"ZINC DEFICIENCY IN LOW BIRTH WEIGHT BABIES & EFFECT OF SUPPLEMENTATION OF ZINC ON THEM -A RANDOMIZED CONTROL TRIAL, A HOSPITAL BASED STUDY"

By

DR. SHRUTI. B. H.

Dissertation submitted to the

B.L.D.E. UNIVERSITY BIJAPUR, KARNATAKA

In partial fulfilment of the requirements for the degree of

DOCTOR OF MEDICINE

In

PAEDIATRICS

Under the guidance of

DR.R.H.GOBBUR$_{\text{MD, DCH}}$

PROFESSOR

DEPARTMENT OF PAEDIATRICS

B.L.D.E.U'S SHRI B.M.PATIL MEDICAL COLLEGE

HOSPITAL & RESEARCH CENTRE, BIJAPUR

KARNATAKA

2014

B.L.D.E.UNIVERSITY'S

SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL &

RESEARCH CENTRE, BIJAPUR

DECLARATION BY THE CANDIDATE

I, **DR. SHRUTI. B. H.,** hereby declare that this dissertation entitled **"ZINC DEFICIENCY IN LOW BIRTH WEIGHT BABIES & EFFECT OF SUPPLEMENTATION OF ZINC ON THEM -A RANDOMIZED CONTROL TRIAL, A HOSPITAL BASED STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **DR. R. H. GOBBUR$_{MD, DCH}$,** Professor, Department of Pediatrics, B.L.D.E.U's Shri B. M. Patil Medical College Hospital and Research Centre, Bijapur.

Date:

Place: Bijapur

DR. SHRUTI. B. H.

Post Graduate Student,
Department of Paediatrics,
B.L.D.E.U's Shri B.M.Patil Medical College, Hospital & Research Centre,
Bijapur.

B.L.D.E. UNIVERSITY'S

SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, BIJAPUR

CERTIFICATE BY THE GUIDE

This to certify that the dissertation entitled **"ZINC DEFICIENCY IN LOW BIRTH WEIGHT BABIES & EFFECT OF SUPPLEMENTATION OF ZINC ON THEM -A RANDOMIZED CONTROL TRIAL, A HOSPITAL BASED STUDY"** is a bonafide research work done by **DR. SHRUTI. B. H**, under my overall supervision and guidance, in partial fulfilment of the requirements for the degree of M.D. in Paediatrics.

Date:

Place: Bijapur

DR. R. H. GOBBUR$_{\text{MD, DCH,}}$

Professor
Department of Paediatrics
B.L.D.E.U's Shri B.M.Patil Medical College, Hospital & Research Centre, Bijapur.

B.L.D.E. UNIVERSITY'S

SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, BIJAPUR

ENDORSEMENT BY THE HEAD OF DEPARTMENT

This to certify that the dissertation entitled **"ZINC DEFICIENCY IN LOW BIRTH WEIGHT BABIES & EFFECT OF SUPPLEMENTATION OF ZINC ON THEM -A RANDOMIZED CONTROL TRIAL, A HOSPITAL BASED STUDY"** is a bonafide research work done by **DR. SHRUTI. B. H,** under the guidance of **DR. R. H. GOBBUR$_{MD, DCH}$,** Professor, Department of PAEDIATRICS, at B.L.D.E.U's Shri B.M.Patil Medical College Hospital and Research Centre, Bijapur.

Date:

Place: BIJAPUR

DR S V.PATIL. M.D.

Professor and Head,
Department of Paediatrics
B.L.D.E.U's Shri B.M.Patil Medical College, Hospital & Research Centre, Bijapur.

B.L.D.E.UNIVERSITY'S

SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL &

RESEARCH CENTRE, BIJAPUR

ENDORSEMENT BY THE PRINCIPAL

This to certify that the dissertation entitled **"ZINC DEFICIENCY IN LOW BIRTH WEIGHT BABIES & EFFECT OF SUPPLEMENTATION OF ZINC ON THEM -A RANDOMIZED CONTROL TRIAL, A HOSPITAL BASED STUDY"** is a bonafide research work done by **DR. SHRUTI. B. H,** under the guidance of **DR. R. H. GOBBUR**$_{\text{MD, DCH,}}$ Professor, Department of Paediatrics, at B.L.D.E.U's Shri B. M. Patil Medical College Hospital and Research Centre, Bijapur.

Date**:**

Place: Bijapur.

DR. M. S. BIRADAR $_{\text{M.D.}}$

Principal,
B.L.D.E.U's Shri B.M.Patil Medical College Hospital & Research Centre, Bijapur.

B.L.D.E. UNIVERSITY'S

SHRI B.M.PATIL MEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE, BIJAPUR

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the B.L.D.E. UNIVERSITY, BIJAPUR, Karnataka shall have the rights to preserve, use and disseminate this dissertation/thesis in print or electronic format for academic/research purposes.

Date:

Place: Bijapur

DR. SHRUTI. B. H

Post Graduate Student,
Department of Paediatrics,
B.L.D.E.U's Shri B.M.Patil Medical College, Hospital & Research Centre,
Bijapur.

ACKNOWLEDGEMENT

I find my words inadequate to express my most humble and profound gratitude to my eminent and esteemed teacher and guide **Dr. R. H. Gobbur** $_{MD,DCH}$ Professor department of Pediatrics, Shri B M Patil Medical, Bijapur. His never ending willingness to render help, guidance and encouragement coupled with his rich knowledge and keen interest were a constant source of inspiration.

I am extremely grateful to my eminent and esteemed teacher **Dr. S. V. Patil**$_{MD}$ professor and head of the department, Pediatrics for his overall guidance and inspiration without which this would not have seen the light of the day. I am grateful to him for what I have learnt from him and for his kind support.

I sincerely thank my learned teachers and greatly thankful to my true teachers **Dr.A.S.Akki**$_{MD,DCH}$Professor, **Dr.S.S.Kalyanshettar**$_{MD}$ Professor, **DrM.M.Patil**$_{MD}$ Associate Professor, department of pediatrics, Shri B M Patil Medical College, Bijapur for their timely suggestions and willingness to help all the time and making me understand the real Pediatrics.

I sincerely thank my **fellow postgraduates** and **friends** for their support and cooperation. My sincere thanks to all **nursing staff** of department of pediatrics, Shri B M Patil Medical College for their kind cooperation from time to time in carrying out the study.

I would also like to acknowledge my **late Mother Shailashree**, to whom I am deeply indebted and she continues to be great source of inspiration.

It is impossible to express my gratitude in words to my **father, my brother, my sister** and **my fiancé Jagadish** for their constant support, motivation and encouragement without which I would have never have been able to complete this study.

I express my thanks to the **library staff** and all **hospital staff** for their kind cooperation in my study.

Finally I thank **god** for making all these wonderful people happen to me and pray for continued blessing and success.

Date:

Place: Bijapur **Dr. Shruti. B. H**

LIST OF ABBREVIATIONS

LBW- Low birth weight babies

Zn – Zinc

WHO- World health organization

AAS- Atomis absorption spectrophotometry

HC- Head circumference

µg/dl- Microgram per decilitre

ABSTRACT

Background- Zinc is known to play a critical role as a cofactor for numerous enzyme functions, protein synthesis, nucleic acid metabolism, gene expression, immune regulation and is essential element for normal growth and development.

Low birth weight babies have low serum zinc levels and have higher rates of morbidity and mortality from infectious diseases because of impaired immunity and are at increased risk of growth failure.

Objectives- This study was undertaken to assess zinc deficiency status in Low Birth Weight Babies and the effect of zinc supplementation on them. This was a hospital based, Prospective randomized control trial study.

Methods- A total of 100 Low Birth Weight babies delivered at Shri B M Patil Medical College, Hospital & Research Centre or delivered at outside hospital & referred to our hospital were included in the study. Quantitative analysis of serum zinc level in LBW babies was made by using commercially available ZINC kits by Colorimetric method.

Results-Better Weight gain of LBW infants, and Prevention of infection in them, was noted by supplementation with Zinc.

Conclusion– Because LBW is a major pediatric problem, accounting for approximately 30% of all live births in developing country like India. Serum Zinc level in LBW babies in our study was low. And Zinc supplementation in them was found to be effective to enhance the growth and decrease morbidity and mortality in them.

Keywords- Zinc, LBW, Preterm, Infants, Trace elements, Growth, Supplementation

TABLE OF CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF FIGURES

INTRODUCTION

Zinc is known to play a critical role as a cofactor for numerous enzyme functions, protein synthesis, nucleic acid metabolism, gene expression and immune regulation. This element therefore is essential for normal growth and development. All its takes is a touch of element number 105.

Zinc is vital micronutrient next only to iron. Dr. Gopalan first discovered human zinc deficiency in the middle east in early 1960s and symptoms included growth retardation, male hypogonadism, anemia, hepatosplenomegaly and geophagia. Since then there have been many reports of zinc deficiency. Symptoms in this population have included decreased growth velocity and loss of appetite in infants and children.

Low birth weight (LBW) infants (infants weighing < 2500 g at birth irrespective of gestational age) have higher rates of morbidity and mortality from infectious diseases because of impaired immunity and are at increased risk of growth failure. Studies have demonstrated low zinc status in LBW infants. And it has been shown that low maternal serum zinc level during pregnancy may be associated with an increased risk of LBW, also zinc supplementation during pregnancy has resulted in reduction of health risk of these infants.

Reduced level of zinc in LBW infants, might well account for the increased morbidity and growth failure in such infants.

Zinc level in breast milk fell from 5.32 to 1.2 mg/L by 7 months of age and mainly during third and fourth month of lactation. LBW infants have higher postnatal requirements of zinc and unless replenished, the newborns remain at increased risk of developing zinc deficiency.

Because LBW is a major pediatric problem, accounting for ~ 30% of all live births in developing country such as India. Hence the need for the study.

This study was undertaken to assess incidence of zinc deficiency in LBW babies and the impact of zinc supplementation on them.

.

AIMS AND OBJECTIVES

- To study the zinc deficiency in Low Birth Weight babies and effect of zinc supplementation on them.

- It is a prospective randomized control trial, a hospital based study.

REVIEW OF LITERATURE

A study by Freil which was performed on chilean infants that were born small for gestational age (mean birth weight , 2300 g ; mean length at birth, 47 cm). They were randomly assigned to a test group receiving 3 mg of elemental zinc per day (mean total zinc intake, 1.5- 1.8 zinc per kg per day) or to a placebo group (mean zinc intake ~ 0.7 mg of zinc per kg per day) for 6 months. Supplemented group demonstrated improved growth, significantly greater weight for age and length for age than the placebo group[1].

Studies on zinc supplementation to LBW infants from birth through 6 months of age are very few. However studies of shorter duration on very LBW infants and also on children in older age groups have shown varying results. Similar placebo controlled studies conducted by Shrivastava[2] et al on malnourished children aged 8 to 24 months showed that children supplemented with zinc for 3 months had a significant weight gain ($P < 0.001$).

Another study made by Rafael Jimenez[3], Mayder Martinez University of Santiago has shown increase in linear growth and weight gain with zinc supplementation. A double blind longitudinal study of a cohort of 163 infants was carried out. Infants were put into two groups, the supplemented group with 87 infants received a dose of 10 mg /day of zinc sulphate solution and non supplemented group with 76 infants received a dose of 10ml/day physiologic

solution without zinc. This showed infants supplemented with 10 mg/dayincrease in weight.

A fourth study by Lira[4] et al. on low birth weight full-term infants in northeast Brazil demonstrates an effect on growth of 1 or 5 mg of zinc/d supplementation during the first 26 wk of life, although an effect is found on weight gain with 5 mg of zinc/d between 17 and 26 weeks.

In addition, zinc requirements of LBW infants are high because of their immature gastro intestinal tract, which leads to high endogenous losses and decreased absorption, an extended period of rapid growth, and low body stores of zinc. Thus zinc supplementation is started at birth in these infants, its sustained impact will continue in the weaning period.

There are few other studies showing zinc supplementation from birth to 2 months of age has been effective in improving weight gain in LBW infants. These findings indicate that zinc supplement could have important implications for child health and survival programs in developing countries with high incidence of LBW.

Zinc is one of the numerous trace elements which are known to have a significant role in the growth and development of an infant. In fact its role has

been attributed right from antenatal period, as deficiency of this micronutrient can have a crucial bearing upon the health of the newborn. Prasad defined the role of zinc in human nutrition in 1991. It was the observation linking increased susceptibility to infectious diseases and nutritional zinc deficiency which lead to the increased interest in the importance of this trace element.[5]

Zinc is required for functioning of over 200 enzymes and hence likely to affect a number of various systems in the human body. Severe to moderate zinc deficiency has been found to cause oxidative damage to proteins, lipids and DNA in rats' testes[6] which may be due to iron accumulation or a reduction in zinc dependent antioxidant processes.

Zinc is present in all organs, tissues and other body fluids. It is primarily an intracellular ion with intracellular zinc contributing to more than 95% of total body zinc. Skeletal muscle and bone together contain 80% of the total body zinc. It is widely distributed within the cells bound to protein. It governs a wide range of body functions:

1. **Cell division and growth**: Zinc has vital role in cell division and growth. It governs cellular growth and differentiation. Early zinc deficiency reduces cell division which in turn affects growth as an adaptive mechanism.
2. **Membrane function**: Zinc has an important role in the stabilization of biomembranes by binding sulfhydryl groups and forming mercaptides.

Decrease in biomembrane zinc is suggested as one of the early biochemical lesions of zinc deficiency.

3. **Protection against free radical change**: Zinc is believed to have a role as an antioxidant against free radical related diseases. Liver injury, chronic inflammatory conditions, essential fatty acid deficiency, cancer and radiation damage are all associated with decreased levels of zinc in the body.

4. **Zinc and sex hormones**: Deficiency of zinc is known to impair testosterone production in humans. In pregnant females difficult labour is believed to be manifestation of zinc deficiency.

5. **Zinc and immune functions**: Animal studies have confirmed the role of zinc in maintaining the immune levels in the body. This is considered to be due its role in cell proliferation and other cellular functions. Zinc is essential for the function of many enzymes, which are vital for growth and regulation of immune cells.

6. **Zinc and mental development**: In experimental animals it has been demonstrated that zinc deficiency has an impact on the fetal outcome. This affect is however dependant on the degree and duration of deficiency.

The adverse affects on the fetal outcome could be in the form of congenital malformation and fetal resorption. In humans however such affects are not well established in case of mild or borderline deficiency states.

7. **Zinc and brain development**: Deficiency of zinc is known to have adverse affects on the cerebral morphology and also on behavioral development of animals.

8. **Zinc and vitamins**: Zinc is present in high concentration in the retina and other ocular tissues, therefore considered to be interrelated with vitamin A metabolism especially in relation to vision. Its deficiency can also affect night vision despite adequate amounts of retinol concentration.

9. Zinc and metals: Zinc absorption, and actions are considered to be adversely affected by interaction by certain metals like iron, calcium, and copper if present in excess.

METABOLISM

Zinc is absorbed from the proximal bowel. 60% of the circulating plasma zinc is found loosely bound to albumin and amino acids, while the remaining 40% is tightly bound to alpha globulins and is not free to diffuse into

tissues. The total zinc content in the body is about 2-3 grams. Almost 50% of the total body zinc is in bone is not readily available for metabolic needs. Zinc is not stored as such in the body which implies that there has to be continuous provision of this micronutrient through the diet for the tissue growth and repair.

Excretion of zinc is mainly through stool. In fact the total zinc content is around 54mg, 60% of which is passed to the fetus in the last trimester at the rate of 30 micrograms per kg of body weight per day. Inadequate amounts of dietary zinc or increased losses may place the infant at increased risk of developing deficiency.

The zinc content of breast milk in Indian mothers is low and gradually decreases later.[7]

This concentration can vary from one mother to another although not significantly. The Average daily intake of zinc in an infant works up to 1+/_0.75mg but its requirement is more.[8] Hence deficiency in zinc occurs.

Zinc Requirements:

Zinc deficiency in humans is mainly due to a lack of bioavailable zinc in the diet, general malnutrition or malabsorption[9].

Nutritional zinc requirements are influenced by many dietary factors that affect its bioavailability and physiological reqirements. On the basis of current

evidence, the suggested recommended dietary intake of zinc during first half of infancy is 3-5 mg per day and during later childhood it becomes 10mg/day[10]. These requirements increase in preterm low birth weight infant and children recovering from malnutrition. These requirements are considered for Indian children as well. For adults the zinc requirement has been set as 15mg/day[11] which are in accordance with the values suggested by WHO[12].

Stevens J and Lubitz L[10] in their study demonstrated inadequate zinc in breast milk and showed rapid clinical response in symptomatic zinc deficient breastfed term and preterm infants following oral zinc supplementation.

Implications of Zinc deficiency

Zinc is perhaps one trace element, the deficiency of which has been implicated with a wide variety of problems like acrodermatitis enteropathica, sickle cell anemia, immunological disorders, and neurological disorders and even in the outcome of pregnancy.

Its role has been well described in treatment of diarrheas, infections like pnumonia and protein energy malnutrition.

In children moderate to severe zinc deficiency is known to depress skeletal growth and gonadal development which were found to reverse on zinc therapy.[5,13]

Zinc Status in Pregnancy

Zinc deficiency in pregnancy not only affects the mother, but it also has immunological consequences for the fetus. Various immune defects have been reported in animal studies.

One of the earliest and clinically most relevant signs of maternal zinc deficiency are low levels of natural immunoglobulins including a persistent defect in IgM and transiently diminished levels of IgA and IgG2 in neonates. The explanation proposed for this is diminished transport of immunoglobulins. This effect has been described even in mild transient deficiency.[14]

Prenatal zinc deficiency might also have an important effect on child immunity as observed in animal studies. Hypogammaglobulinemia together with altered antibody response and decreased T cell proliferation in response to T cell dependant antigens may cause poor success of vaccination in the infant, which in turn can have important consequences for the health status of the population. In humans, immunological defects may possibly have a bearing on subsequent generations as suggested by animal studies which may be irreversible.[15]

Supplementation trials on pregnant women who can be at risk of zinc deficiency have been not conclusive. Controversy exists between different

authors regarding the role of supplementation in this group, therefore no extra dose, is required except, when there might be some definite indication for deficiency.

Zinc and diarrhea: Zinc deficiency has been associated with high rates of infectious Diseases including skin infections, diarrhea and respiratory infections besides malaria, and delayed wound healing. In the developing countries extensive studies have been done regarding diarrhea and respiratory infections.

The results from all the groups show that zinc supplemented children have lower rates of diarrhea than those of normal children[16]. Trial studies of zinc supplementation during acute persistent diarrhea have shown consistent benefits of zinc supplementation. These benefits being in the form of shorter episode duration of diarrhea. More significantly, there were large reductions in the rate of 'treatment failure' or death in these trials.

Zinc supplementation is known to significantly reduce lactose excretion in Persistent diarrhea and this effect was seen to be more marked in malnourished children. Therefore, zinc has significant effect on intestinal epithelial integrity and is likely to contribute to a better recovery. Besides, children with diarrhea who received

Supplementation 15mg of zinc acetate per day ,for 15 days, had significantly greater gains in height and weight in the following 9 weeks than the unsupplemented children.[17]

It was therefore suggested that for preventive use of zinc, there is need to evaluate various ways to improve zinc nutriture. These include dietary sources and availability of zinc, fortifying foods with zinc and supplementation programs.

Zinc and respiratory infection: Several field studies have shown that zinc supplementation is beneficial in preventing pneumonia in children in developing countries. A pooled analysis(Zinc investigation collaborative group,1999) has shown that zinc supplemented children have a 41% reduced rate of pneumonia compared to control group.[18]

Zinc in protein energy malnutrition: Rehabilitation from severe sever protein energy malnutrition requires the provision of adequate quantitatives macro and micronutrients. Zinc deficiency has been implicated as limited factor in the recovery [19] and WHO recommends that all severely malnourished children be treated with zinc along with other micronutrients.

A study from India[20] has shown that though there was no difference in weight gain between zinc supplemented and placebo group, the former showed

an increase in plasma zinc which rose to normal levels. In the latter group, the plasma zinc decreased significantly during the period of rapid growth. This indicates that though dietary zinc may be sufficient for efficient weight gain, it is not possible to compensate for the extra requirements in the process of new tissue deposition.

Zinc and cognitive development: The role of the zinc in the cognitive development and behavior of a child has been explained based on its critical role in the function of several structural regulatory and catalytic proteins.

It is present in the brain bound to proteins and is important for its structure and Function[21,22].

There is also some evidence to suggest that zinc deficiency results in lowered levels of omega-3 and omega -6 chains possibly causing impaired fatty acid metabolism in the neurons[23].

Moreover, it seems to be important for neurogenesis, neuronal generation and Synaptogenesis and its deficiency could interfere with neuro-transmission and subsequent neurophysiological development. Besides zinc is also understood to be involved in the metabolism of thyroid hormones, recptor functions and transport of other hormones that could influence central nervous system.[24]

Findings from the studies in monkeys suggest that the zinc deprived group showed progressive decline in day time activity and attention performance. The study also indicate that zinc deprived adolescents may be more susceptible to behavioral changes before the onset of growth retardation.[25] Studies from India have shown a positive association between zinc deprivation and activity in malnourished children.

Reduced activity inhibits exploration which may directly contribute to diminished Cognitive development. It was observed from this study that children randomized to Receive 10mg/day of zinc gluconate in addition to vitamins A,B_1,B_2,B_6,D_3, E and niacin , spent 72% more time performing high movement activities like running.

The effects were greater in boys and this could be due to extra zinc requirement in them[26].

There is evidence to prove the association between zinc status and neurophysiological behavior also. Supplementation with zinc have resulted in alteration in the fetal neurobehaviour, better motor development in very low birth infants.

More vigorous physical activity in malnourished infants and toddlers and improved neurophysiological functions in school age children.

Zinc deficiency affects cognitive development by alterations in the attention, activity, other features of neurophysiological behavior and motor development. These effects vary by age and may be influenced by care giving environment, particularly the behavior of the mother and social context.[27]

Acrodermatitis enteropathica: The most extreme forms of zinc deficiency can be studied In zinc specific malabsorption syndrome 'acrodermatitis enteropathica': a rare autosomal recessive inheritable disease[28] which appears to be more common in girls.

This disorder manifests insidiously from the age of weaning, characterized by Severe skin lesions, alopecia, failure to thrive and diarrhea. The lesion appears typically on the cheeks, knees and elbows. The hair becomes reddish in color. Even ocular manifestations in the form of photophobia, conjunctivitis and corneal dystrophy can be observed.

Associated characteristics like chronic diarrhea, stomatitis, glossitis, personality changes, Intercurrent bacterial infections are also commonly seen.

Administration of oral zinc therapy in doses of 50-150 mg/day reverses the symptoms dramatically.

A possible role of zinc involving metabolic inter relationship with other micronutrients have also been postulated.

Some of these are:

1. 1.Zinc deficiency may lead to poor mobilization of hepatic stores of vitamin A and thus cause hypovitaminosisA .

2. Zinc absorption may be affected by inorganic iron.

3. Zinc may also depress copper absorption which can lead to biochemical evidence of copper deficiency.

Zinc Toxicity

Although zinc toxicity is not common, it is known to occur if ingested in large quantities. Vomitting, nausea, abdominal pain. If taken over a prolonged period, it interferes with copper metabolism.[29]

Dietary Sources of Zinc-

If a normal balanced diet is taken the requirements are generally met with. Good sources of zinc are whole pulses, nuts like almonds and cashew, oilseeds like gigelly, mustard, safflower and poppy seeds.

Serum Zinc level Estimation

It is estimated by Colorimetric method[30] (Zinc Kit) by Crest Biosystems, a division of coral clinical systems**.** A direct colorimetric assay of zinc in 0.02-ml of serum using a new, water-soluble reagent, 2-(5-nitro-2-pyridylazo)-5-(N-

propyl-N-sulfopropylamino) phenol disodium salt dihydrate (nitro-PAPS epsilon = 14.5 X 10(4) l/mol per cm at 574 nm), is presented. Use of microwell plates allowed a reduction in the sizes of samples and reagents without affecting the sensitivity or the precision. Zinc and interfering metal ions in serum are bound as cyanide complexes; the zinc ions are preferentially demasked by use of the chloral hydrate, permitting a colorimetric reaction with the chromogen. Within-run and between-run coefficients of variation (CV) were in the ranges of 1.6-2.3% and 1.8-5.2%. This method correlated well with atomic absorption spectrometry. nitro-PAPS is a chromogenic reagent for the colorimetric assay of serum zinc; assay of micro amounts of metals following ion-pair extn. with nitro-PAPS.

Principle – Zinc in an alkaline medium reacts with Nitro-PAPS to form a purple coloured complex. Intensity of complex formed is directly proportional to the amount of zinc present in the sample.

Normal reference values-

Serum - 60 – 120 µg/dl

Contents –	25 ml	75 ml
L1 : Buffer reagent	20 ml	60ml
L2 : Colour reagent	5 ml	15 ml
S :	2 ml	2 ml

Working Reagent : Pour the contents of 1 bottle of L2 into L1. This working reagent is stable for atleast 2 weeks when stored at 2-8 degree temperature.

Zinc is reported to be stable in serum for 7 days at 2-8 degree temperature. Pippete into clean dry test tubes labeeled as Blank(B), Standard(S), Test(T).

Mix well and incubate at room room temperature for 5 min. Measure the absorbance of the Standard(Abs.S) and Test Sample (Abs.T) against the blank within 20 mins.

$$\text{Zinc in } \mu g/dl = \frac{\text{Abs.}\mathbf{T}}{\text{Abs.S}} \times 200$$

In our study 60 samples serum zinc estimation done by colorimetric method. Remaining 40 samples serum zinc estimation were done by Atomic absorption Spectrophotometry[31] (AAS).

A study made by Friel JK[1], Andrew WL, Cornel AM, Memorial University of Newfoundland St John's Canada showed that inadequate zinc intake may lead to poor growth and developmental outcome in low-birth-weight infants. Fifty-two infants (LBW) were randomly allocated to two groups. Supplemented (SUPP) infants received a regular term formula plus zinc

supplements (4.4 mg/L; final content, 11 mg/L); PLAC infants received the same formula plus placebo (final content, 6.7 mg/L).

Infants started their formula at 1,853 +/- 109 g and consumed the formula for 6 months. All subjects were evaluated at 3, 6, 9, and 12 +/- 0.75 months corrected-for-gestational-age. At each evaluation, weight, length, and head circumference were measured, a Griffiths developmental assessment was performed, and a blood sample was taken. Higher plasma zinc levels ($p < 0.05$) were found in the SUPP group at 1 and 3 months, and improved linear growth velocity was found in the SUPP group over the study period for the whole group as well as for girls alone. Maximum motor development scores were higher ($p = 0.018$) in the SUPP (98 +/- 10) than the PLAC (90 +/- 8) group, indicating that increased zinc intake in early infancy may be beneficial to LBW infants.

Another study made made by Rafael Jimenez[3], Mayder Martinez University of Santiago shows increase in linear growth and weight gain with zinc supplementation.

Zinc is a trace element with a great importance for both intrauterine and postnatal growth of infant with growth retardation.

A double blind longitudinal study of a cohort of 163 infants was carried out.

Infants were randomly assigned into two groups, the supplemented group with 87 infants received a dose of 10 mg/day of zinc sulphate solution during 6 months and the non supplemented group with 76 infants received a dose of 10 ml/day of physiologic solution without zinc in the same period.

Results: The increased weight is positively related to zinc supplementation as is evidenced by the weight gain graph and the repeated measures of analysis, whereas, the height variable is not influenced in the same way. In relation to the psychomotor variables, the motor developmental index is positively influenced by zinc supplementation.

Hence they concluded that Zinc supplementation with 10 mg of zinc sulphate to infants with low birth weight during 6 months may be beneficial for increasing weight and motor development.

There are other few other studies showing zinc supplementation from birth to 2 months of age has been effective in improving weight gain in LBW infants. These findings could have important implications for child health and survival programs in developing countries with high incidence

Another study made by Sunil Sazawad and Robert E Black[32], Department of international Health, John Hopkins Bloomberg School of public health, North wolfe Street, Baltimore, MD Showed that preterm infants are at increased risk of death, acute and long-term morbidity; often associated with

nutritional compromise and impaired growth. With about 13 million preterm babies born each year worldwide, the burden is disproportionately concentrated in Africa and Asia, where about 85% of all preterm births occur (31% and 54%, respectively)(1). Preterm and low birth weight babies may have impaired zinc status due to low body stores, limited capacity to absorb and retain micronutrients coupled with increased endogenous losses associated with organ immaturity, high nutrient demand to support catch-up growth, and inadequate intakes because exclusive breastfeeding does not compensate for increased demand due to prematurity. Preterm infants have high zinc deficit and dietary requirements as 60% fetal zinc is acquired during third trimester of pregnancy. Zinc deficiency has a negative effect on endocrine system leading to growth failure among other clinical manifestations.

Islam and colleagues[33] report the findings of a double blind randomized controlled trial evaluating the efficacy of oral zinc supplementation on the growth of hospital born preterm infants in the Neonatal Special Care Unit of Dhaka in Bangladesh(2). This is the first study carried out selectively among preterm babies to evaluate the effect of zinc supplementation in a developing country setting. In this study, 100 preterm infants (below 37 weeks of gestation) weighing between 1000 g and <2500 g were enrolled and randomized to receive either zinc and multi-vitamin supplement (Group I; *n*=50) or only multivitamin supplement (Group II; *n*=50) for 6 weeks. At enrollment, serum zinc levels were in the lower limit of the normal range. The investigators concluded that

zinc supplementation among preterm babies for 6 weeks resulted in improved weight gain and linear growth, enhanced serum zinc status and reduced incidence of diarrhea. There were no significant side effects of the supplements.

The limitations of the study reported by authors included: infants were not followed up actively on daily basis to check compliance, and a long-term follow-up was not undertaken. However with observed change in plasma zinc concentration and growth impact, compliance does seem to have been adequate. Supplementation was given for shorter duration (6 weeks) whereas in the previously conducted studies in preterm infants the average period of supplementation was for 6 months (3,4). It would have been of interest to evaluate sustainability of improved growth because shorter period of supplementation may in fact be more pragmatic and achievable in routine care.

So far only a few double blind randomized controlled trials, three from developed country sett-ings, two of which were in premature infants, and five from developing country settings, have reported the effects of zinc supplementation during the first months of life on growth of infants born prematurely or small for their gestational age. The dose in these studies varied between 3 mg to 10 mg of zinc per day. Of the 3 studies conducted in developed countries (Spain and Canada), 2 studies among preterm infants showed positive effect on plasma zinc concentrations and linear growth and 1 on LBW infants

showed no effect. However, no significant effect on weight gain was observed in any of these studies. The available evidence for the effect of zinc supplementation on growth among low birth weight infants from developing countries setting is from India (2 studies), Bangladesh (1 study), Chile (1 study) and Brazil (1 study). The duration of supplementation in these studies ranged from 4 weeks to 1 year and the dosage of zinc supplement varied between 3 mg to 5 mg per day in first 6 months of age and 10 mg of zinc per day for >6-12 months. Both short term (4-6 weeks) and long term (6 months-1 year) zinc supplementation had a beneficial effect on weight gain. However, only 2 long term supplementation studies conducted in India and Chile documented a significant increase in length gain with zinc supplementation. On the contrary, the largest RCT conducted on LBW Indian infants concluded no beneficial effect on length and weight gain with zinc supplementation given for a period of 1 year, although a positive effect on plasma zinc concentration was observed. There are bound to be physiological differences between the preterm births and non-preterm small for gestational age births because the period available for zinc accumulation during gestation is different. Therefore some of the conflicting data regarding impact of zinc on growth in low birth weight infants may be contributed by mixing low birth weight and preterm births.

Most of the studies that have evaluated impact in low birth weight infants in developing countries have not reported gestational age due to difficulty of ascertaining it and so would have recruited a variable mixture of preterm births and small for gestational babies. In the light of available evidence, the findings of the current study provide an important piece of additional data, which needs further confirmation. If replicated, zinc supplementation as an intervention to improve growth of hospital born preterm infants in developing country settings would be an inexpensive and easy intervention to scale up and even take to community service delivery. Studies with adequate sample size, preferably multicentre and with longer-term follow up are needed to confirm and quantify the magnitude of the beneficial effect of zinc supplementation on growth among preterm babies.

MATERIALS AND METHODS

SOURCE OF DATA

All the low birth weight babies delivered at Shri B M Patil Medical College, Hospital & Research centre and delivered at outside hospital & referred to our hospital between November 2011 to August 2013. It is a randomized control trial.

SAMPLE SIZE- 100

Determination of sample size (n)

Sample size, n for estimating proportion of the low birth weight babies under study is determined from following formula for the proportion of the incidence p = 28%

$$n = \frac{Z^2 pq}{e^2}$$

$$= \frac{(1.96)^2 \times 0.28 \times 0.72}{(e)^2}$$

= 100 sample size

i.e n = sample size

Z = Table value of the standard normal variant (SNV)

p= proportion of neonates having the disease

q= proportion of neonates not having the disease

e=possible error is assumed as e= 0.088,

i.e 8% permissible error for the study

based on sample observation

STATISTICAL ANALYSIS

The observations for different parameters under study is depicted by suitable diagrams and graphs.

For example: pie chart and multiple bar diagrams.

For the comparative study of the parameters z or t test is applied.

SELECTION CRITERIA

INCLUSION CRITERIA

- All the LBW babies delivered at our hospital and delivered at outside hospital & referred to our hospital.
- Neonates weighing from 1500 to 2499 g, clinically stable and are exclusively breastfed, and whose parents give written consent for voluntary willingness, consent for the study.

EXCLUSION CRITERIA

- Infants with septicemia
- Infants with congenital heart disease
- Infants with significant genetic/ chromosome disorder

- Infants with allergy and eczema
- Infants blood transfusion, or iron supplement
- Infants with congenital anomalies like cleft lip & cleft palate
- Infants with immunodeficiency

METHOD OF COLLECTION OF DATA

After taking written informed consent from the parents and fulfilling inclusion and exclusion criteria of neonates were included in the study.

METHOD OF STUDY

Open label, Randomized Control trial study.100 LBW babies were randomly assigned into two groups, case group (n=50) and control group(n=50). The study was approved by ethical committee of BLDE University. After taking written consent, history and examination 3 ml of of blood was collected in plain vial was sent to department of biochemistry BLDEA's Shri B M Patil Medical college.Serum was separated from the whole blood and investigated for zinc level by Zinc Kit, Colorimetric method[30].Out of total 100 samples only 60 were done done by colorimetric method. Due to non availability of Zinc kit remaining 40 blood samples for Zn analysis were done by atomic absorption spectrophotometry[31](AAS) at Karnataka University, Dharwad.

Cases were supplemented with 10mg of elemental zinc for 3 months. Anthropometry measurement of each baby was done at 0, 1 and 3 months . Weight was measured on a electronic weighing scale, length was measured with infantometer and HC with non stretchable tape.

Follow up was done for all 100 LBW babies till 3 months age. And each follow-up visit, infant weight, length and HC were measured. Cases(50) with Zinc supplementation were compared with control group(n=50) not supplemented with zinc, for difference in the growth, development and morbidity and mortality in these groups. Z score statistical analysis will used to compare the difference in the serum zinc level, and difference in their growth and development ,of Zinc supplemented and control LBW babies at the end of the study period.

INVESTIGATION

Serum Zinc estimation was done by using "CREST BIOSYSTEMS, CORAL DIVISION" ZINC KIT by colorimetric method. nitro-PAPS is a chromogenic reagent for the colorimetric assay of serum zinc; assay of micro amounts of metals following ion-pair extn. with nitro-PAPS.

Principle – Zinc in an alkaline medium reacts with Nitro-PAPS to form a purple coloured complex. Intensity of complex formed is directly proportional to the amount of zinc present in the sample.

Normal reference values-

Serum - 60 – 120 µg/dl

Contents –	25 ml	75 ml
L1 : Buffer reagent	20 ml	60ml
L2 : Colour reagent	5 ml	15 ml
S : Standard	2 ml	2 ml

Working Reagent : Pour the contents of 1 bottle of L2 into L1. This working reagent is stable for atleast 2 weeks when stored at 2-8 degree temperature.

Zinc is reported to be stable in serum for 7 days at 2-8 degree temperature.

Pippete into clean dry test tubes labeeled as Blank(B), Standard(S), Test(T). Mix well and incubate at room room temperature for 5 min. Measure the absorbance of the Standard (Abs.S) and Test Sample (Abs.T) against the blank within 20 mins.

Reading done by using analyser at 578nm

$$\text{Zinc in µg/dl} = \frac{\text{Abs.}\mathbf{T}}{} \times 200$$

ATOMIC ABSSORPTION SPECTROMETRY (AAS)

Zinc Atomic weight – 65.37

Reagents for standard preparation

Aqueous- zinc metal(99.99%)

Non aqueous zinc 4-cyclohexylbutyrate preparation of 1000µg/ml standard

Metal in 40ml of 5N hydrochloric acid and dilute to 1 litre to obtain 1000µg/ml Zn

Atomic absorption

Lamp current – 5.0 Ma

Flame type- air- Acetylene(Oxidizing)

Optimum

Wavelenght (nm)	Slit worth (nm)	Working range (µg/ml)	sensitivity (µg/ml)
213.9	0.5	0.4-1.5	0.008
307.6	0.5	3000-12000	66

Working Zn standards-0, 0.1,02, and 0.3 µrmol/L in 150mmol/L NaCI for the direct method:

Dilute 0, 0.5, 1.0, and1.5mLof the 10 µmol/L zinc standard, each plus 5 mL of 1.5mol/L NaC1,to 50 mL.

Serum-Zn. We diluted 100 µL of serum with 1.0 mL of 0.1mol/L HCl. We measured the serum-Zn concentrations with flame atomic absorption spectrophotometry, using the continuous-aspiration technique. The mean of two determinations was used in the calculations. As standards, samplesof Zn in 0.1 mol/L HC1 were used.

Direct method-The samples and standard solutions were injected into the cone and the absorbance values recorded.

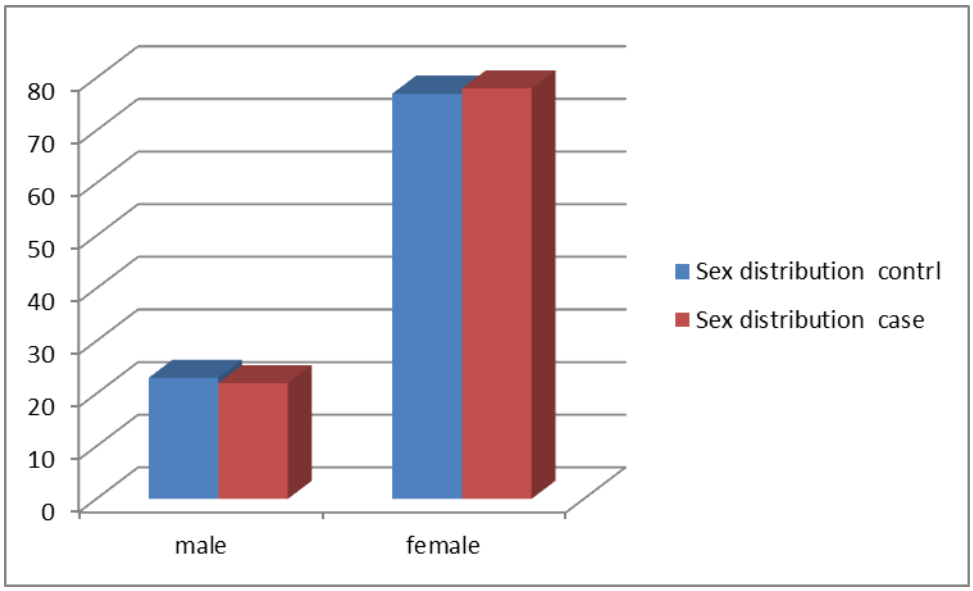
Fig 1 : Zinc Kit (Colorimetric Method)

Fig 2 : Atomic Absorption Spectrophotometry (AAS)

RESULTS

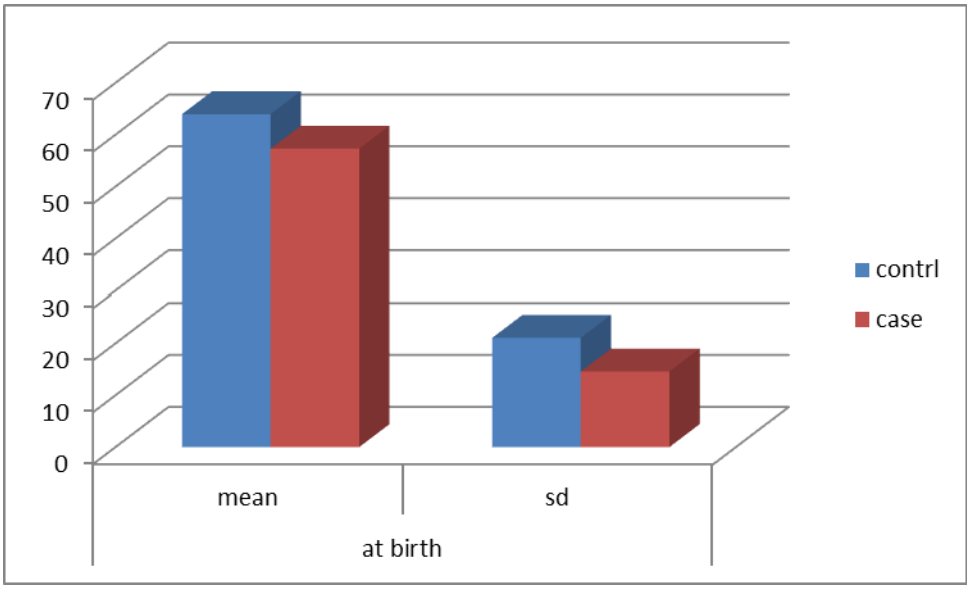
Graph 1. Shows sex distribution

	Control	Case
Male	23	22
Female	77	78



Graph 2. Shows serum Zn values

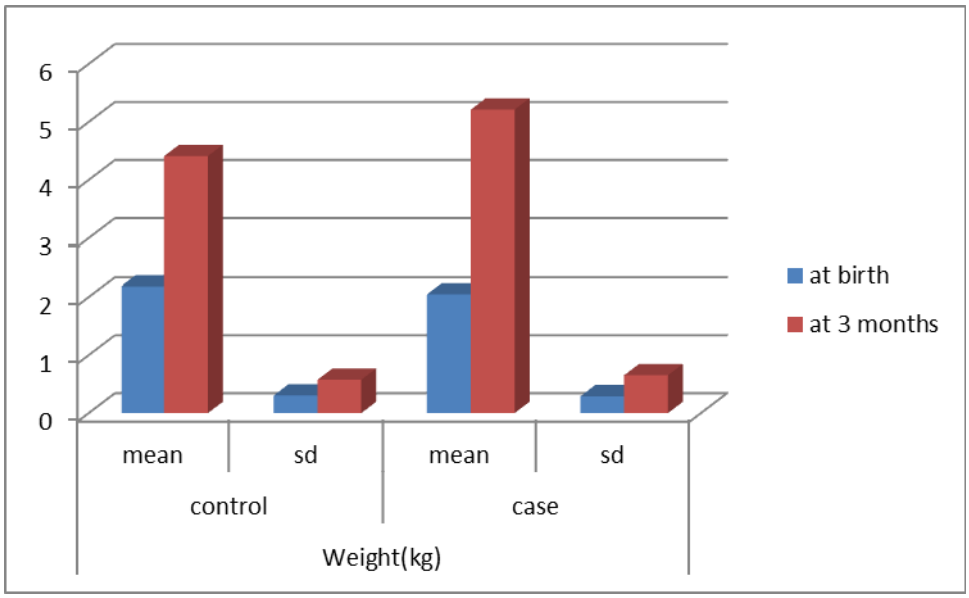
Serum Zn	At Birth	
	Mean	**Sd**
Control	63.952	21.05144563
Case	57.3	14.56729633



Anthropometry measurement 0f 50 cases and 50 control were taken at birth and at 3months followup. The cases supplemented with zinc and control group were comparable for weight, length, HC, and male/female ratio(Graph 1). Serum zinc levels(Graph 2) were in lower limit of normal range. After supplementation weight, height and head circumference were comparable in both groups. Significant differences in weight gain and increment in length were found in first and second follow up between two groups. Reduction of morbidity was seen in zinc supplemented group with no apparent infection and hospitilisation. No serious No serious adverse effect was noted related to supplementation therapy.

Graph 3. Shows weight at birth and 3 month

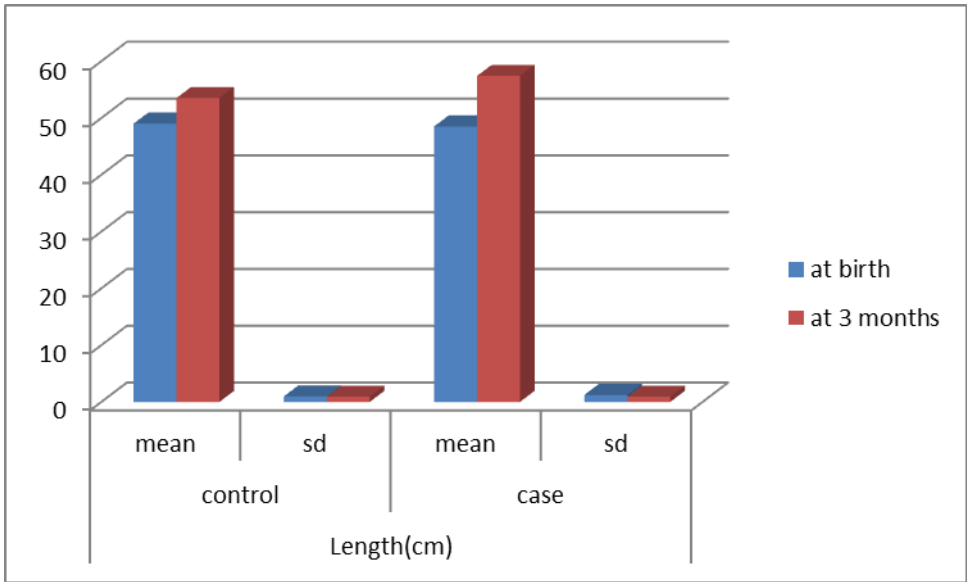
	Weight(kg)			
	Control		Case	
	Mean	Sd	Mean	Sd
At birth	2.1822	0.304183685	2.04782	0.2901043
At 3 Months	4.411	0.574418073	5.2122	0.6527127



In our study growth parameter i.e., weight of cases supplemented with zinc were significantly higher than the control group not supplemented with zinc. This was stastistically significant with p value of 0.009 (<0.05).

Graph 4.Shows length at birth and at 3 month

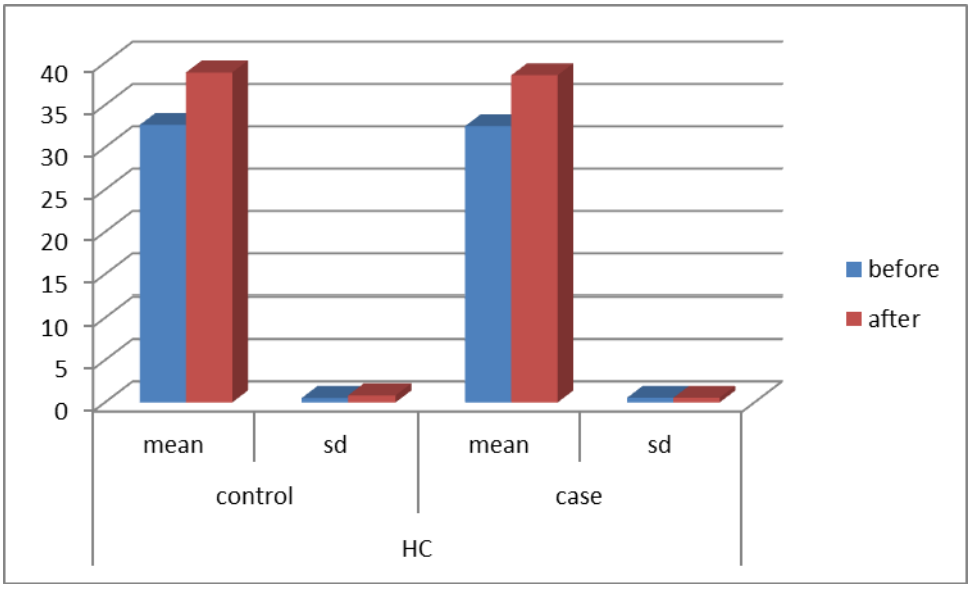
	Length(cm)			
	Control		Case	
	Mean	Sd	Mean	Sd
At Birth	49.006	0.974032225	48.508	1.2494636
At 3 Months	53.516	0.917040493	57.412	0.9252997



The length velocity in the case group supplemented with zinc were significantly higher compared to control group not supplemented with zinc. This was stastically significant with the p value 0.003(<0.05) .

Graph 5. Shows HC at birth and at 3months HC(cm)

	Control		Case	
	Mean	**Sd**	**Mean**	**Sd**
At Birth	32.65	0.523820346	32.502	0.5497643
At 3 Mth	38.856	0.828118103	38.524	0.5434433

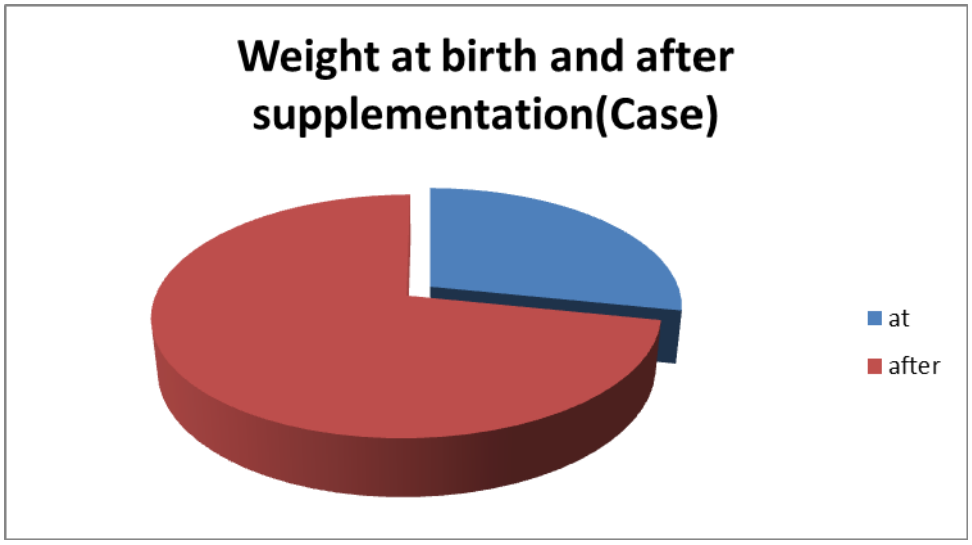


In our study head circumference increased in both the groups but difference was not statistically significant with the p value 0.599(>0.05)

Graph 6. Shows Weight

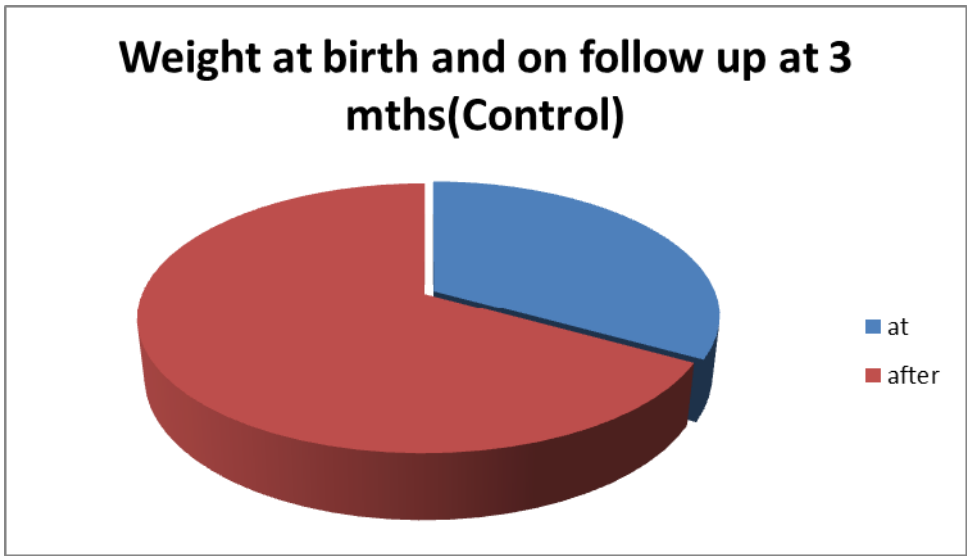
Weight Case

Weight	Case
	Mean
At	2.04782
After	5.2122



Weight Control

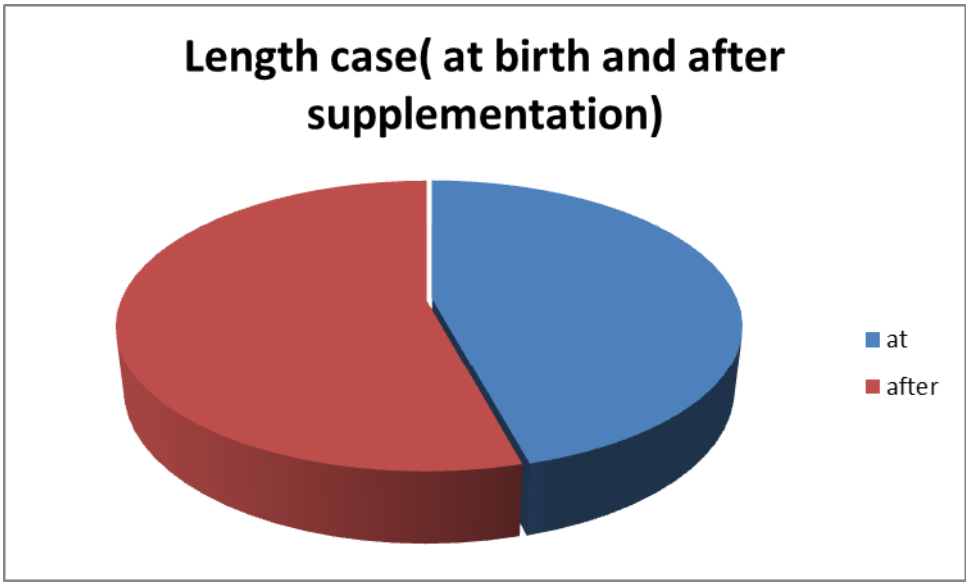
Weight	Control
	Mean
At	2.1822
After	4.411



Graph 7. Shows Length

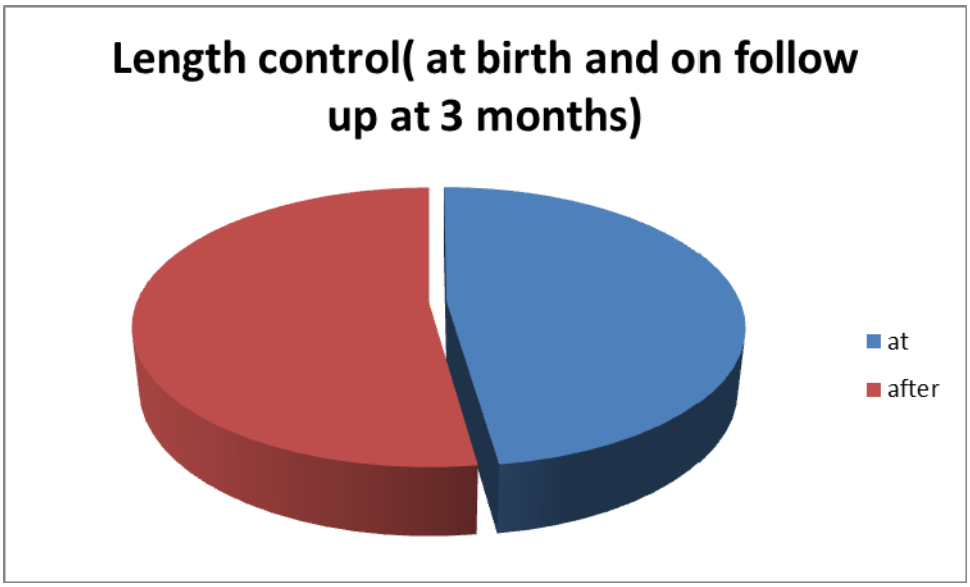
Length Case

Length	Case
	mean
at	48.508
after	57.412



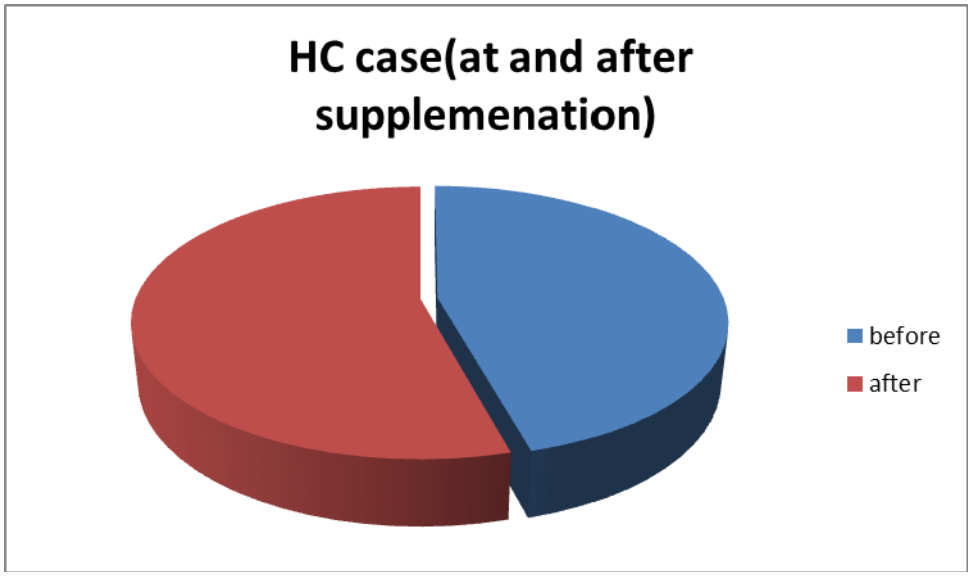
Length Control

Length	Control
	Mean
At	49.006
After	53.516



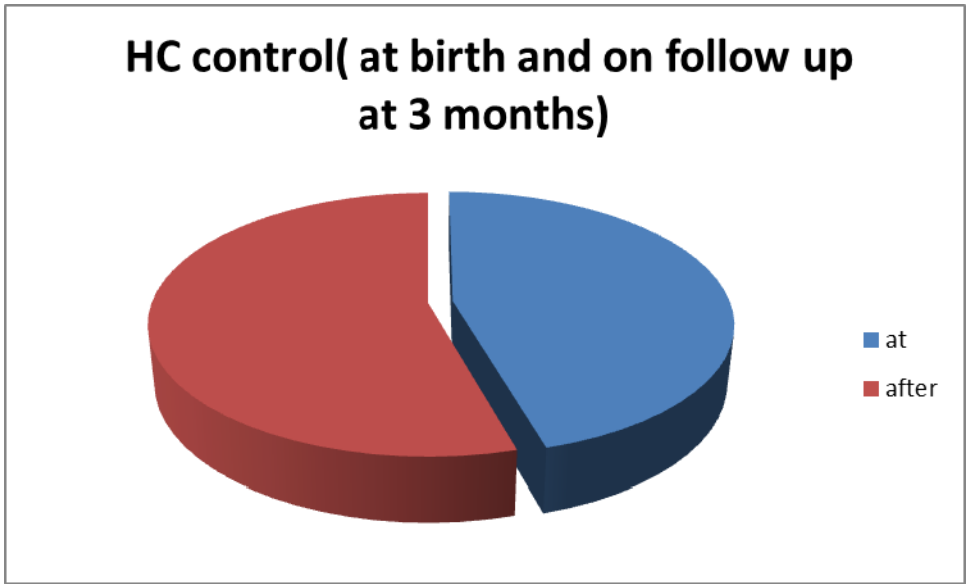
Graph 8 . Shows HC

HC	Case
Before	32.502
After	38.524



HC Control

Hc control	Mean
At	32.65
After	38.856



DISCUSSION

During this study 100 LBW neonates were randomly assigned into two groups, case and control group. In both groups serum zinc level estimation was done by colorimeric[30] and atomic absorption spectrophotometry[31] (AAS) methods. Case group were supplemented with 10 mg of elemental zinc for 2 months and control group not supplemented. Follow up is done for 3 months and reassessed for anthropometric parameters to see for weight gain and increase in linear growth. Cases with zinc supplementation are compared with control group not supplemented with zinc for difference in growth, development and morbidity and mortality in these groups.

In our study we observed decreased serum zinc levels in study group and at follow up we observed remarkable and significant weight gain and increased length in case group supplemented with zinc compared to control group.

These findings were compared with following studies done by Castillo-Duran et al[34] and TV Ramkumar[35] et al.

Table1. Shows anthropomery parameters after zinc supplementation in present study and compared with following studies.

	Present study	**TV Ramkumar[35] et al**	**Castillo- Duran[34] et al**
Weight	Significant Weight gain	Increased	Increased
Length	Increased	Increased	Increased
Serum zinc level	Low(mean 57.3)	Low	Low
HC	No significant change	Not significant	No significant change

Table 2. Shows changes in weight after supplementation in case and control group

Weight(g)	**Case**	**Control**	**P value**
Present study (at birth)	1510 ± 860	1800 ± 400	
Present study (after supplementation)	5210 ± 200	4100 ± 180	**0.009**
TV Ramkumar[35] et al (at birth)	1310 ± 185	1268 ± 197	
TV Ramkumar et al (after supplementation)	4120 ± 635	3404 ± 802	**0.003**

Present study showed significant increase in weight in case group supplemented with zinc compared to control group not supplemented with zinc. Castillo-Duran[34] et al and TV Ramkumar[35] et al also showed the same results.

In a study done by Castillo-Duran MD[34] the z scores for weight by groups showed better catchup growth in supplemented group(S) than in placebo group(P).Group S, -2.05 ± 0.52 to -0.24 ± 0.64; group P, -2.06 ± 0.48 to -1.07 ± 0.61.These differences were significant(p value<0.003) after 2 months of supplementation.

Table 3 Shows changes in length after supplementation

Length(cm)	Case	Control	P value
Present study (at birth)	48.0 ± 1.6	49 ± 1.2	
Present study (after supplementation)	56 ± 2.2	52 ± 2.3	0.003
TV Ramkumar[35] et al (at enrollment)	43.8 ± 2.4	42.8 ± 2.3	
TV Ramkumar (after supplementation)	55.9 ± 2.4	50.7 ± 3.9	0.001

Present study shows significant increase in length in zinc supplemented group compared to control group with p value0.003 (<0.05). It was also same in

other studies by TV Ramkumar[35] et al,Castillo-Duran[34] et al, Diaz- Gomez[36] et al and Friel[1] JK et al.Castillo-Duran[34] et al study showed length were identical at birth, but at 6 months were 64.9 ± 1.8cm versus 63.4 ± 3.5cm for supplemented and placebo group respectively with p value<0.01.

Table 4. Shows changes in HC after supplementation

HC(cm)	Case	Control	P value
Present study (at birth)	29 ± 1.4	29.2 ± 1.2	
Present study (after supplementation)	36 ± 2.4	36 ± 2.46	0.599
TV Ramkumar et al (at birth)	30.9 ± 1.7	30.9 ± 2.2	
TV Ramkumar et al (after supplementation)	37.5 ± 1.7	36.1 ± 2.2	0.008

In our study HC increased in both groups. The difference was not statistically significant. But TV Ramkumar[35] et al showed significant increase in HC post supplementation with zinc.

Diaz-Gomez[36] et al and Lind[37] et al also showed no significant increase in HC.

The present study demonstrated that LBW infants who were exclusively breastfed and supplemented with zinc for 60 days had significantly higher weight, length at follow up after 3 months after birth per compared to those who had not received zinc.

Zinc supplementation to LBW babies for 3 months resulted in improved weight gain, linear growth. There were no significant side effects of the supplements. These findings could have important implications for the child health survival program in developing countries with high incidence of LBW babies and preterm low birth infants.

The strength of this study includes its randomized, open label and minor differences in initial anthropometric status. The groups were similar at baseline, thus any differences in study outcomes were likely due to the supplements that are provided.

Follow up between the two groups was observed. Compliance with supplementation was good.

Limitations of the study include sample size is small, this cannot be applied in community based study. Larger sample size may confirm our findings. Follow up serum sinc level estimation could not be done, though not able to do ten cases serum zinc estimation were done post supplementation which showed higher serum zinc level. If this can be extrapolated to rest of the sample size.

Dose of zinc supplemented 10mg elemental zinc/day. taken is arbitrary, but 7 follow-up samples serum zinc level showed signicant improvement in serum zinc level post supplementation. Probably 10 mg/day elemental zinc is approved for LBW babies as supplement.

Baseline serum zinc levels were seen in both groups. Altigani[38], *et al* reported serum zinc concentration approximately 65µg/dL in low birth weight babies in their study. Itabashi[39], *et al* found mean serum zinc concentration 54 ± 14.4µg/ dL in their study. Our findings corroborated the findings of these studies.

There were no significant difference in weight, length and head circumference at enrollment but a significant difference were found at 6 weeks and 12 weeks follow up ($p < 0.05$).

This is understandable as zinc has profound role on cellular growth and proliferation and performs various metabolic functions.

Castilo-Duran[34], *et al* demonstrated improved growth of LBW babies in their study, significantly greater weight for age and length for age were found in zinc supplemented group. Lira[4], *et al* found the growth was enhanced in low birth weight babies by giving 10mg zinc. Osendarp[40], *et al* found similar results.

Head circumference was increased in both groups after supplementation. The difference was not statistically significant. This results was consistent with Lind[37], *et al* and Diaz- Gomez[36] *et al.* Mortality pattern of both the groups were observed and significant difference in morbidity was found between two groups. Our findings are comparable with these studies.

Thus zinc supplementation should be recommended along with other vitamins and minerals for all low birth weight infants for their optimal growth and development.

CONCLUSION

In conclusion zinc supplementation especially among Low Birth Weight babies has significant benefit on their growth and is found effective to enhance the growth in early months of life, particularly weight and linear growth.

These findings support the implementation of zinc supplementation 10mg elemental zinc/day is Justified, where as other micronutrient supplement should also given in view of coexisting deficiencies.

Limitation of the study-

1. It is a open label study. A double blind study removes bias.
2. Small sample size because of financial constraints.[ICMR/ government of India to fund a large scale study]
3. Follow up serum zinc estimation could not be done in control and majority of the case[Though 7 case follow-up serum zinc estimation done which shows higher serum zinc level]

SUMMARY

- The study was conducted at our medical college hospital tertiary care centre in north Karnataka
- 100 LBW babies were investigated for serum zinc level and randomly assigned (odd/even) into two groups study group(n = 50) and control group (n=50). Study group were supplemented with 10 mg of elemental zinc for 3 months and control group were not supplemented with zinc.
- Serum zinc levels were in lower limit of normal range.
- Follow up is done for all 100 LBW babies till 3-4 months of age and reassessed for the anthropometric parameters.
- Zinc supplemented case group were compared with the control group not supplemented with zinc.
- Better weight gain of LBW infants and increase in linear growth of LBW infants of zinc supplemented group compared to control group.

BIBLIOGRAPHY

1. Friel, J. K., Andrews, W. L., Matthew, J. D., Long, D. R., Cornel, A. M., Cox, M., McKim, E. & Zerbe, G. O. (1993) Zinc supplementation in very-low-birth-weight infants. J. Pediatr. Gastroenterol. Nutr. 17: 97–104.

2. Shrivastava, S. P., Roy, A. K. & Jana, U. K. (1993) Zinc supplementation in protein energy malnutrition. Indian Pediatr 30:779-782.

3. Rafael Jiménez, Mayder Martínez, Ronoel Peñalver.zinc effects on growth and development of infants with LBW. Colombia Médica, Vol 38, No 1 Supl 1 (2007).

4. Lira, P. I., Ashworth, A. & Morris, S. S. (1998) Effect of zinc supplementation on the morbidity, immune function, and growth of low-birth-weight, full term infants in northeast Brazil. Am. J. Clin. Nutr. 68(suppl. 2): 418S–423S.

5. Prasad AS. Discovery of human zinc deficiency and studies in an experimental human model. Am J Clin Nutr.1991;53;403-12.

6. Oteza PJ, Olin KL, Fraga CG, Keen CL. Zinc deficiency causes oxidative changes to proteins, lipids and DNA in rat testes, J Nut.1995;125:823-29.

7. Bhaskaram P, Hemalatha P. Zinc status in breast fed infants. Lancet. 1992;2:1416-17.

8. Zlottkin SH.Assessment of trace element requirements in newborns and young infants, Nestle nutrition workshop, New york, Raven press.1991;(23):49-77.

9. Prasad as.Zinc: an overview,Nutrition 1995;11:93-99.

10. Stevens J, Lubitz L. Symptomatic zinc deficiency in breast-fed term and premature infants. J Paediatr Child Health 1998;34:97.

11. ICMR, Nutritional requirements and RDA for Indians. A report of the Expert Group of the Indian Council of Medical Research.2002;41-42.

12. World Health Organization. Trace Elements in Human Nutrition(WHO Tech Rep Sr No.532).

13. Agget PJ, Severe zinc deficiency. Zinc in human biology.Ed.Mills CF. Berlin, Springer Verlag.1988;259-279.

14. Prasad AS. Discovery of human zinc deficiency and studies in an experimental human model. Am J Clin Nutr.1998;68:447S-63S.

15. Shankar AH, Prasad AS.Zinc and immune function:the biological basis of altered resistance and infection. Am J Clin Nutr.1983;38:579-90.

16. Beach RS, Gershwin ME, Hurley LS. Persistent immunological consequences of gestational zinc deprivation. Am J Clin Nutr.1983;38:579-90.

17. Sazawal S, Black R, Bhan M, et al. Zinc supplementation in children with acute diarrhea in India. N Eng J Med.1995;333:839-44.

18. Behrans RH, Tomkins AM, Roy SK. Zinc supplementation during diarrhea:A fortification against malnutrition. Lancet,1990;2;442-3.

19. Zinc investigators Collaborative group. Pooled analysis of randomized controlled trials. J Peditr.1999;13Nutr.1993;135:689-97.

20. Hemlatha P,Bhaskaran P, Khan MM. Role of zinc supplementation in the rehabilitation of severely malnourished children. Eur J Clin Nutr.1993; 47: 395-9.

21. Fierka C. Function and mechanism of zinc.J Nutr.2000;130:1437S-46S.

22. Hambridge M.Human zinc deficiency.J Nutr.2000;130:13445-95.

23. Wauben PM, Wainwright PE. The influence of neonatal nutrition on behavioral development : a critical appraisal. Nutr Rev.1999;57:35-44.

24. Morley JE, Gordan J, Hershman JM. Zinc deficiency, hypothalamic pituitary-thyroid function. Am J Clin Nutr.1980;33:1767-70.

25. Golub MS, TakeruchiPT, Keen CL, Hendricks AG, Gershwin EM. Activity and attention in zinc deprived monkeys. AmJ Clin Nutr.1996;64:905-15.

26. Sazawal S, Bentley M, Black RE, Dhingra P, George S, Bhan MK.Effect of zinc supplementation in preschool children in an urban slum population. Pediatrics.1996;98:1132-7.

27. Black MM. Zinc deficiency and child development. Am J Clin Nutr 1998;68:464S-9S.

28. Bhaskaram P, Krishnaswamy K. Trace elements of clinical significance. Zinc and selenium, Text book of human nutrition Eds Bamji MS, Rao NP,Reddy V;Oxford and IBH publication Co Pvt Ltd.New Delhi 1996.

29. Gopalan C. Micronutrient deficiencies- Public health implications. NFI. 1994;15:1-6.

30. Zinc estimation done by colorimetric method. Umbilical cord blood nutrients in low birth weight babies in relation to birth weight and gestational age. K .E. Elizabeth, Viji Krishnan Government medical college, Thiruvananthpuram and University of HS, Kozhikode, India. Indian J Med Res 128, Aug 2008,pp128-33.

31. Meret S, Henkin R J. Simultaneous direct estimation by atomic absorption spectrophotometry of copper and zinc in serum, rine, and CSF. Clin Chem 1971;17:369-73.

32. Sunil Sazawal and Robert E Black. Effect of Oral Zinc Supplementation on the Growth of Preterm Infants Indian Pediatr 2010;47: 841-842.

33. Islam MN, Chowdhury M, Siddika M, Qurishi SB, Bhuiyan MK, Hoque MM, *et al*. Effect of oral zinc supplementation on the growth of preterm infants. Indian Pediatr 2010; 47: 845-849.

34. Castiio-Duran C, Rodriguez A, Venegas G, et al. Zinc supplementation and growth of infants born small for gestational age. J Pediatr 1995; 127:206–11.

35. T.V.Ramkumar, Siddharth Ramji.et al effect of zinc supplementation on growth in very lowbirth weight infants. Journal of tropical pediatric advance access May 5 2011 .J Trop Pediatr 2012;58:50–54.

36. Lind T, Lonnerdal B, Stenlund H, Gamaynti IL, Ismail D, Seswandhana R, *et al.* A Community based randomized controlled trial of iron and zinc supplementation in Indonesian infants; interactions between iron and zinc. Am J Clin Nutr 2003; 77:883-890.

37. Altigani M, Murphy JF, Gray OP. Plasma zinc concentration and catch up growth in preterm infants. Acta Paediatr Scand 1989; 357: 20-33.

38. Itabashi K, Saito T, Ogawa Y, Uteni Y. Incidenceand predicting factors of hypozincemia in very low birth weight infants at near term postmenstrual age. Biol Neonate 2003; 83: 235-240.

39. Osendarp SJM, Santosham M, Black RE, Wahed MA, Van Raaij JMA Fuchs GJ. Effect of zinc supplementation between 1 and 6 mo of life on growth and morbidity of Bangladeshi infants in urban slums. Am J Clin Nutr 2002; 76: 114-119.

40. Gomez N, Domenech E, Barroso N, et al. The effect of zinc supplementation on linear growth, body composition, and growth factors in preterm infants. Pedaiatr 2003;111:1002–9.

ANNEXURE – A

CASE PROFORMA

A / B

CASE/CONTROL

Name	:	CASE NO	:
Age	:	IP NO	:
Sex	:	DOA	:
Religion	:	DOD	:
Postal address	:	Mobile No	:

Occupation & Income

Of parents :

MATERNAL MEDICAL History-

1. History suggestive of diabetes mellitus yes/no

2. History suggestive of cardiac diseases yes/no

3. History suggestive of renal diseases yes/no

4. History suggestive of hypertension /PIH/eclampsia yes/no

5. History suggestive of chronic diseases yes/no

6. History suggestive of chronic drug intake yes/no

7. History suggestive of anaemia yes/no

8. History suggestive of intercurrent infections yes/no

9. Maternal Zinc supplementation if any:

10. Past History :

11. Family history:

12. ANC : ANTENATAL

NATAL

POSTNATAL

13) General Physical Examination

SINGLE/TWIN…….

EGA:by dates…….weeks :byexam…….weeks;

LENGTH……..cms; MAC……..cms

BIRTH WEIGHT……..gms; HC…….cms

NEWBORN MATURITY RATING AND CLASSIFICATION

ESTIMATION OF GESTATIONAL AGE BY MATURITY RATING

Symbols : X - 1st Exam O- 2nd Exam

NEUROMUSCULAR MATURITY

	0	1	2	3	4	5
Posture						
Square Window (Wrist)	 90°	 60°	 45°	 30°	 0°	
Arm Recoil	 180°		 100°-180°	 90°-100°	 <90°	
Popliteal Angle	 180°	 160°	 130°	 110°	 90°	 <90°
Scarf Sign						
Heal to Ear						

Gestation by Dates _____wks

Birth Date _____Hour _____ am pm

APGAR _____1 min _____ 5 min

SCORING SECTION

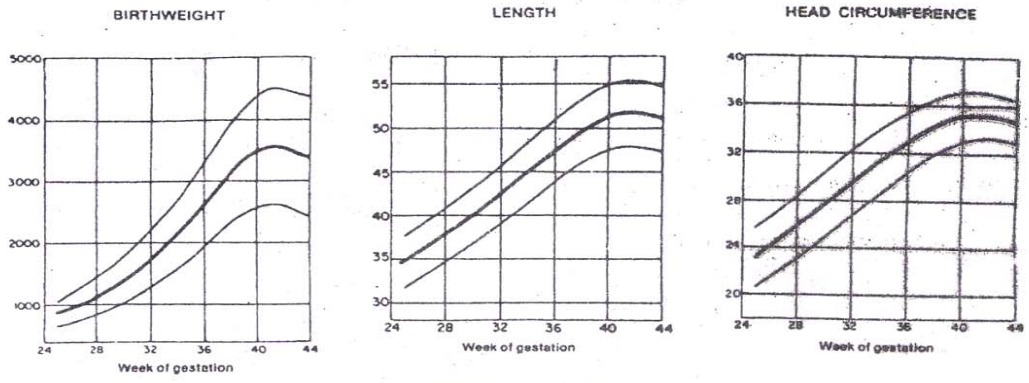
	1st Exam =X	2nd Exam=O
Estimating Gest Age by Maturity Rating	_____Weeks	____ Weeks
Time of Exam	Date_____ Hour____ am pm	Date_____ Hour____ am pm
Age at Exam	_____Hours	_____Hours
Signature of Examiner	_____ _____M.D.	_____ _____M.D.

PHYSICAL MATURITY

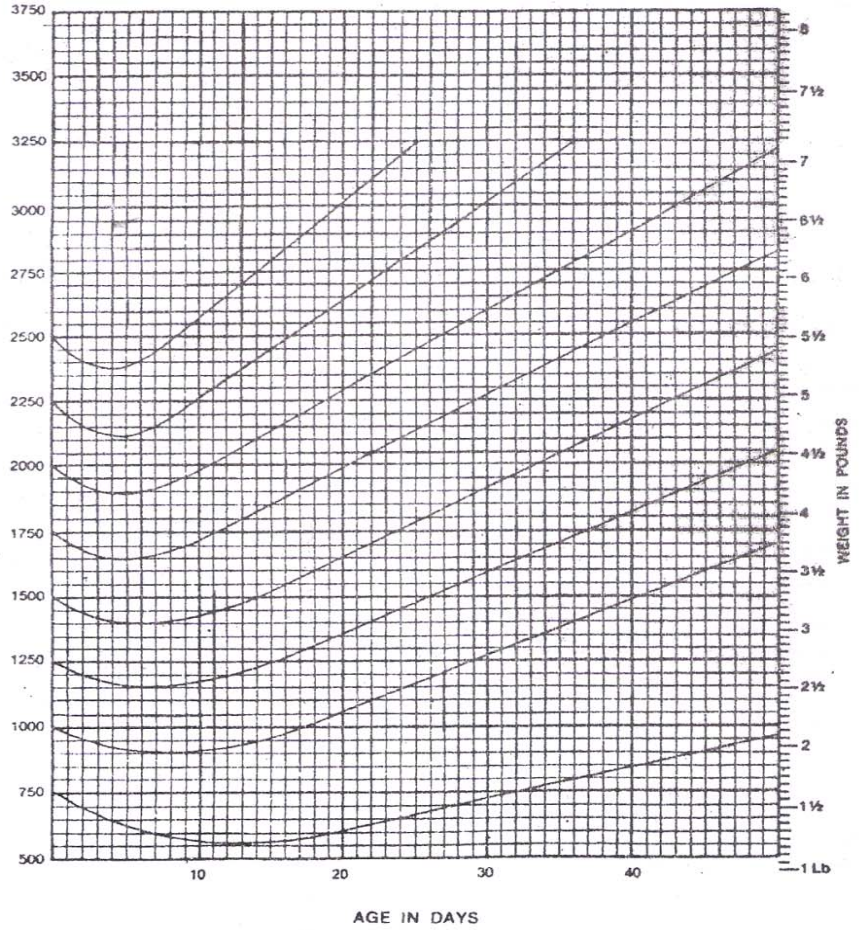
	0	1	2	3	4	5
Skin	gelatinous red, transpare-nt	Smooth pink, visiblle veins	superfici-al peeling & /or rash few veins	cracking pale area rare veins	parchment deep cracking no vessels	leathery cracked wrinkled
Lanugo	none	abundant	thinning	bald areas	mostly bald	
plantar Creases	no crease	faint red marks	anterior transverse crease only	creases ant. 2/3	creases cover entire sole	
Breast	barely percept.	flat areola no bud	stippled areola 1-2 mm bud	raised areola 3-4 mm bud	full areola 5-10 mm bud	
Ear	pinna flat, stays folded	sl. curved pinna; soft with slow recoil	well-curv. pinna; soft but ready recoil	formed & firm with instant recoil	thick cartilage ear stiff	
Genitals	scrotum empty no rugae		testes descendi-ng, few rugae	testes down, good rugae	testes pendulous deep rugae	
Genitals	prominent clitoris & labia minora		majora & minora equally prominent	majora large, minora small	clitoris & minora complete-ly covered	

MATURITY RATING

Score	Wks
5	26
10	28
15	30
20	32
25	34
30	36
35	38
40	40
45	42
50	44



GROWTH RECORD



14) Systemic examination:

- Vitals:
- Skin:
  - Anterior aspect of forearm
  - Behind the ear.
- Craniofacial:
- Oral cavity
- Chest:
- Cardiovascular system:
- Respiratory system:
- Abdomen:
- Genitalia:
  - Perianal region
  - Nappy Rash
- Extremities:
- Back:
- Spine:
- Central nervous system:

.

Impression

Provisional Diagnosis:

Investigation:

Complete Hemogram:

Special investigations:

Serum Zinc Level

Final Diagnosis:

FOLLOW UP –

	I	II
C/O		
O/E		
Length-cm		
Weight-kg		
HC-cm		
CC-cm		

SERUM ZINC LEVELS micro gm/dl at BIRTH

ANNEXURE – B

BLDEA's Shri B.M.PATIL Medical College, Hospital & Research Centre,

Bijapur-586103.

RESEARCH INFORMED CONSENT FORM

TITLE OF THE PROJECT:		**"ZINC DEFICIENCY IN LOW BIRTH WEIGHT BABIES AND EFFECT OF SUPPLEMENTATION OF ZINC ON THEM – A RANDOMIZED CONTROL TRIAL, A HOSPITAL BASED STUDY"**
GUIDE	**:**	**Dr. R.H.GOBBUR, PROFESSOR, DEPT OF PAEDIATRICS**
P G STUDENT	**:**	**Dr. SHRUTI. B. H**

PURPOSE OF RESEARCH:

I have been informed that the present study will help in assessing the incidence of zinc deficiency in low birth weight babies and effect of supplementation of zinc and folic acid on them and improve the quality of life in these neonates.

PROCEDURE:

I understand that after having obtained a detailed clinical history, thorough clinical examination and relevant investigations, a final work up for the etiological identification and appropriate management is planned.

RISK AND DISCOMFORTS:

I understand that I may experience some pain and discomforts during the examination or during my treatment. This is mainly the result of my condition and the procedures of this study are not expected to exaggerate these feelings which are associated with the usual course of treatment.

BENEFITS:

I understand that my participation in the study will have no direct benefit to me other than the potential benefit of the treatment.

CONFIDENTIALITY:

I understand that the medical information produced by this study will become a part of hospital records and will be subject to the confidentiality. Information of sensitive personal nature will not be part of the medical record, but will be stored in the investigations research file.

If the data are used for publication in the medical literature or for teaching purpose, no name will be used and other identifiers such as photographs will be used only with special written permission. I understand that I may see the photograph before giving the permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at anytime; Dr.Shruti.B.H at the department of pediatrics is available to answer my questions or concerns. I understand that I will be informed of any significant new findings discovered during the course of the study, which might influence my continued participation. A copy of this consent form will be given to me to keep for careful reading.

REFUSAL OR WITHDRAWAL FROM PARTICIPATION:

I understand that my consent is voluntary and that I may refuse to participate or may withdraw consent and discontinue participation of my baby in the study at any time without prejudice. I also understand that Dr.Shruti.B.H may terminate my participation in the study after She has explained the reasons for doing so.

ANNEXURE C

INJURY STATEMENT:

I understand that in the unlikely event of injury to my baby resulting directly from his / her participation in this study, if such injury were reported promptly, the appropriate treatment would be available to me. But, no further compensation would be provided by the hospital. I understand that by my agreements to participate in this study and Iam not waiving any of my legal rights.

Signature of parent / guardian

Name and relation to the baby.

I have explained to _Shri/Smt._____the purpose of the research, the procedures required and the possible risks to the best of my ability.

_____ _____

(Investigator) Date

STUDY SUBJECT CONSENT STATEMENT:

I confirm that _____(name of the PG guide/chief researcher) has explained to me the purpose of research, the study procedure, that I am willing to allow my baby to undergo the investigation and the possible discomforts as well as benefits. I have been explained all the above in detail in my own language and I understand the same. Therefore I agree to give consent to participate as a subject in this research purpose.

(Participant)

PARTICIPANTS PARENT/GUARDIAN:

_____ _____

(Witness to signature) Date

ANNEXURE – D

MASTER CHART (RANDOMIZED)

REARRANGED MASTER CHART(1-50 as Cases, 51-100 Control)

ANNEXURE – E

KEY TO MASTER CHART

BW- Birth Weight

HC- Head Circumference

S.zinc- Serum Zinc

WT- Weight

Ethical Committee
BIJAPUR-586103
OUT WARD
No 27/2011
Date 24-10-11
Sri B. M. PATIL Med. Col. College

B.L.D.E. UNIVERSITY'S

SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103

INSTITUTIONAL ETHICAL COMMITTEE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 20-10-2011 *at* 10-30 am *to scrutinize the Synopsis/Research projects of postgraduate/undergraduate student/Faculty members of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis/Research project has been accorded Ethical Clearance.*

Title "Zinc defieiency in low birth weight babies and effect of supplementation of zinc on them"

Name of P.G./U.G. student/Faculty member Dr. Shruti. B.H.
Dept of Pediatrics

Name of Guide/Co-investigator Dr. R.H. Gabbur. prof. Pediatrics

DR.M.S.BIRADAR,
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Chairman
Ethical Committee
BLDEA'S Shri. B.M. Patil
Madical College
Bijapur-586103

Following documents were placed before E.C. for Scrutinization
1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

ANNEXURE – D

RANDOMIZED MASTER CHART

Sl. No	NAME	Age	Sex	IP No	BW (KG)	LENGTH (CM)	HC (CM)	S.Zinc (µg/dl)	After Follow up 1			After Follow up2		
									WT(KG)	LENGTH (CM)	HC (CM)	WT(KG)	LENGTH	HC (CM)
1	B/O LAKSHMI	D9	F	26506	1.77	48	32	51	2.32	52	34	4.6	58	38.6
2	B/O SHOBHA	D3	M	27395	2.48	50	33	51	2.98	51.2	35	5.08	54.2	40
3	B/O SHOBHA	D4	M	647	1.9	50	33	62	2.41	54	35	5.2	57.6	39
4	B/O SIDDAMMA	D2	M	12367	2.15	48.5	32	94	2.6	49.7	34	3.8	52	39
5	B/O SUNITA	D3	M	27976	2.32	49	33	56	2.86	53	35	6.08	57	39
6	B/O SARASWATI	D4	F	13979	2.23	50	32.5	58	2.7	51.2	35	4.5	54	39
7	B/O SHANKARAMMA	D7	M	27326	2.14	48.6	32	88	2.65	52.6	34	4.32	58.4	38
8	B/O JAYASHREE	D3	F	1961	2.44	50	33	42	2.85	51.3	35.2	4.8	53.8	38.6
9	B/O NEELAMMA	D3	F	11950	1.9	47.8	33	43	2.4	51	34	4.68	58	37.8
10	B/O SUNANDA	D4	M	10352	2.1	48	32	64	2.56	49.3	34	4.4	52.4	38
11	B/O JYOTI	D5	F	12233	2.45	49	32	51	2.98	53	34	5.08	57.2	39
12	B/O SUJATA	D3	M	4844	2.4	50	33	51	2.88	51.2	35	4.84	54.2	40
13	B/O BABUBAI	D6	M	12455	2.2	48	32	64	2.72	52	34	6.2	58.4	38
14	B/O VEENASHRI	D3	F	4691	2.48	48	32	48.2	2.52	49.2	34	5.08	52.4	39
15	B/O LAXMI	D11	F	26506	1.66	48	33	56	2.14	52	34.6	5.1	58	38.4
16	B/O SUNANDA	D4	F	10352	2.2	49	33	46	2.68	50.4	35	4.6	54	38.8
17	B/O PARMAVVA	D3	F	13611	2.2	48	32	50	2.72	50.6	34	5.68	57.8	38.8
18	B/O MUNEERA	D8	F	1521	2.1	49	32	76	2.59	50.2	34.2	4.18	54.2	38.4
19	B/O REKHA	D3	M	14717	2.3	48	33	42	2.83	51	35	6.1	58	39
20	B/O MEHBOOBA	D6	F	10353	2.03	49	33	132	2.48	50.4	35	4.08	53	38
21	B/O LAKSHMI	D14	F	14126	2.31	50	33	64	2.91	52	34.8	5.88	57.6	38.6
22	B/OBHAGAMMA	D3	F	480	1.65	47	32	87	2.1	48.6	34.4	3.9	52.2	39
23	B/O LAKSHMIBAI	D8	M	11471	1.93	48	34	88.4	2.64	51.4	36	5.42	56.8	39.2
24	B/O NAGAMMA	D3	M	743	2.5	50	32	43	2.88	51.4	35	5.14	54.2	40
25	B/O SHOBHA	D29	F	31007	1.88	48	32	56	2.53	50.6	34	5.06	57.2	38
26	B/O LAKSHMI	D8	M	30744	2.4	49	33	58	2.86	50.6	35	4.86	53	38.4
27	B/O LAKSHMI	D3	F	30774	2.38	51	32	62	2.92	52.6	33.8	5.89	58.8	38
28	B/O MEENAKSHI	D5	F	27694	2.48	50	33	88	2.9	51.2	35.6	5	54.2	39
29	B/O MUSKAAN	D3	F	12050	1.9	48	32	48	2.57	50.4	34	5.08	58.2	39
30	B/O YALLAWWA	D5	F	24512	2.33	47	32	44	2.87	48.6	35	4.6	51	39.4
31	B/O RENUKA	D3	F	1483	2.42	48	32	50	2.98	49.8	34	5.3	57.2	39
32	B/O KAVITA	D6	F	879	2.43	50	33	87	2.9	51.4	35	4.81	54	40
33	B/O GOURAWWA	D11	F	4015	2.11	49	32	43	2.83	51	34	4.87	56	38.4
34	B/O LAKSHMI	D3	F	13756	2.45	49	33	48	2.86	50.4	35	4.98	53.2	40
35	B/O SUNANDA	D7	F	12736	2.3	48	33	92.2	2.96	49.8	35	4.98	57.2	38
36	B/O SAVITA	D3	F	879	2.2	48	32	75.2	2.68	49.6	34.2	4.67	52.8	38
37	B/O SAVITA	D8	M	879	2.251	50	33	51	2.8	52	34.8	6.04	58.4	37.8
38	B/O SHOBHA	D5	F	229612	2.3	48	32	51	2.8	49.4	34	4.8	52	38.4

Sl. No	NAME	Age	Sex	IP No	BW (KG)	LENGTH (CM)	HC (CM)	S.Zinc (µg/dl)	After Follow up 1			After Follow up2		
									WT(KG)	LENGTH (CM)	HC (CM)	WT(KG)	LENGTH	HC (CM)
39	B/O YALAWWA	D6	M	1125	2.48	50	32	64	3.18	53	34	5.98	57.8	39
40	B/O TRIVENI	D3	M	16482	2.3	47	33	64	2.78	48.6	35	4.59	52.6	40
41	B/O SHANKARAWWA	D10	F	23051	1.85	46	32	87	2.6	49.2	33.8	5.57	56	38
42	B/O MAMATA	D3	M	136546	2.4	50	33	48	2.92	51.6	35	5.08	54.2	40
43	B/O IRAMMA	D21	M	527	1.61	48	31.6	43	2.32	51	33	5.64	57.6	38
44	B/O VINUTA	D4	F	140557	2.36	48	32	64	2.7	49.4	35	4.68	52	39.4
45	B/O MOTIBAI(T1)	D10	F	12050	1.7	47	32.5	50	2.42	49.6	34	4.86	56.4	37.4
46	B/O REKHA	D3	F	14717	2.3	48	33	104	2.8	49.2	35	4.76	53.2	40
47	B/O MOTIBAI(T2)	D10	F	12051	1.43	46	32	48	2	48.8	34	4.6	56.8	38.6
48	B/O SHOBHA	D3	M	27395	2.5	50	33	42	3.06	51.3	35	4.78	54	40
49	B/O SUNANDA	D2	M	2087	1.69	49	32	51	2.19	53	34	3.98	57.8	38
50	B/O VIDYA	D6	F	22593	1.88	49	32	50	2.3	52.2	34	3.8	53	38.4
51	B/O MEENAKSHI	D3	F	27821	1.84	47	32	87	2.4	51	34	4.86	56.4	37.8
52	B/O JAGADEVI	D4	M	22796	2.4	49	33.8	56	2.83	50.4	36	4.56	53.2	40
53	B/O GEETA	D5	F	30756	2.4	51	32	56	3.1	53	34	6.08	58.4	38
54	B/O SWAPNA	D4	F	22858	1.6	50	32.8	64	2	51.2	34	3.48	54.6	38.2
55	B/O SUMLATA	D6	M	26394	1.66	48	33	43	2.3	50.8	35	5.2	56.6	38.6
56	B/O KAVITA	D3	M	23017	2.29	50	33.2	94.2	2.7	52.4	35	4.54	54.2	39
57	B/O SANGAMMA	D5	M	12234	2.09	47	32	72.8	2.64	49.6	34	5.08	56	38
58	B/O MUSKAAN	D6	M	12493	2	49.2	32.8	51	2.46	50.6	35	3.98	54	38.8
59	B/O ASHWINI	D3	F	24477	2.21	48	33	51	2.8	49.4	35	5.87	58.2	39
60	B/O MAHADEVI	D4	M	23015	2.39	49.2	33.2	82	2.83	50.4	35.2	4.74	54.4	39
61	B/O SAVITA	D5	F	879	2.2	49	33	64	2.76	51.6	35	5.18	57.4	38.8
62	B/O MEENAKSHI	D4	F	22725	1.8	48	33	68	2.2	49.6	35	4.1	53	38
63	B/O SUNANDA	D2	M	2986	1.62	49	33	48	2.2	52.8	34.6	4.98	56.8	38
64	B/O GEETA	D4	F	22705	1.7	50	33	46	2.24	51.3	34.6	3.82	54.6	37.4
65	B/O SHOBHA	D8	F	22962	2.3	48	33	56	2.8	51	35	5.3	56	39
66	B/O ANNAPURNA	D14	M	24490	2.23	49	33	62	2.6	50.4	34.6	4.56	53	38
67	B/O AMBAKKA	D3	M	15014	2.4	51	33	51	2.98	53.4	35	6	58.8	39.4
68	B/O MUSKAAN	D6	M	12494	2.3	50	33	48	2.8	51.2	35	4.28	54.8	38.2
69	B/O REKHA	D3	M	140557	2.3	48	32	43	2.9	51.8	35	5.28	57.4	39
70	B/O ANUSHREE	D7	F	20021	2.4	50	33	58	3	51.4	34.2	4.68	54	38.6
71	B/O JAGADEVI	D5	M	21782	2.46	50	33	58	3	53	35	6.13	58.2	40
72	B/O GADEMMA	D6	M	19744	2.32	49.4	32	51	2.76	50.8	34	4.42	53	39
73	B/O BISMILLAH	D3	M	130663	2.3	50	33	40	2.84	53.2	35	5.8	58.8	39
74	B/O AMEENA	D6	F	20021	2.49	50	32	92	2.89	51.2	34	4.76	54.6	40
75	B/O MUSKAAN	D3	F	12907	2.38	47	33	51	2.9	48.8	35	5	57.6	39
76	B/O SHOBHA	D6	M	22790	2.48	49	33.6	46	2.9	50.4	35	5.18	54	38.6
77	B/O SAKKUBAI	D3	F	145937	2.27	50	33	88	2.7	52.8	34.8	4.84	58.8	38.2
78	B/O VIJAYA	D4	M	22581	1.7	50	33	75	2.1	51.3	35	3.48	55	38
79	B/O NEELAMMA	D3	M	11950	2.1	47	32	52	2.68	49.6	34	4.78	57.6	39
80	B/O TABASUM	D3	M	22564	1.9	47	32	64	2.3	48.6	34	3.78	53	38.2

Sl. No	NAME	Age	Sex	IP No	BW (KG)	LENGTH (CM)	HC (CM)	S.Zinc (µg/dl)	After Follow up 1			After Follow up2		
									WT(KG)	LENGTH (CM)	HC (CM)	WT(KG)	LENGTH	HC (CM)
81	B/O BABUBAI	D4	F	12455	1.8	47	33	43	2.43	50.2	35	4.2	57	38.6
82	B/O REKHA	D6	M	22495	1.65	49	33	42	2	50.2	33.8	3.86	54	38
83	B/O SIDDAMMA	D5	F	12367	2.1	47	32	50	2.7	48.8	34.4	5.6	56.6	38
84	B/O SHARADA	D4	F	23025	1.48	50	32	59	1.98	51.4	34	3	54.2	38
85	B/O SAROJA	D6	M	12550	1.9	48	33	48	2.48	51	35	4.89	57.2	37.8
86	B/O GEETA	D5	F	22705	1.7	49	32	56	2.2	50.2	34	2.98	53	37.6
87	B/O SANGAMMA	D3	F	12234	1.7	49	33	85.6	2.3	51.8	35	4.6	58	38
88	B/O SAROJA	D3	F	12550	1.73	48	33	64	2.26	49.4	35	3.6	53.4	37.2
89	B/O JYOTI	D5	F	12233	1.88	49	33	46	2.48	52	35.4	5.74	56	38.4
90	B/O PUSHPA	D11	M	2831	2.38	49	33	51	2.75	50.2	34	4.76	54	39
91	B/O SWATI	D6	F	13099	2.1	49	32	72	2.6	52.6	34	6	57.2	39
92	B/O REKHA	D8	M	1863	2.18	48	32	43	2.48	49.6	34	4.32	52.8	38
93	B/O PARAMMA	D3	M	13611	1.58	47	32	43	2	49.2	34	3.98	56.6	38.2
94	B/O JAYASHREE	D6	F	19612	2.44	48	32.6	50	2.8	49	35	5.08	53	40
95	B/O LAXMI	D3	M	13756	2.2	50	32	52	2.68	52.2	34.6	5	58.4	39
96	B/O PUSHPA	D2	M	1920	1.6	50	32	122	2	51.4	34	3.28	54.8	38.2
97	B/O MALLAMMA	D6	M	14991	2	49	33	48	2.58	52.2	35	4.83	58	38.8
98	B/O SHAKUNTALA	D2	F	12758	2.4	48	33	50	2.92	49.3	35	4.38	52.4	40
99	B/O SUNANDA	D2	F	2085	1.52	50	32	56	1.9	51.4	34	3.2	54.4	39
100	B/O GANGABAI	D5	F	198	2.46	50	33	88	3	51.2	35	5.12	55	39

REARRANGED MASTER CHART (1-50 as Cases, 51-100 Control)

Sl. No	NAME	Age	Sex	IP No	BW (KG)	LENGTH (CM)	HC(CM)	S.Zinc (µg/dl)	At Follow up 1			At Follow up2		
									WT(KG)	LENGTH (CM)	HC(CM)	WT(KG)	LENGTH	HC(CM)
1	B/O LAKSHMI	D9	F	26506	1.77	48	32	51	2.32	52	34	4.6	58	38.6
2	B/O SHOBHA	D4	M	647	1.9	50	33	62	2.41	54	35	5.2	57.6	39
3	B/O SUNITA	D3	M	27976	2.32	49	33	56	2.86	53	35	6.08	57	39
4	B/O SHANKARAMMA	D7	M	27326	2.14	48.6	32	88	2.65	52.6	34	4.32	58.4	38
5	B/O NEELAMMA	D3	F	11950	1.9	47.8	33	43	2.4	51	34	4.68	58	37.8
6	B/O JYOTI	D5	F	12233	2.45	49	32	51	2.98	53	34	5.08	57.2	39
7	B/O BABUBAI	D6	M	12455	2.2	48	32	64	2.72	52	34	6.2	58.4	38
8	B/O LAXMI	D11	F	26506	1.66	48	33	56	2.14	52	34.6	5.1	58	38.4
9	B/O PARMAVVA	D3	F	13611	2.2	48	32	50	2.72	50.6	34	5.68	57.8	38.8
10	B/O REKHA	D3	M	14717	2.3	48	33	42	2.83	51	35	6.1	58	39
11	B/O LAKSHMI	D14	F	14126	2.31	50	33	64	2.91	52	34.8	5.88	57.6	38.6
12	B/O LAKSHMIBAI	D8	M	11471	1.93	48	34	88.4	2.64	51.4	36	5.42	56.8	39.2
13	B/O SHOBHA	D29	F	31007	1.88	48	32	56	2.53	50.6	34	5.06	57.2	38
14	B/O LAKSHMI	D3	F	30774	2.38	51	32	62	2.92	52.6	33.8	5.89	58.8	38
15	B/O MUSKAAN	D3	F	12050	1.9	48	32	48	2.57	50.4	34	5.08	58.2	39
16	B/O RENUKA	D3	F	1483	2.42	48	32	50	2.98	49.8	34	5.3	57.2	39
17	B/O GOURAWWA	D11	F	4015	2.11	49	32	43	2.83	51	34	4.87	56	38.4
18	B/O SUNANDA	D7	F	12736	2.3	48	33	92.2	2.96	49.8	35	4.98	57.2	38
19	B/O SAVITA	D8	M	879	2.25	50	33	51	2.8	52	34.8	6.04	58.4	37.8
20	B/O YALAWWA	D6	M	1125	2.48	50	32	64	3.18	53	34	5.98	57.8	39
21	B/O SHANKARAWWA	D10	F	23051	1.85	46	32	87	2.6	49.2	33.8	5.57	56	38
22	B/O IRAMMA	D21	M	527	1.61	48	31.6	43	2.32	51	33	5.64	57.6	38
23	B/O MOTIBAI(T1)	D10	F	12050	1.7	47	32.5	50	2.42	49.6	34	4.86	56.4	37.4
24	B/O MOTIBAI(T2)	D10	F	12051	1.43	46	32	48	2	48.8	34	4.6	56.8	38.6
25	B/O SUNANDA	D2	M	2087	1.69	49	32	51	2.19	53	34	3.98	57.8	38
26	B/O MEENAKSHI	D3	F	27821	1.84	47	32	87	2.4	51	34	4.86	56.4	37.8
27	B/O GEETA	D5	F	30756	2.4	51	32	56	3.1	53	34	6.08	58.4	38
28	B/O SUMLATA	D6	M	26394	1.66	48	33	43	2.3	50.8	35	5.2	56.6	38.6
29	B/O SANGAMMA	D5	M	12234	2.09	47	32	72.8	2.64	49.6	34	5.08	56	38
30	B/O ASHWINI	D3	F	24477	2.21	48	33	51	2.8	49.4	35	5.87	58.2	39
31	B/O SAVITA	D5	F	879	2.2	49	33	64	2.76	51.6	35	5.18	57.4	38.8
32	B/O SUNANDA	D2	M	2986	1.62	49	33	48	2.2	52.8	34.6	4.98	56.8	38
33	B/O SHOBHA	D8	F	22962	2.3	48	33	56	2.8	51	35	5.3	56	39
34	B/O AMBAKKA	D3	M	15014	2.4	51	33	51	2.98	53.4	35	6	58.8	39.4
35	B/O REKHA	D3	M	140557	2.3	48	32	43	2.9	51.8	35	5.28	57.4	39
36	B/O JAGADEVI	D5	M	21782	2.46	50	33	58	3	53	35	6.13	58.2	40
37	B/O BISMILLAH	D3	M	130663	2.3	50	33	40	2.84	53.2	35	5.8	58.8	39
38	B/O MUSKAAN	D3	F	12907	2.38	47	33	51	2.9	48.8	35	5	57.6	39
39	B/O SAKKUBAI	D3	F	145937	2.27	50	33	88	2.7	52.8	34.8	4.84	58.8	38.2
40	B/O NEELAMMA	D3	M	11950	2.1	47	32	52	2.68	49.6	34	4.78	57.6	39
41	B/O BABUBAI	D4	F	12455	1.8	47	33	43	2.43	50.2	35	4.2	57	38.6

Sl. No	NAME	Age	Sex	IP No	BW (KG)	LENGTH (CM)	HC(CM)	S.Zinc (µg/dl)	At Follow up 1			At Follow up2		
									WT(KG)	LENGTH (CM)	HC(CM)	WT(KG)	LENGTH	HC(CM)
42	B/O SIDDAMMA	D5	F	12367	2.1	47	32	50	2.7	48.8	34.4	5.6	56.6	38
43	B/O SAROJA	D6	M	12550	1.9	48	33	48	2.48	51	35	4.89	57.2	37.8
44	B/O SANGAMMA	D3	F	12234	1.7	49	33	85.6	2.3	51.8	35	4.6	58	38
45	B/O JYOTI	D5	F	12233	1.88	49	33	46	2.48	52	35.4	5.74	56	38.4
46	B/O SWATI	D6	F	13099	2.1	49	32	72	2.6	52.6	34	6	57.2	39
47	B/O PARAMMA	D3	M	13611	1.58	47	32	43	2	49.2	34	3.98	56.6	38.2
48	B/O LAXMI	D3	M	13756	2.2	50	32	52	2.68	52.2	34.6	5	58.4	39
49	B/O MALLAMMA	D6	M	14991	2	49	33	48	2.58	52.2	35	4.83	58	38.8
50	B/O SUNANDA	D2	F	2085	1.52	50	32	56	1.9	51.4	34	3.2	54.4	39
51	B/O SHOBHA	D3	M	27395	2.48	50	33	51	2.98	51.2	35	5.08	54.2	40
52	B/O SIDDAMMA	D2	M	12367	2.15	48.5	32	94	2.6	49.7	34	3.8	52	39
53	B/O SHAKUNTALA	D2	F	12758	2.4	48	33	50	2.92	49.3	35	4.38	52.4	40
54	B/O SARASWATI	D4	F	13979	2.23	50	32.5	58	2.7	51.2	35	4.5	54	39
55	B/O JAYASHREE	D3	F	1961	2.44	50	33	42	2.85	51.3	35.2	4.8	53.8	38.6
56	B/O SUNANDA	D4	M	10352	2.1	48	32	64	2.56	49.3	34	4.4	52.4	38
57	B/O SUJATA	D3	M	4844	2.4	50	33	51	2.88	51.2	35	4.84	54.2	40
58	B/O VEENASHRI	D3	F	4691	2.48	48	32	48.2	2.52	49.2	34	5.08	52.4	39
59	B/O SUNANDA	D4	F	10352	2.2	49	33	46	2.68	50.4	35	4.6	54	38.8
60	B/O MUNEERA	D8	F	1521	2.1	49	32	76	2.59	50.2	34.2	4.18	54.2	38.4
61	B/O MEHBOOBA	D6	F	10353	2.03	49	33	132	2.48	50.4	35	4.08	53	38
62	B/OBHAGAMMA	D3	F	480	1.65	47	32	87	2.1	48.6	34.4	3.9	52.2	39
63	B/O NAGAMMA	D3	M	743	2.5	50	32	43	2.88	51.4	35	5.14	54.2	40
64	B/O LAKSHMI	D8	M	30744	2.4	49	33	58	2.86	50.6	35	4.86	53	38.4
65	B/O MEENAKSHI	D5	F	27694	2.48	50	33	88	2.9	51.2	35.6	5	54.2	39
66	B/O YALLAWWA	D5	F	24512	2.33	47	32	44	2.87	48.6	35	4.6	51	39.4
67	B/O KAVITA	D6	F	879	2.43	50	33	87	2.9	51.4	35	4.81	54	40
68	B/O LAKSHMI	D3	F	13756	2.45	49	33	48	2.86	50.4	35	4.98	53.2	40
69	B/O SAVITA	D3	F	879	2.2	48	32	75.2	2.68	49.6	34.2	4.67	52.8	38
70	B/O SHOBHA	D5	F	229612	2.3	48	32	51	2.8	49.4	34	4.8	52	38.4
71	B/O TRIVENI	D3	M	16482	2.3	47	33	64	2.78	48.6	35	4.59	52.6	40
72	B/O MAMATA	D3	M	136546	2.4	50	33	48	2.92	51.6	35	5.08	54.2	40
73	B/O VINUTA	D4	F	140557	2.36	48	32	64	2.7	49.4	35	4.68	52	39.4
74	B/O REKHA	D3	F	14717	2.3	48	33	104	2.8	49.2	35	4.76	53.2	40
75	B/O SHOBHA	D3	M	27395	2.5	50	33	42	3.06	51.3	35	4.78	54	40
76	B/O VIDYA	D6	F	22593	1.88	49	32	50	2.3	52.2	34	3.8	53	38.4
77	B/O JAGADEVI	D4	M	22796	2.4	49	33.8	56	2.83	50.4	36	4.56	53.2	40
78	B/O SWAPNA	D4	F	22858	1.6	50	32.8	64	2	51.2	34	3.48	54.6	38.2
79	B/O KAVITA	D3	M	23017	2.29	50	33.2	94.2	2.7	52.4	35	4.54	54.2	39
80	B/O MUSKAAN	D6	M	12493	2	49.2	32.8	51	2.46	50.6	35	3.98	54	38.8
81	B/O MAHADEVI	D4	M	23015	2.39	49.2	33.2	82	2.83	50.4	35.2	4.74	54.4	39
82	B/O MEENAKSHI	D4	F	22725	1.8	48	33	68	2.2	49.6	35	4.1	53	38
83	B/O GEETA	D4	F	22705	1.7	50	33	46	2.24	51.3	34.6	3.82	54.6	37.4
84	B/O ANNAPURNA	D14	M	24490	2.23	49	33	62	2.6	50.4	34.6	4.56	53	38
85	B/O MUSKAAN	D6	M	12494	2.3	50	33	48	2.8	51.2	35	4.28	54.8	38.2

Sl. No	NAME	Age	Sex	IP No	BW (KG)	LENGTH (CM)	HC(CM)	S.Zinc (µg/dl)	At Follow up 1			At Follow up2		
									WT(KG)	LENGTH (CM)	HC(CM)	WT(KG)	LENGTH	HC(CM)
86	B/O ANUSHREE	D7	F	20021	2.4	50	33	58	3	51.4	34.2	4.68	54	38.6
87	B/O GADEMMA	D6	M	19744	2.32	49.4	32	51	2.76	50.8	34	4.42	53	39
88	B/O AMEENA	D6	F	20021	2.49	50	32	92	2.89	51.2	34	4.76	54.6	40
89	B/O SHOBHA	D6	M	22790	2.48	49	33.6	46	2.9	50.4	35	5.18	54	38.6
90	B/O VIJAYA	D4	M	22581	1.7	50	33	75	2.1	51.3	35	3.48	55	38
91	B/O TABASUM	D3	M	22564	1.9	47	32	64	2.3	48.6	34	3.78	53	38.2
92	B/O REKHA	D6	M	22495	1.65	49	33	42	2	50.2	33.8	3.86	54	38
93	B/O SHARADA	D4	F	23025	1.48	50	32	59	1.98	51.4	34	3	54.2	38
94	B/O GEETA	D5	F	22705	1.7	49	32	56	2.2	50.2	34	2.98	53	37.6
95	B/O SAROJA	D3	F	12550	1.73	48	33	64	2.26	49.4	35	3.6	53.4	37.2
96	B/O PUSHPA	D11	M	2831	2.38	49	33	51	2.75	50.2	34	4.76	54	39
97	B/O REKHA	D8	M	1863	2.18	48	32	43	2.48	49.6	34	4.32	52.8	38
98	B/O JAYASHREE	D6	F	19612	2.44	48	32.6	50	2.8	49	35	5.08	53	40
99	B/O PUSHPA	D2	M	1920	1.6	50	32	122	2	51.4	34	3.28	54.8	38.2
100	B/O GANGABAI	D5	F	198	2.46	50	33	88	3	51.2	35	5.12	55	39