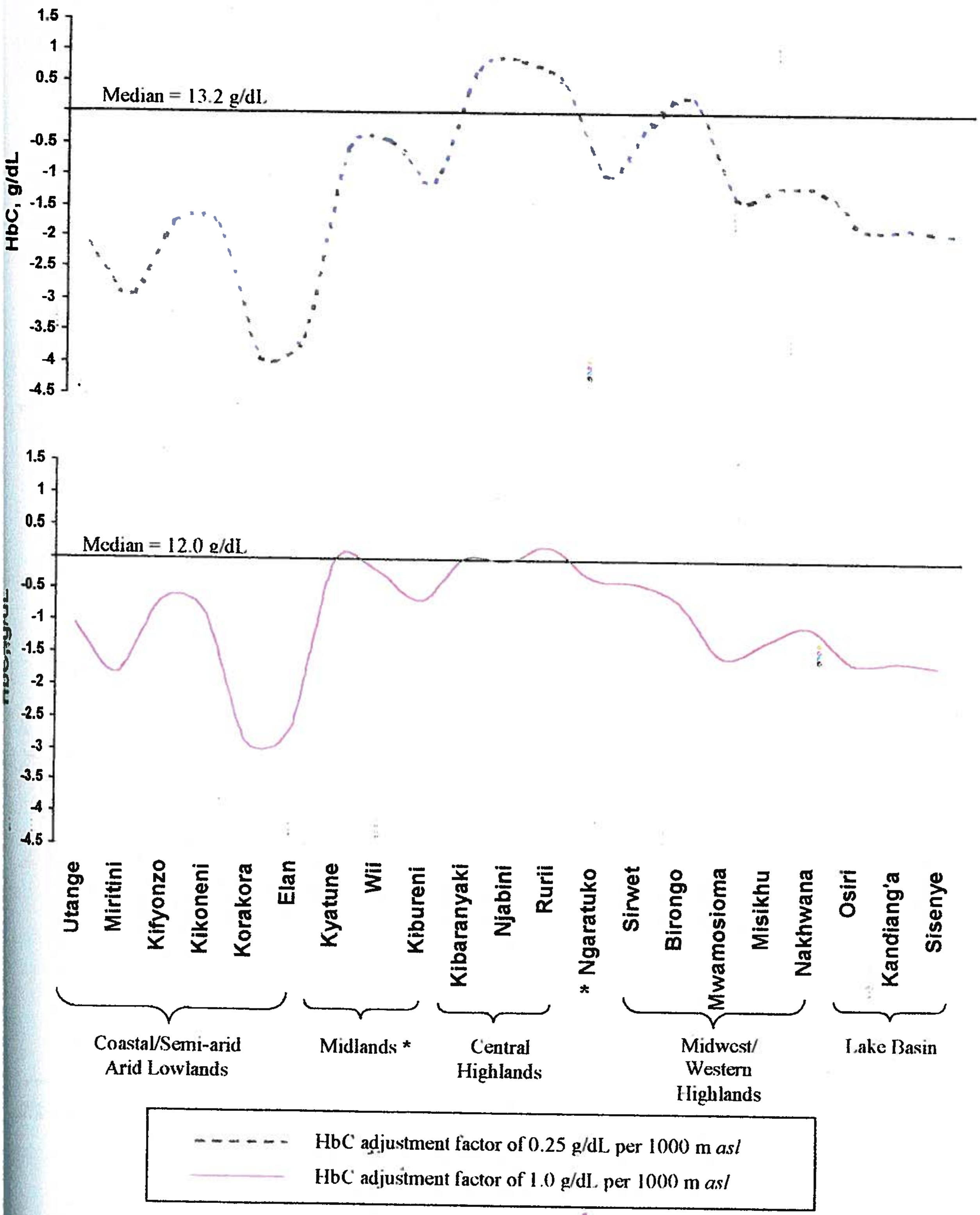


Figure 5.1: Distribution of mean Hb concentration among adult males

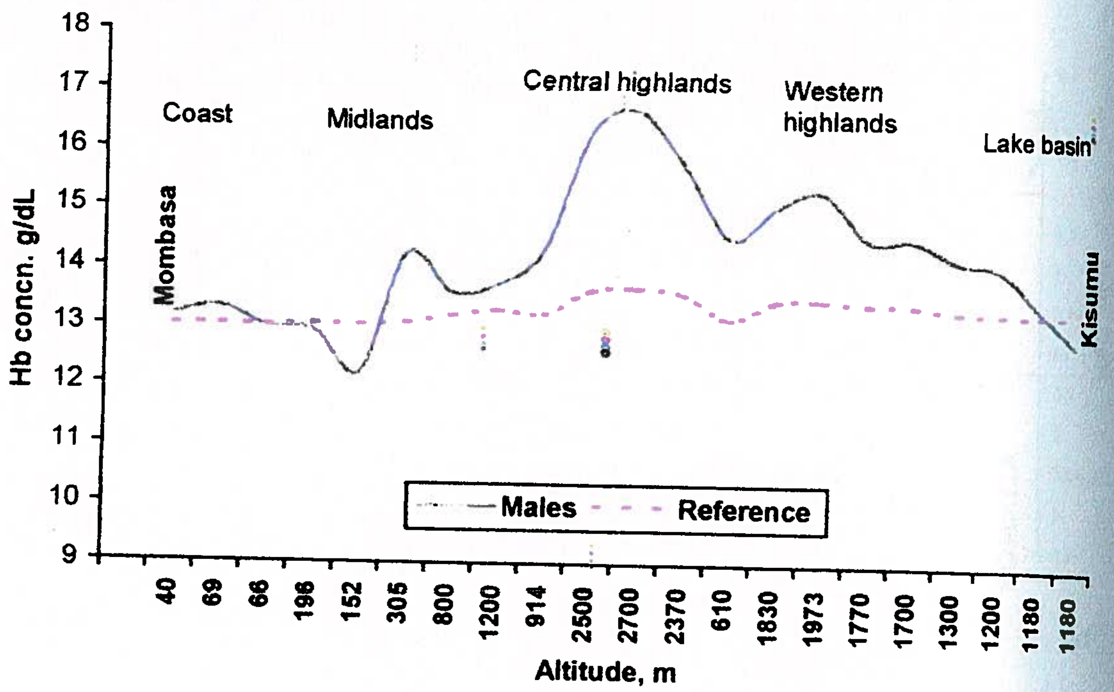
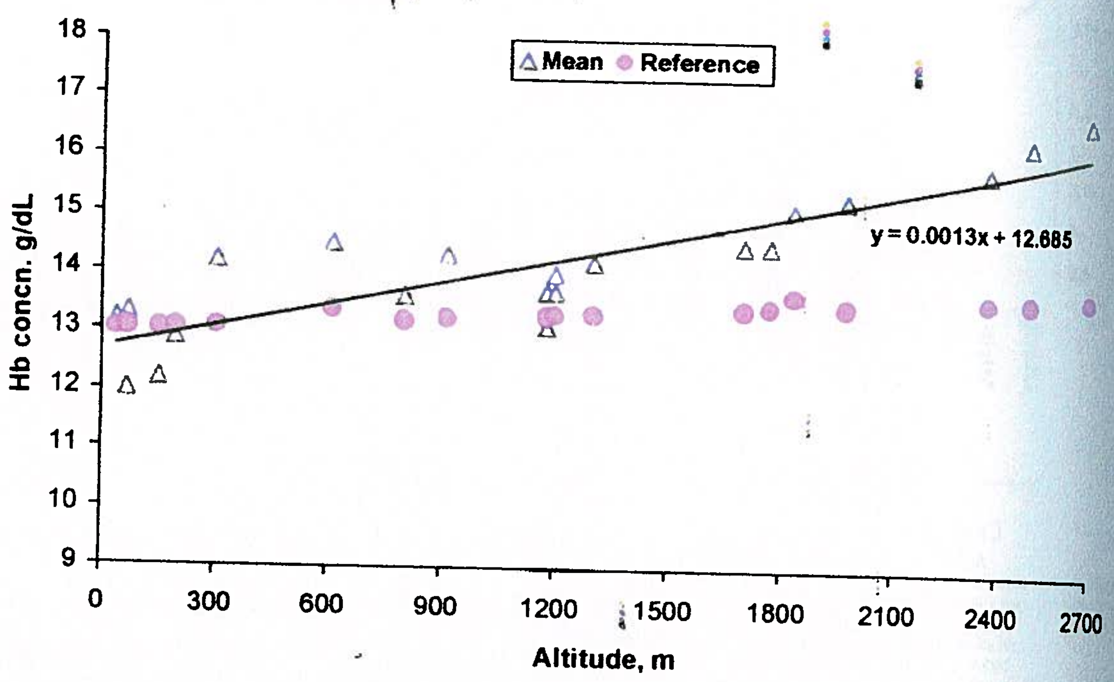
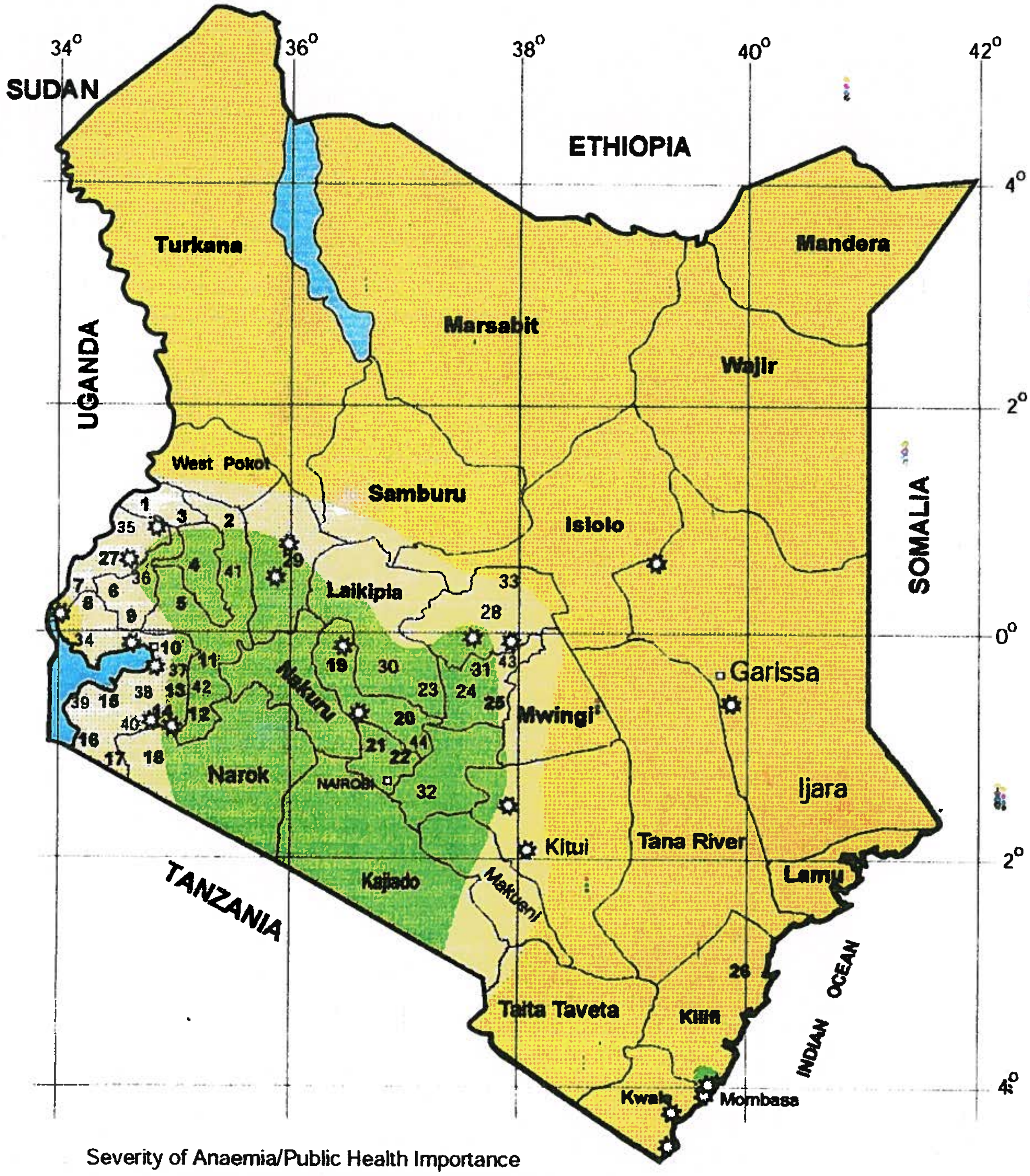


Figure 5.2: Variations in mean Hb concentration with altitude among adult males



Appendix 5.3: Estimated isoanaems for adult males



Severity of Anaemia/Public Health Importance

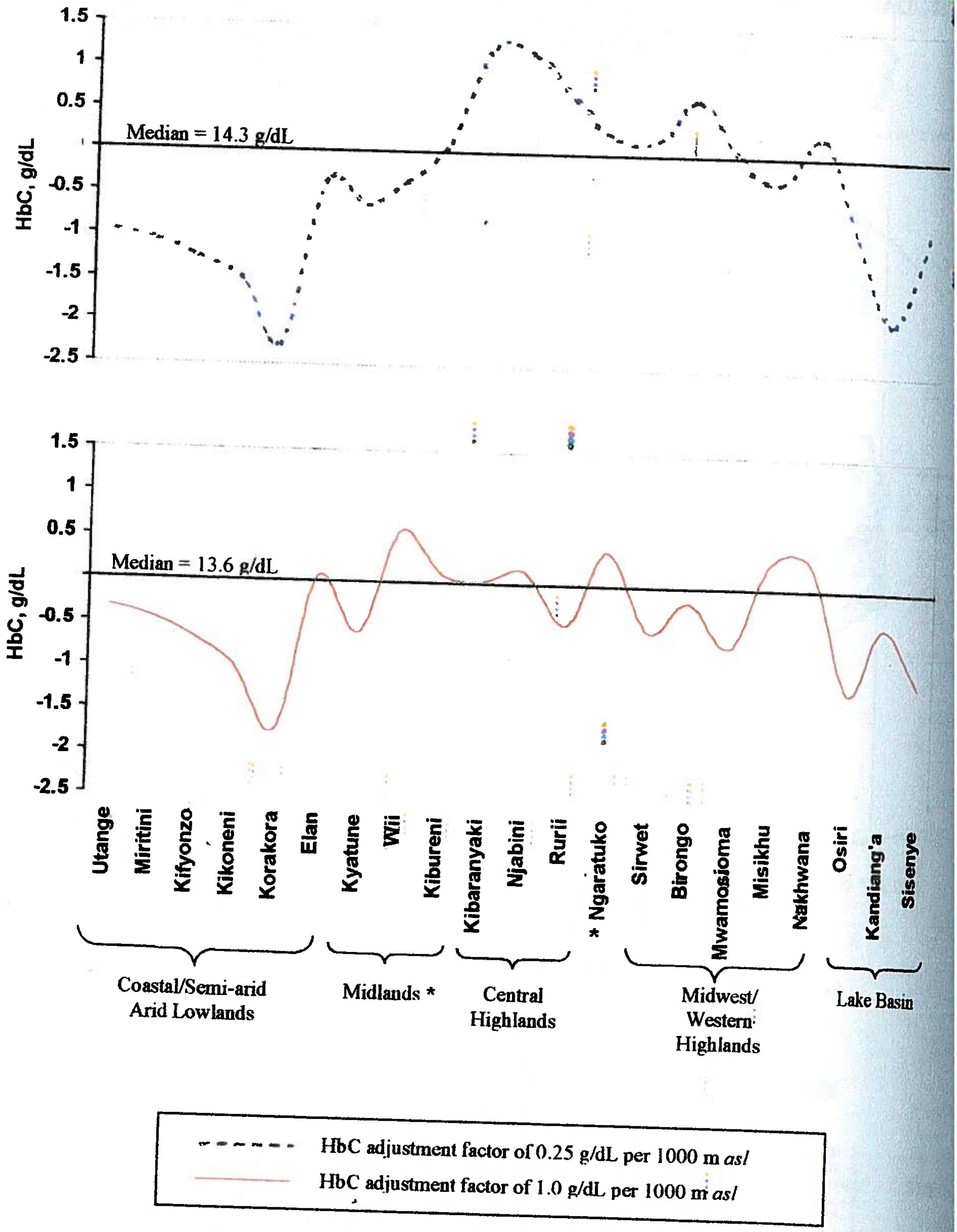
- Moderate/moderate to highly significant problem
- Mild/moderately significant problem
- None/low significance

1 - Mt. Elgon
2 - Marakwet
3 - Trans Nzoia
4 - Uasin Gishu
5 - Nandi
6 - Kakamega
7 Busia
8 Siaya
9 - Vihiga
10 Kisumu
11 - Kericho
12 - Bomet
13 - Nyamira
14 - Kisii
15 - Homa Bay
16 - Migori
17 - Kuria
18 - Trans Mara
19 Nyandarua
20 Murang'a
21 - Kiambu
22 - Thika
23 - Kirinyaga
24 Embu
25 - Mbeere
26 Malindi
27 - Bungoma
28 - Meru
29 - Baringo
30 - Nyeri
31 Nithi
32 Machakos
33 Nyambene
34 - Bondo
35 - Teso
36 - Butere Mumisa
37 - Nyando
38 - Rachuonyo
39 - Suba
40 - Gucha
41 - Keiyo
42 - Buret
44 - Maragua
43 - Tharaka

✲ Survey Cluster

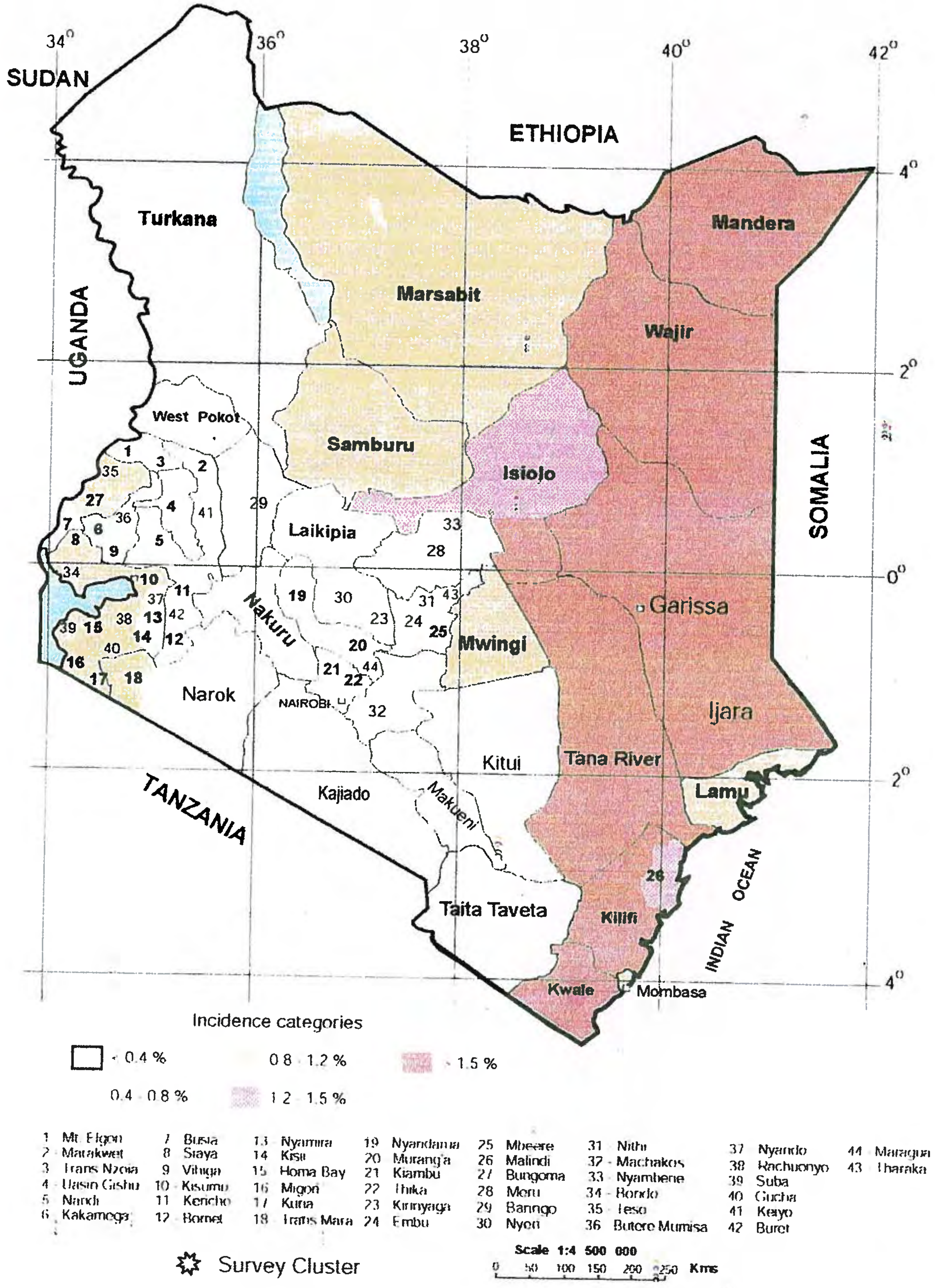
Scale 1:4 500 000
0 50 100 150 200 250 Kms

Figure 5.4 : Distribution of difference between altitude adjusted median and reference HbC by cluster



Appendix 7.1:

Estimated incidence of anaemia among out-patients in public facilities, 1995-1999



ANNEXES

Annex 1.1: Mean Hbc (g/dl) and prevalence of anaemia among different ethnic communities in their respective ancestral areas[1]

Ethnic group and sub region	Sex	Mean HbC, g/dL for <1 yr-olds	Mean HbC, g/dL for 1 - 4 yrs-olds	% Anaemia	Mean HbC, g/dL for ∃15 yr-olds	% Anaemia
Luo, Sondu - Lake basin	M F All	10.5 (1.1) 9.7 (2.2) 9.9 (1.9)	11.5 (0.9) 11.17 (1.3) 11.34 (1.1)	35.3 51.2 44.0	14.06 (1.4) 12.56 (1.5) -	40.2 28.4 -
Kipsigis, Sossiot Midwest highlands	M F All	9.85 (1.6) 10.53 (1.9) 10.2 (1.7)	10.73 (1.6) 11.27 (1.1) 11.01 (1.4)	55.5 34.5 44.6	14.45 (1.4) 13.25 (1.3) -	24.4 12.3 -
Kikuyu, Karuri - Central highlands	M F All	11.78 (0.9) 11.53 (1.3) 11.68 (1.1)	11.70 (1.1) 11.93 (1.2) 11.83 (1.1)	14.7 12.1 13.4	14.85 (1.2) 13.18 (1.0) -	12.7 0 -
Masai, Lorkinye - humid dry midlands	M F All	10.47 (1.5) 11.18 (0.4) 10.80 (1.0)	11.52 (1.9) 13.08 (1.5) 1243 (1.8)	33.3 0 14.2	16.0 (1.2) 14.0 (1.0) -	2.9 0 -
Akamba, Masii - humid dry midlands	M F All	9.91 (2.2) 10.6 (1.6) 10.37 (1.8)	11.92 (0.6) 12.11 (1.4) 12.04 (1.1)	30.8 43.5 38.9	15.0 (1.3) 13.31 (1.1) -	11.4 4.9 -
Nduruma, Kinango - coastal lowlands	M F All	7.37 (1.3) 7.84 (1.9) 7.62 (1.6)	8.9 (1.4) 9.26 (2.4) 9.15 (2.1)	94.1 78.6 84.4	11.82 (1.9) 10.11 (1.6) -	85.1 87.6 -
Digo, Kikoneni, coastal lowlands	M F All	7.41 (1.9) 8.10 (1.8) 7.66 (1.9)	7.8 (1.6) 8.08 (1.6) 7.96 (1.6)	98 100 99	11.69 (1.9) 9.94 (1.5) -	93.0 90.8 -
Giriama, Sokoke - coastal lowlands	M F All	7.23 (1.6) 7.47 (1.9) 7.31 (1.7)	8.15 (1.2) 8.54 (1.7) 8.57 (1.6)	100 92.7 96.2	11.27 (1.4) 9.65 (1.8) -	95.1 89.4 -

I - Adapted from Levy (5) and modified to include estimated altitude, mean HbC and prevalence of anaemia that was based on cut-offs recommended by WHO (TRS, 1959). These are 10.8 g/dL for < 5 yr-old, 14 g/dL for adult males and 12 g/dL for adult females (non gravid). M - males; F - females; All - pooled males and females

ınex 1.2: Distribution and trend of antenatal mothers testing hiv positive by sentinel site in kenya

entinel site: Urban	1990	1993	1995	1997
ʼusia	17.1	22.2	22	28.1*
ʼarissa	4.9	3.8	5.8	8.1
.akamega	5.3	8.6	11.7	10
.isii	1.6	2.5	4.3	16.3
isumu	19.2	19.6	25.3	34.9
itale	3.5	7.5	10	12.7
itui	1	2.0**	4.2	5.9
leru	2.7	2.3	8.7	13.8
lombasa	10.2	16.5	15.7	17.4
airobi+	12.1	16.2	15.7	15.9
akuru	10	22.5	27.2	24.6
yeri	2.9	5.4	9.6	10.1
ıika	2.5	9.6***	19.6****	23.1
:ri-urban/rural	District	1994	1995	1997
ıulaimboi(r)	Kisumu	49.4	21.8	27.2*
arurumo(r)	Embu	2	10.3	26.6
aragua(p/u)	Muranga	7	12.7	10.8
bale (p/u)	Vihiga	11.9	10.7	15.9
osoriot (r)	Uasin Gishu	2	12.5	9.1
wi (p/u)	Kwale	12.2	24.1	-
otomo (r)	Kitui	-	4.7	5.7*
ıplong(r)	Bomet	-	-	6.4

1996 data fror Busia ** 1992 data for Kitui *** Data for Thika
* 1994 data for Thika + data for Nairobi from University of Nairobi study clinics
1996 data for Chulaimbo, Motomo and Kaplong
rce: NASCOP Annual Report 1999

Annex 2.1: Ida household questionnaire

PART A: IDA HOUSEHOLD FORM		
HOUSEHOLD NUMBER		
DISTRICT	LOCATION	Sub-location
DATE:	INTERVIEWER	

PART B - SECTION ONE: Socio-DEMOGRAPHICS AND SOCIO-ECONOMICS (The respondent is the mother of an <5 year-old)

Name of respondent: ______________________ Duration of Residence in the area ....YRS

DEMOGRAPHIC CHARACTERISTICS

List all members of the household who usually live in the household starting with the head of the household

NAME	Q1.1	Q1.2	Q1.3	Q1.4	Q1.5	Q1.6	Q1.7
	Age /DOB DD/MM/YR	Sex	Relationship to the head of the household	Marital status	Religion	Education (Highest level completed)	Main economic activities
1.							
2.							
3.							
		F=1 M=2	hh head = 1 wife = 2 husband = 3 son = 4 daughter = 5 G/daughter = 6 G/son = 7 Other = 8 (specify) ______	S = 1 M = 2 D = 3 Se = 5 Coh = 6 N/A = 7	1=Cath 2=Prot 3=Mus 4=Trad 5=Hind 6=Others (specify) ______	1=None 2=pre-school 3=Std 1-4 4=Std 5-8 5=Form1-4 6=Dip. 7=Univer. 8=Adult Lit	1=Farmer 2=housewife 3=Cas/labour 4=Teacher 5=Civil ser 6=Student 7=Business 8=Unemployed 9=Others (specify) ______

S = Single SE = separated Cath = Catholic Mus = MuslimTrad = Traditional
M = Married Coh = cohabiting Prot = Protestant Hin = Hindu Oth = Others

OCO-ECONOMICS (Interview & Observations on Assets)

	Assets	Owned (YES =1, NO=2)	Number/No. of Acres
1.8	Land		
1.9	Coffee		
1.1	Tea		
1.12	Sugar cane		
1.13	Pyrethrum		
1.14	Maize		
1.15	Wheat		
1.16	Horticulture.		
1.17	Tobacco		
1.18	Others......................................		
1.19	Animals: Cows		
1.2	Goats/sheep		
1.21	Camels		
1.22	Donkeys		
1.23	Poultry		
1.24	Others:		
.25	Cooking energy - Fuelwood/kerosene		N/A
.26	Cooking energy - Gas/electricity		N/A
.27	Radio		
.28	TV		
.29	Bicycle		
.3	Motor cycle		
.31	Motor vehicle		
.32	Permanent house		Rooms \\------\\
.33	Semi-permanent house		Rooms \\------\\
.34	Temporary house		Rooms \\------\\

House codes:

Permanent: stone/brick wall + corrugated iron sheets/tiles roof + cement/wood floor

Semi permanent: Mud/timber walls + tin roof or Stone wall + thatch

Temporary: mud or paper or cardboard walls + thatch 1.35 If rented, how much do you pay per month? Ksh...................

1.36 Please tell me what the main source(s) of income for the household are in order of there importance?

Source of income	Yes=1 No=2	Rank 1, 2, 3, etc the order of IMPORTANCE
Salary/wage		
Sale of crops		
Sale of livestock/products		
Business		
Supplements from relatives		
Others		

SECTION TWO: WATER AND SANITATION, AND MALARIA CONTROL

2.1 What are the main sources of water for this household during DRY season?

1 Well
2 River/spring
3 River bed
3 Lake/dam
4 Piped
5 Roof catchment 6 Others(Specify)________

2.2 What are the main sources of water for this household during WET season?

1 Well
2 River/spring
3 River bed
3 Lake/dam
4 Piped
5 Roof catchment 6 Others (Specify)________

2.3 Do you treat your cooking/drinking water?

1 No
2 Boiling
3 Chlorine
4 Alum
5 Others (specify)................

2.4 What type of container is drinking/cooking water stored in?

1 Plastic container 2 Tin/drums 3 Standard galvanized iron tanks
4 Earthware jug 5 Ferro-cement tanks 6 Gourds
7 Other........................

2.5 Is there a latrine/toilet in the compound? (Observe path)

1. Yes - regularly used 3. NO **[IF NO MOVE TO Q 2.10]**
2. Yes - Not regularly used

2.6 What type of latrine/toilet does the household use?
1 Pit latrine 2 communal pit latrine
3 Modern flush toilet 4 communal flush toilet
5 Others......................

2.7 What is the state of the floor of the latrine? (Observe)
1 Clean 2 has faeces 3 Has flies 4 filled-up 5 wet-soil/floor

2.8 Are there faeces in the compound around the toilet? 1 Yes 2 No

2.9 Do members of the family wear any form of foot wear all the time? (Ask and observe)
1 Mother 1 Yes 2 sometimes 3 No
2 Father 1 Yes 2 sometimes 3 No
3 Children 1 Yes 2 sometimes 3 No

MALARIA CONTROL

2.10 How many mosquito nets do you have in this household?
0 1 2 3 4 5

[IF 0 GO TO 3.1]

2.11 What was the source of the nets? **(Circle all correct)**
1 Donation 2 Purchased 3 Others-specify.............................

2.12 Had the net(s) been treated or washed with chemicals (insecticides)? 1 Yes 2 No

2.13 After acquiring them, have your ever washed (re-treated) the net(s) with chemicals (insecticides)?
1 Yes 2 No

2.14 If yes, how many of the mosquito nets in this household have been re-treated with insecticide during the last 6-12 months? No. ....

2.15 Who uses these nets?**(Circle all correct)**
1 Mother 2 Father
3 Young Children 4 Older children
5 Others e.g. visitors...........................

SECTION THREE: HEALTH SEEKING PRACTICES

3.1 Which illnesses are of greatest concern in this household? (Number them in order of importance)

1 Malaria [ ]

2 Diarrhoea [ ]

3 Respiratory tract infections [ ]

4 Intestinal worms [ ]

5 Others (specify) [ ]....................

3.2 For these illnesses where is treatment usually sought from first and last if not resolved? Use codes shown below

Illness	Source of treatment first	Source of treatment if unresolved

1. GoK health facility
2. Private clinic
3. Mission health facility
4. Private chemist/Pharmacist
5. Community pharmacy/CHWs
6. Traditional healer
7. Private hospital/Nursing home
8. Spiritual healer
9. Shops
10. Others - specify....................

Name of the **most commonly** used facility...

3.3 What is the approximate distance from this household to the health facility? (Interviewer to estimate)

1 < 2 km   2 3-5 km   3 > 5 km

3.4 Has any member of your household been ill during the last two weeks?

Demog. Number	Name	Illness suffered	Source of treatment

3.5 For which illnesses do you use home remedies? (List) ....

(PROBE for HERBAL MEDICINES) ....

3.6 For which illnesses do you visit traditional healers and spiritual healers?.......................... ....

3.7 In this household, has any of the parents or index child (<5 yrs) been admitted to hospital during the last 3 month?

1 Yes 2 No **[IF NO MOVE TO Q 3.9]**

3.8 If **yes**, to Q. 2.6 who was admitted and what was the reason?

Person	Illness(es)
Father	
Mother	
Child	

3.9 Has any member of this household been continuously ill for a long time?

1 Father 2 Mother. 3 Child 4 No

Which illness ....

3.10 Has the index child been treated for intestinal worms in the last three months?

1 Yes 2 No

3.11 Has any of the parents (or reference male) and index child been treated for malaria during the last one month?

1 Father/reference male - 1 Yes 2 No
2 Mother - 1 Yes 2 No
3 Child - 1 Yes 2 No

3.12 Has any of the parents or index child been treated for bilharzia during the last one year?

1 Father - 1 Yes 2 No
2 Mother - 1 Yes 2 No
3 Child - 1 Yes 2 No

3.13 Does the father or mother smoke? (Specify average number of cigarettes smoked /day)

1 No, father does not
2 Yes, father: . ...cigarettes per day
3 No, mother does not
4 Yes, mother : No......... cigarettes per day

<u>SECTION FOUR:</u> ANAEMIA PREVENTION AND CONTROL PRACTICES [ALL MOTHERS]

4.1 Did you attend MCH clinic during your last pregnancy? 1 Yes 2 No **[IF NO MOVE TO Q 4.5]**

4.2 If yes, where did you go for MCH clinic?

1 GoK health facility
2 Private clinic
3 Mission health facility
4 Private hospital/Nursing home
5 Out reach clinic
6 Others ....

4.3 Which services were provided to you in the MCH clinic?

Services	YES=1, N0=2	Descriptions (medications and counseling where needed)
Examination		
Weight taken		
Blood pressure taken		
Blood examined		
Urine examined		
Tetanus toxoid given		
Medicines given/prescribed - Vitamins .... - Antimalarials............................. - Deworming............................... - Others......................................		
Counseling/Health education given		
Others..........................		

4.4 During your last pregnancy, how many times did you attend MCH clinic?

1 During early pregnancy..times 2 During mid-term.times
(first 3 months (3 - 6 months)

3 During last-term.time 4 Can't remember...........................
(7 - 9 months)

5 Others..

4.5 If NO to Q4.1, what were the main reasons for not attending MCH clinic?

1 None
2 Too far
3 Too busy/no time
4 Not necessary
5 No money
6 Staff rude/uncourteous
7 Facility dirty
9 Others (specify). ....

4.6 During your last pregnancy, did you suffer any illness?

1 No
2 Morning sickness
3 Malaria
4 Respiratory problem
5 Urinary tract problem
6 Inadequate blood/anaemia
7 Backaches
8 Other (specify).....................................

4.7 Do you know of an illness where the affected person is said to have little or no blood?
1 Yes 2 No **[IF NO MOVE TO 4.11]**

4.8 If yes, what is the local name and description of this disease?..

4.9 Do you know what causes the disease?
1 Intestinal worm infestation 2 Malaria
3 Over-working 4 Inadequate food intake
5 Pregnancy 7 Don't know
6 Other (specify)..

4.10 Where or from whom did you learn about this disease?
1 Friends 5 Reading magazines/news papers
2 School 6 Through radio/Tv
3 Health workers 7 TBAs
4 Neighbours/relatives 8 Others..

4.11 When you attended MCH clinic, how often were drugs to increase blood prescribed for you?
1 Never **[IF NEVER MOVE TO Q 4.17]** 4 Whenever they were available
2 Every visit 5 Whenever the health worker found it necessary
3 Sometimes 6 Others.......................................
....
7 Dont know

4.12 Did you pay for the drugs? 1 Yes 2 No
If yes, amount paid Ksh. .... and for how many tablets or capsules?
....

4.13 Did you take the tablets/capsules given to you? 1 Yes 2 No **[IF NO MOVE TO Q 4.16]**

4.14 If yes, what quantities did you take?

1 Most of them — 2 Only a few
3 All of them — 4 About a half

4.15 Which problems did you experience when you took these drugs?

1 None — 5 Upper abdominal upset or pain
2 Headaches — 6 General weakness
3 Feeling like vomiting (nausea) — 7 Bad taste
4 Constipation — 8 Black stools
7 Others (specify)......................................

4.16 If NO to Q 4.13 why?... ....
....

4.17 Did you eat any non-food items during your last pregnancy? 1 Yes 2 No **[IF NO MOVE Q 4.21]**

4.18 If YES which non-food items did you eat?

1 Ice — 4 Baked clay
2 Soils — 5 Fibers
3 Soft stones — 6 Others(Specify).........................
....

4.19 From where did you get these non-food items from?

1 Got from a friend/relatives/neighbours — 2 Collected surrounding(specify)......
3 Collected from specific site eg ant hills (specify).....................................
4 Bought from a shop/market — 5 Others (specify)............................

4.20 What period during the pregnancy did you eat non-food items?

1 During early pregnancy — 4 Throughout the pregnancy
2 During mid-pregnancy — 5 Others...
3 During late pregnancy

4.21 What information was given to you about what to eat or not to eat during pregnancy and by whom?

Information given (indicate if encouraged or prohibited)	Person or facility giving information

4.22 What information was given to you about what to eat or not to eat during lactation and by whom?

Information given (indicate if encouraged or prohibited)	Person or facility giving information

4.23 Which foods are culturally considered special or forbidden during pregnancy?. (List)

List Foods that are encouraged or prohibited	State whether encouraged or prohibited

4.24 Which foods are culturally forbidden during lactation?.

List Foods that are encouraged or prohibited	State whether encouraged or prohibited

4.25 Where did you deliver your last baby?

1 GoK health facility
2 Mission health facility
3 Private hospital
4 At home/TBAs home
5 On the way
6 Others...

4.26 Who attended to you during your last delivery?

1 Self
2 Relatives/neighbours
3 TBA
4 Nurse/midwife
5 Doctor
6 Others.....................

DISTRICT.. HOUSEHOLD NUMBER..

SECTION FIVE: CARE AND FOOD SECURITY

5.1 Is the INDEX child breast feeding?

1. YES 2. NO 3. Not applicable

5.2. If NOT breast feeding, how long did you breast feed the child?

1 ....months 2. N/A

5.3 At what age did you introduce liquids to your infant's diet? ....months

5.4 At what age did you first introduce semi-solid foods in your infant's diet

5.5 Which liquids, did you first introduce to your infant's diet?

1 Water alone
2 Cow's milk
3 Fresh Fruit juice
4 Water & Sugar/salt
5 Thin porridge
6 Tea
7 Preserved fruit juices (bottled)
8 Others.........................

5.6 Which semi-solid foods that you first introduced in your infant's diet?

1 Porridge
2 Fruit (solid)
3 Minced meat
4 Blood
5 Mashed potatoes
6 Mashed legumes
7 Ugali & milk/soup............
8 Fish
9 Others

5.7 If porridge, which flour do you use?

1 Whole maize flour
2 Sorghum flour
3 Whole Millet flour
4 Mixed flour
5 Cassava flour
6 Others (Specify)..................

5.8 Is the flour sifted? 1 Yes 2 No

5.9 If mixed flour, what ingredients were mixed?..

5.10 What do you add to the porridge?............................. ....

5.11 Which of following do you use as complementary foods for the index child?

1 Fermented porridge
2 Porridge fortified with fish
3 Porridge from germinated seeds flour
4 Porridge fortified with pulses/soy
5 Porridge with lemon/orange juice
6 None of them

5.12 Do you ever leave the child behind? 1 Yes 2 No

5.13 If Yes, who looks after her/him?

1. House help/child minder/maid
2. Older siblings
3. Father
4. Other relatives
5. Others ____________________

5.14 How old is the maid or sibling?_________ years

5.15 What is the highest education level attained by maid or sibling?
1. None 2. Lower Primary 3. Upper primary
4. Secondary

5.16 Which of the following vitamin supplements do you give to the index child?
1 None 2 Cod liver oil 3 Multivitamin syrup
4 Hariborange 5 Others....................

5.17 What is the main source(s) of your staple food?
1 Farm/garden 3 Market
2 Shop/kiosk 4 Other (specify)

5.18 If garden, is food usually sufficient for the household needs?
1 Yes 2 No

5.19 Which is the main source of vegetable (s) for your household?
1 Farm/garden 3 Market
2 Shop/kiosk 4 Gathered from roadside /bush/

5 Other (specify).....................

5.20 Which is the main source of fruits?
1 Farm/garden 3 Market
2 Shop/kiosk 4 Gathered from roadside /bush/

5 Other (specify).....................

5.21 Does the household have a home garden? 1 Yes 2 No

5.22 Is the Index child's food prepared separately? 1. YES 2. NO

5.23 What do you do to make the child eat more/enough food?
1. Stimulate by coaxing 3. Scare/Threaten/beat
2. Force 4. Others ___________

5.25 Who in the household usually eats the following foods? (TICK CLEARLY)

Food type	Under 5 yr old	Older children	Mother	Father
Milk				
Chicken				
Eggs				
Meat				
Fish				
Blood & blood products				
Fruits				
Beans				
Green vegetables				
Fermented porridge				
Tea/coffee/cocoa				

5.25 When is tea/coffee/cocoa usually taken ?

1. Breakfast time
2. With snacks
3. With or immediately after main meals
4. Others..................

5.26 When are fruits usually taken?

1. Breakfast time
2. With or as snacks
3. With or immediately after main meals
4. Others

5.27 For the vegetables that are main consumed in your household please explain how they are prepared?

Vegetable name	cooked for a long time	cooked slightly/steamed	served raw	others

5.28 Which type of pots do you usually cook in?
1 Aluminium 2 iron 3 copper 4 Earthen ware 5 Others..........

5.29 Please indicate the meals that are usually served in your household?

Meal	Wet season			Dry season		
	Always	Sometimes	Never	Always	Sometimes	Never
Breakfast						
Lunch						
Supper						
Snacks						

5.30 Please name the MAIN foods that are commonly consumed in your household?

Food category		Typical number of TIMES it is consumed/period							
Name of food		Wet season				Dry season			
		Week	Month	Occasionally	Never	Week	Month	Occasionally	Never
Cereals	1								
(State whole W or sifted S)	2								
	3								
Pulses	1								
	2								
Meat	1								
Blood and products									
Fish									
Chicken									
Eggs									
Vegetables	1								
	2								
Fruits	1								
	2								
Drinks/ foods	BLACK tea/ coffee/ cocoa								
	Tea/coffee Cocoa WITH MILK								
	3 MILK alone								

:TION SIX: PHYSICAL AND LABORATORY EXAMINATIONS

:RICT:................ SUBLOCATION.......................VILLAGE................. DATE........./...C:.................Mo.................Fa............
of child...........mo

:ategory of household :Regular clients= 1; Detailed analysis clients=2

2 Current and past medical history: (For Blood and remarks sections specify otherwise enter Yes = 1 OR No/None = 0)

	Fever		Gastrointestinal tract history					Mala-ria 1/12	<u>Blood:</u> Trans-fused OR Donate d 3/12	Cardio-respiratory Hx					Hx Hospitali -ation 3/12	**Remarks:** ***RTA(1/12), haematuria, pain, headaches, oedema, frequent heart burns, current medications (specify)***
			Ape-tite	Surger y	Epigast/ stomach pain	Diarrhoe a				Dysp noea	Dizzy spells	Tire d ness	Cough			
	C	RC >1/1 2				C	RC> 1/12						C	RC >1/ 12		
he																
d																
er																

C= Current RC= Recurrent - > 1 month [1/12 = 1 month; 3/12 = 3 months]

3 **Non-pregnant Mother:** LMP: ....../......./...... : Perceived features - Light 9 Norm/Usual 9 Heavy/prolonged 9
4 **Pregnant Mother:** Gestation age ....months

5 **Examination:(Except for Temp. Skin lesions, Malnutrition and others enter Yes = 1 OR No/None = 0)**

	Pallor		Finger and Toe nails Shapes						Temp EC (Axilla)	Immunosuppression		Features of Chronic Malnutrition (Oedema, Skin, Hair)	Others/General remarks
	Palms	Finger nails	Fingers			Toes							
			Normal	Flat*	Spoon*	Normal	Flat*	Deformed*		Oral-pharn. Candidiasis	Skin lesions		
Mother													
Child													
Father													

*Examine Fingers & Toes for koilonynchia of fingernails (Y/NO) and deformed/"pinched" toe nails (Y/NO) **[Rule out TRAUMA or FUNGAL infections]**

Household Number.....................................

Date: ..../.........../

6. Child DOB ..../........................./............................

DD MM YR

7. Immunization Card *[examine for BCG SCAR in ALL cases]*

BCG/P		P/DPT 1	P/DPT 2	P/DPT 3	Measles
Scar					

Notes: Card available or not..........................

Special events eg NIDs..

8. Growth monitoring curve: Above curve .9. Below curve .9. Mixed 9.

9 Child anthropometry: Weight.................kg; Height:..............................cm

Mother anthropometry: Weight.................kg; Height:..............................cm

10 Child organomegally : Liver: Mid-clav. line...................cm; Mid-sternal line:...............................cm

Spleen: Mid-clav line..................cm; Mid-axilla line:..............................cm

11 Laboratory: Blood and Stool investigations [*indicate whether the stools are Diarrhoeic: Yes = 1 No = 2]*

Time:blood collected ...... : ..... am or pm	KHb, g/dL or µmol/L	Malaria /200 OR /500 wbc R1	R2	Intestinal parasites, epgf										*W bancrofti*	Hematuria/ S. haematobium		RBC sickling
				H worm R1	R2	S mansoni R1	R2	T trichuris R1	R2	Ascaris R1	R2	E. histolytica R1	R2		Membrane	Hema stix	
Mother																	
Child																	
Father																	

(KIndicate units of Hb); R1 & R2 are 1st and 2nd Reading in case blood or Slide in case of stool

NOTES: Malaria - the denominator wbc count **MUST** be shown *ie* 200 or 500.

Filariasis - Only clients for **detailed analysis** in the **Kwale** district will be considered.

Urinalysis: S. haematobium + haematuria - Only **Kwale, Kitui** and **Kisumu** will be considered. **E histolytica -** Only 10% of **detailed analysis** group will be considered.

DISTRICT:	
SUBLOCATION:	
VILLAGE:	
HOUSEHOLD NO.:	

	CHILD	FATHER	MOTHER	
SUBJECT ID NO.				
AGE (YRS):				
WEIGHT (Kgs):				
ACTIVITY LEVEL:	[ ] Rest	[ ] Rest	[ ] Rest	
	[ ] Light	[ ] Light	[ ] Light	[ ] Pregnant
	[ ] Moderate	[ ] Moderate	[ ] Moderate	[ ] Lactating 1st 6 mths
	[ ] Heavy	[ ] Heavy	[ ] Heavy	[ ] Lactating 2nd 6 mths

A	B	C	D	E	F	EATEN		
MEAL TIME	DISH	INGREDIENTS	DESCRIPTION	AMOUNT COOKED	PREPARATION	MOTHER	FATHER	CHILD

Date Entry Staff No.: ....

NB. Prove of beverages taken with meals/fruits/snacks

Annex 2.3: Ida survey: health provider questionnaire

Enumerator----------------

1. District-------------------------------------- 2. Division------------------

3. Location------------------- 4. S/location----------- 5.Date-------------

---

6. Category of facility-------------------------- 7.Name of respondent-----------
----

8. Designation---------------------------------- 9.Name of facility---------------
----

10. Date of establishment ----------------19--------(month/year)

11. Please state the staff in post for the following cadres

Cadre	Number	Cadre	Number
Drs.		Nutrition	
COs		Public Health	
Nurses		Health Education	
Laboratory		Others	

12. Which of the following laboratory services are routinely provided in the facility?

1 *Microscopy - stool*...

2 *Microscopy - blood slides*..

3 *Haemoglobin assessment (specify method ....)*

4 *None*...
.....

13. Please list 5 most common diseases/conditions that your facility handles and their peak periods (in order of importance).

Disease	Peak period/months
1.	
2.	
3.	
4.	

14. Where do majority of your patients come from?
2. Within sublocation.......................... 3. Within division...
1. Within location............................... 4. Others...

15. Does the facility provide MCH services? 1. Yes 2. No
[IF NO MOVE TO Q25]

16. If YES, what is the range of services provided in the MCH clinic?
1. AN services.............................. 3. Immunization + CWC services
2. FP services............................... 4. Others.................................

17. If AN services are given, what are the constituents of the package given to clients?
1. N/A.................................. 5. Hematinic supplements......................
2. Physical examination......... 6. Malaria prophylaxis............................
3. IEC talk............................ 7. Others...
4. Deworming......................

18. Which AN clients receive hematinic (Hb correcting) supplements?
1. N/A................................. 3. All at specific times (specify)...........................
2. All AN mothers throughout pregnancy 5. None............................
1. Some (specify).......................... 6. Others.......................................

19. If SOME OR SPECIFIC TIMES, what criteria are used?
1. *Clinical features (specify)*..
2. *Lab cut-offs (specify)*...
3. *Others*..

20. What is the composition of the commonly used supplements?
1. *Combined iron/folate*........... 3. *Folate alone*................
2. *Iron alone*............................ 4. *Others*.................................

21. In which form is the Hb correcting supplements that you provide or prescribe in your facility?
1. *Inorganic iron sulphate* 3. *Organic/complexed iron preparations*
2. *Chelated iron* 4. *Others*

22. What are the main reasons for using the supplements that you referred in Q21?
....

23. Please state the usual source of the supplements...

24. Is the prescription of hematinics (iron, folate etc) among children visiting your facility common? 1. Yes 2. No

25. Is deworming of AN clients routinely performed?
1. *Yes* 2. *Yes for some* 3. *No*

26. If some what criteria is used?
1. *Laboratory diagnosis*.............. 3. *Clinical features (specify*.....................
2. Others (specify.......................)

27. Is deworming of children common in this facility? 1. Yes 2. No
[If NO, MOVE TO Q30]

28. If some what criteria are used in diagnosis?
1. *Laboratory diagnosis*............. 2. *Clinical features (specify*.....................
3. Others (specify......................)

29. What drugs do you most commonly prescribe or provide for deworming?
....

30. Do AN clients receive malaria treatment/prophylaxis routinely in your facility?
1. *All* 2. *Some* 3. *No [If NO, MOVE TO Q32]*

31. If some what criteria are used?
1. *Laboratory diagnosis*............. 2. *Clinical features (specify*.....................
4. Others (specify......................) 4. N/A

32. Which drugs do you most commonly prescribe for malaria to AN mothers?
....

33. What AN care and PN care IEC materials are available in the facility?

Name	Content	source	Target (disease/age group
-------------------	---------------	---------------	------------------------
-------------------	---------------	---------------	------------------------
-------------------	---------------	---------------	------------------------
-------------------	---------------	---------------	------------------------

In each case, please indicate the type/form of IEC materials e.g. posters, brochures etc [TAKE SAMPLES OF THE MATERIALS IF AVAILABLE]

34. How is IEC services delivered to the clients?

HealthTalks...

Health talks + poster illustrations...

Health talks + demonstration..

4. Health talks + materials to take home..

5. Others...

Please indicate the number of patients your facility attended to during the period January to December. 1997 and 1998.

	1997		1998	
	Outpatients	Inpatients	Outpatients	Inpatients
<5 yr olds				
Other children				
Adult women				
Men				

36. Please complete the following workload data by year

YEAR 1997/1998	Jan	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
No. of outpatients												
Anaemia												
Malaria												
Worms												
Schisto												
HIV/AIDS												
Total MCH attebdance												
Total Antenatal - New cases - Re-visits												
Total immunization - New cases - Re-visits												
Total with worns - MCH												
Total with anaenua - MCH#												
Total with malaria - MCH#												
Total INPATIENTS with anaemia												
Total tranfusions due to anaemia (Exclude surgical and trauma cases)												

What is the proportion of the lab diagnosed - anaemia ....% and malaria ....%

Please indicate the quantities of the listed drugs that were dispenced during 1997/98 by year

Indicate if >00 or 000'

YEAR 1997/98	Price/ course	Jan	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Chloroquine													
Stock out-time													
Fansidar													
Stock out-time													
Other anti malarials													
Stock out-time													
Haematinics* Comibined iron folate													
Iron alone													
Folate alone													
Stock out-time (specify)													
Antihelminthics (specify)													
Stock out-time (specify)													

Price: in KSh/course

Annex 2.4: Altitude adjustment factor for Hbc using the 0.25 g/dl/1000 m asl guideline and average altitude by cluster

District	Sub-locations (cluster)	Altitude, m	HbC adjustment factor, g/dL
Kwale	Kikoneni Kifyonzo	196 66	0.049 0.015
Mombasa	Miritini Utange	69 40	0.017 0.01
Kisumu	Osiri	1200	0.3
Nyando	Kadiang'a	1180	0.29
Kisii	Birongo Mwamusioma	1973 1770	0.49 0.46
Bungoma	Nakhwana Misikhu	1300 1700	0.33 0.43
Busia	Sisenye	1180	0.29
Baringo	Sirwet and Tenges Ng=aratuko and Sibilo	1830 610	0.65 0.38
Nyandarua	Rurii Njambini	2370 2700	0.59 0.68
Kitui	Kyatune and Kanguli Wii and Wikiliye	800 1200	0.20 0.30
Meru	Kibaranyaki Kibureni	2500 914	0.63 0.25
Garissa	Korakora Elan and Gurufa	152 305	0.03 0.07

Annex 3.1 Age distribution of children

Table A3.1: Age distribution based on age-groups by cluster

Sub-region	Clusters	n	Age-groups, months						
			≤6	>6-12	>12-18	>18-24	>24-30	>30-36	>36
Lake basin midlands	Osiri (Ksm)	186	19.4	18.8	11.8	9.7	12.4	5.9	22.0
	Kandiang=a (Nya)	184	16.8	19.9	12.0	17.9	7.1	6.5	20.7
	Sisenye (Bus)	175	14.3	13.7	9.7	14.9	17.1	9.7	20.6
Western highlands	Nakhwana (Bun)	227	14.5	20.7	15.9	13.2	9.7	5.7	20.3
	Misikhu (Bun)	166	9.01	15.1	15.7	15.7	10.8	9.6	24.1
	Mwamosioma (Kis)	207	9.7	17.4	7.7	11.6	14.0	12.6	27.1
	Birongo (Kis)	167	13.2	17.4	15.0	9.6	11.4	7.8	25.7
Central and mid west highlands	Sirwet (Bar)	142	14.1	14.8	19.0	16.2	5.6	7.0	23.2
	Rurii (Nya)	135	11.9	12.6	11.9	8.9	11.9	3.7	39.3
	Njabini (Nya)	82	11.0	9.8	19.5	15.9	12.2	6.1	25.6
	Kibaranyaki (Mer)	141	6.4	11.3	10.6	17.0	12.1	9.9	32.6
Dry humid and semi-arid midlands	Ngaratuko (Mer)	98	10.2	27.6	21.4	15.3	13.3	1.0	11.2
	Kibureni (Mer)	156	14.7	22.4	8.3	10.3	7.7	11.5	25.0
	Kyatune (Kit)	180	11.1	16.1	16.1	12.8	9.4	12.2	22.2
	Wii (Kit)	140	7.1	11.4	16.4	19.3	14.3	7.1	24.3
Coastal and semi arid lowlands	Elan (Gar)	58	10.3	13.8	17.2	10.3	6.9	3.4	37.9
	Kikoneni (Kwa)	214	10.7	13.1	15.9	15.9	12.6	7.9	23.8
	Kifyonzo (Kwa)	168	19.0	18.5	10.1	12.5	10.7	11.9	17.3
	Miritini (Msa)	145	13.8	20.7	11.0	10.3	11.7	9.0	23.4
	Utange (Msa)	115	11.3	14.8	13.9	16.5	14.8	4.3	24.3
	Korkora (Kwa)	90	6.7	13.3	13.3	7.8	15.6	2.2	41.1

Annex 3.2: Characteristics of the sample of children examined in kibera, Nairobi

The mean age of the children was 30.2 ∀ 17.7 months (n=302) the mean HbC was 11.0 ∀ 1.95 g/dL (n=293). The new HbC increased at a rate of 0.25 g/dL per 6 months increase in age. From altitude adjusted HbC, 54.9% of children were anaemic with 34.1% being moderate to severely anaemic. Pallor was significantly associated with anaemia ($p<0.001$) but not clinical history. The median s-ferritin concentration was 36.7Φg/L (mean 62.5 ∀ 75.5 Φg/L), (n=67). Overall, 31.2% had acutely to moderately low s-ferritin (<20 Φg/L). The pool with high risk iron deficiency i.e. <40 Φg/L was 53.1%. The median s-retinol concentration was 14.7 Φg/L (mean 15.7 ∀ 7.3 Φg/L), (n=62). 29.0% and 48.4% of these children had acutely low and moderately low s-retinol respectively. With regard to zinc concentration, the median was 66.0 Φg/L (mean 61.6 ∀ 13.9 Φg/L), (n=42). 66.7% of these children had s-zinc concentration below the 65 Φg/L cut-off.

It should be noted that 65.4% of the children did not present with a significant salient history. 16.9% of the children had either fever, respiratory tract or urinary tract infections. Malaria parasitaemia and splenomegaly were observed in 24% and 4.1% of the children respectively. Detailed findings and discussions are presented in the M. Med. Thesis by Dr. Otieno (50).

Annex 4.1: Anaemia among school age children and the elderly

A review of available information about anaemia among school age children (6-18 years) and the elderly (>50 years) is presented in Annex 4.1. Excepting in selected clusters where school boys aged 15 years and over were included to boost the number of adult males these population groups were excluded from the survey because of logistic problems.

Among school age, anaemia in general and especially IDA has attracted considerable attention because of its demonstrated role in educational performance, threats posed by relative large burden of helminthic and schistosoma infections, increased iron requirements during pubertal growth spurts and as an opportunity to improve pre-pregnancy iron status among women ( ). The first two have been the focus in most of the studies carried out so far. Details of these studies and their outcomes are shown in A2.

Reports of anaemia among school age children predominantly cover the lake basin, the coast and dry midlands. The reported anaemia prevalence range between 4% and 61.3%. The higher prevalences are associated with hookworm and schistosomiasis infections and the occurrence of splenomegaly. Correspondingly, high prevalence are evident in the coast and lake basin where both diseases are endemic but with significant variations. These reports along with those of Stephenson et al ( ) demonstrate the importance of hookworm and schistosomiasis among school age children with respect to among others correcting low HbC, improved physical fitness and educational performance. In the central highlands, a survey of school aged boys in a juvenile rehabilitation school indicate possibility of low HbC among highland children in disadvantaged situations.

Limited information is available about anaemia and hematinic deficiencies among older Kenyan population. Interest derived from Asuccessful aging@ concept under-pins the need to pay attention to physiological requirements of a slowing down system and increasing demand for inputs from elderly persons. The latter emanates from social-cultural transformation, prevailing poverty and increasing grand-parenting responsibilities to orphans and young children. The findings reported in two masters dissertations during the 80's indicated considerable prevalence of mild anaemia among older populations. The prevalence was markedly high among institutionalized individuals than those in their own homes (63.6% *vs* 21%).

Table A2: Distribution of haemoglobin concentration and anaemia among school age children and older population

Source reference	Study design	Sub-region	District	Age group	Main findings
KEDAHR et al ( )	Placebo controlled study with cross-sectional HbC surveys of a cohort 746 school children who were on daily multi-micronutrient supplementation and chemotherapy for schistosoma intestinal helminth	Lake basin	Bondo-Usigu	9-18 yrs	Overall mean HbC for boys and girls was 12.35g/dL in January/February (dry season) and 13 g/dL in October following wet season). At baseline the prevalence of anaemia was 12.4% and 30.4% for children without and with organomegaly respectively.
Chania ( )	Controlled trial with cross-sectional HbC surveys of 106 school children on a ration of pulverized comfrey (a dark green leafy vegetable) added to their midday meal for 3 weeks.	Central highlands	Nairobi	8-13 yrs	Overall mean HbC of 12.7 ✕ 1.1 g/dL did not change significantly following daily dark green leafy vegetables supplements. Only s-carotenoid changes were evident.
Sturrock et al ( )	Cross-sectional HbC survey during trial of chemotherapy (Praziquantel for schistosomiasis)	Dry humid semi-arid	Machakos	5-17 yrs	Mean HbC was 12.36 g/dL: Prevalence moderate anaemia was 4%. AMany@ children had HbC of 10-11 g/dL.
Ayah et al ( )	A placebo controlled study with cross-sectional HbC surveys in a cohort of 199 school children treated with an anti-schistosomal drug.	Dry humid semi-arid midlands	Makueni	7-11 yrs	Overall baseline mean HbC of 10.9 g/dL and 11.4 g/dL among boys and girls respectively. Increases by 0.9 to 1.3 g/dL 6 months after treatment was demonstrated.
Olsen et al ( )	A placebo controlled study with cross-sectional HbC surveys whose cohorts included 231 children who were given twice weekly iron supplementation for 12 months.	Lake basin	Kisumu	4.15 yrs	Overall baseline mean HbC of 11.66 (11.47-11.85) g/dL was observed. Anaemia was estimated to be between 35.0% and 61.3%.
CDC ( )	Longitudinal study with monthly follow-up of malaria morbidity the child population 0-14	Lake basin	Bondo-Asembo	5-14 yrs	Pooled anaemia estimated 25% and 36% among 5-9 and 10-14 years old respectively

Levy ( )	Community cross-sectional survey among selected ethnic groups in the country.	Included 8 ethnic groups from coast, midlands central highlands and lake basin	Kwale, Kilifi, Kajiado, Machakos, Kiambu, Kericho, Nyando	5-9 yrs and 10-14 yrs	For the 5-9 year olds, mean HbC for children ranged from 8.66-9.47 g/dL, Machakos 13.28 g/dL, Kajiado 13.78 g/dL, Kiambu 12.96 g/dL, Kericho 11.92 g/dL, and Nyando 11.75 g/dL. For the 10-14 year olds, mean HbC for coastal children ranged from 9.52-10.17 g/dL, Kajiado 14.65 g/dL, Kiambu 14.32 g/dL, Kericho 13.21 g/dL and Nyando 12.74 g/dL. The distribution of mean HbC was related to altitude. Anaemia was predominantly observed in coastal areas (85.7% to 7.5%), Nyando (17.3 to 37.2%), Kericho (18.2% to 21.8%) and Machakos (4.5% to 8.1%) in both age groups.
Vaswa)	Cross-sectional community survey of elderly population (n=199).	Central highlands	Embu	50-80 yrs	Mean HbC decreased from 13.8 g/dL among 50-59 years age group to 12.01 g/dL for males and 12.7 g/dL among 50-57 year olds to 12.3 g/dL among ≥80 year olds over prevalence of anaemia stood at 21% consisting of 13% male and 8% female.
thangata (	Cross-sectional survey of residential and day care elderly population (n=217)	Central highlands	Nairobi	55-98 yrs	Mean group HbC of females decreased with increasing age anaemia. Overall anaemia was 63.6%. Moderate to severe anaemia (<8.0 g/dL) was seen in 5.2%. Intestinal parasitosis rates were 8% for hookworm and 31% for ascaris.

Annex 5.1: Prevalence of vitamin a deficiency, malaria parasitaemia and hookworm infection among <5 year-olds by district/district area in 1994 and 1999

District /district area	Micronutrients survey, 1994'			National IDA survey, 1999[I]		
	VAD <10μg/dL %	Malaria prevalence %	Hookworm prevalence (%)	VAD <10μg/dL %	Malaria prevalence %	Hookworm prevalence (%)
Kwale	8.4	81.2	39.1	47	42.5-51.8	18.1
Mombasa	10.6	42.2	23.3		26.3-34.0	6.1-8.4
Kitui	4.6	14.9	5.9	3.4	0-2.0	0-2.0
Meru	0.6	0.4	5.4	7.5-21.9	9.4-37.2	0-3.0
Nyeri	0.9	0	2.7	-	-	-
Kiambu	0.9	2.7	1.6	-	-	-
Baringo	4	2.2	0.7	0-7.4	3.0-6.5	0
Nakuru	0.8	1.9	0.8	-	-	-
Bungoma	18.4	80.8	13.7	51.2-56.0	57.8-78.8	16.7-28.0
Kisumu	13.4	89.9	29.5	31.6-50.0	65.8-80.4	8.3-12.3
S. Nyanza	12.8	-	-	-	-	-
Kisii	21.5	67.6	25.3	20.5-25.4	19.8-43.3	5.0-18.6
Garissa	3.8	11.3	0.7	21.4	5.1-12.1	0
Mandera	5.3	3.6	0.3	-	-	-
Nairobi	-	15.1	6.4	-	-	-

' - The values were based a pooled sample drawn usually from two areas in majority of cases.

I - The values were presented as a range of observations from 2 clusters per district area except for Busia, Kitui and Mombasa/Kwale districts.

Annex 5.2: Prevalence of vitamin a deficiency among mothers by district/district area in 1994 and 1999

DISTRICT	VAD n	VAD <10μg/dL	VAD 10-19.9μg/dL	IDA survey[$] <10 μg/dL	IDA survey 10-20μg/dL
Mombasa	14	14.3	14.3	47.5-65.2	31.9-41.0
Kwale	53	1.9	17	4.3-36.3	41.9-51.1
Kitui	99	0	6.1	0.7	14.1-20.7
Nyeri	87	0	1.1	-	-
Meru	65	0	1.5	0-5.7	18.8-42.0
Kiambu		0	4.7	-	-
Kisumu	103	1.9	15.5	19.0-19.8	42-55.6
Kisii	44	0	18.2	2.6- 4.4	33.8-41.6
Bungoma	107	5.6	25.2	11-12.3	46.2-50.2
Nakuru	58	1.7	8.6	-	-
Baringo	158	1.9	8.2	0- 4.3	26.1-36.1
Garissa	46	4.3	34.8	10.2	64.3
Mandera	58	0	24.1	-	-
Nairobi	51	0	7.8	-	-

[$] - sample sizes are shown in Table 4.8