CHAPTER 6

SUMMARY AND CONCLUSION

Undernutrition commonly affects all groups in a community, but infants and young children are the most vulnerable because of their high nutritional requirements for growth and development. Undernutrition may not be considered as specific disease but it's certainly known to be a mother of lot of acute and chronic diseases such as **diarrhea** and **acute respiratory infections or common colds.** Therefore, combating such a dreaded issue proven to be an uphill task for us till now. Gut microflora could be used as a decipherable mode to understand and correct the various troubles linked to undernutrition. FOS is considered to be a "true prebiotic"- essential nourishment for human gut. In view of stated rationale present doctoral work entitled **"Morbidity Status and Gut Health of Normal and Undernourished School Going Children and its Alteration Upon Feeding Them With Fructooligosaccharide Incorporated Ice-Cream"** was planned and executed and can be summarized with certain conclusion in following four phases:

6.1. **Phase I** of the research was undertaken to determine the nutritional status and morbidity profile and its possible determinants of primary school going children of urban Vadodara. It was a prospective study in which a cross sectional design was used where in 218 school going children studying in the primary section of a semi-private school were enrolled. Nutritional status of

the children was determined by anthropometry using WHO (2007) standards (BMI for age and gender). Morbidity profile, past breast feeding practices, immunization status, and dietary intake of the children was determined by interviewing their parents, including economic and educational status of their family, using a pretested structured questionnaire. Chi square test, Exposure/outcome ratios (Odds ratio) were used to analyze and interpret the results of Phase I.

Result highlights of Phase I were:

❖ 71% of the studied population was undernourished with 14%, 46% and 40% in the severe, moderate and mild undernutrition.

❖ More number of boys (73%) were undernourished than girls (69%*).*

❖ Following statistically significant contributors for undernutrition (mild, moderate, severe) were observed:

   ✓ Joint/extended family (OR=1.53)

   ✓ Not practicing exclusive breast feeding (OR=1.45)

   ✓ Partial/Nil immunization status of child (OR=1.63)

   ✓ Illiterate mother (OR=1.27)

   ✓ Illiterate father (OR=5.30)

   ✓ Low family income (OR=2.57)

❖ 33% of the children had diarrhea in the last month and the statistically significant contributors for Diarrhea were:

   ✓ Not practicing exclusive breast feeding (OR= 2.86)

- ✓ Partial/Nil immunization status of child (OR= 1.86)

- ✓ Illiterate mother (OR= 3.15)

- ✓ Illiterate father (OR= 1.31)

- ✓ Low family income (OR=1.11)

❖ 65% of the children suffered with Common colds and the statistically significant contributors for Common colds were:

- ✓ Partial/Nil immunization status of child (OR= 1.66)

- ✓ Illiterate mother (OR=1.52)

- ✓ Low family income (OR= 2.20).

Results of phase I clearly depicts that undernutrition is a rampant multi dimensional problem affected by multiple factors with partial/nil immunization, illiteracy of mother and low family income are common contributory elements for undernutrition, diarrhea and common colds in the school going children. Results also reaffirmed the fact there exists a vicious cycle of undernutrition and infection that needs to be intervened through appropriate alternative strategies.

6.2. **Phase II** was an observational comparative study using case control design wherein 32 nourished and 80 undernourished children were compared for their gut microflora, serum IgA, morbidity profile and dietary profile. Gut microflora was determined in terms of favorable bacteria viz. *Lactic acid bacteria* and *Bifidobacteria* and pathogenic bacteria viz. *E. coli*, using pour plate and selective media techniques. Immunoturbidmetric essay was employed to

analyze serum IgA and Independent 't' test, chi square, Spearman's correlation, Pearson's correlation, linear regression, quartile analysis and post hoc LSD tests were implied for interpreting the data.

Result highlights of this phase are presented as under:

❖ Mean counts of *E. coli* were significantly associated with lower BMI of the children whereas higher counts of *Bifidobacteria* and *Lactic acid bacteria* associated significantly with better nutritional status.

❖ Morbidity profile significantly associated with the gut microflora. Children with lower counts of *Bifidobacteria (r= -0.220)* and *Lactic acid bacteria (r= -0.232)* experienced significantly higher episodes of diarrhea and common colds respectively.

❖ Counts of favorable bacteria (*Lactic acid bacteria* r= -0.263; *Bifidobacteria* r=-0.246) were inversely proportional to pathogenic bacteria (*E. coli*).

❖ Incidence of common cold was 19% (p<0.04) higher in undernourished children compared to nourished ones.

❖ Severely undernourished children suffered from significantly higher (p<0.01) incidence (62.5%) of diarrhea compared to moderate (36%) and mildly (22%) undernourished children.

❖ Counts of pathogenic bacteria i.e. *E. coli* were 2.75% higher in the gut of undernourished children compared to nourished ones (p<0.001).

❖ Counts of favorable bacteria i.e. *Bifidobacteria* (3.50%) and *Lactic acid bacteria* (3.20%) were significantly higher (p=0.000) in the gut of nourished children compared to undernourished children.

- ❖ Gut microflora profile showed significant deviations (p=0.000) across all the three grades of undernutrition:
  - ✓ Severely undernourished children had 6.1% and 1.85% higher counts of *E. coli* compared to mild and moderate (p=0.000) whereas moderately undernourished children had 4.10% higher counts compared to mildly undernourished (p=0.000).
  - ✓ Counts of *Bifidobacteria* were 3.37% and 2.62% higher in mildly and moderately undernourished compared to severely undernourished children respectively (p=0.000).
  - ✓ Moderate and mildly undernourished children had 6.10% and 5.12% higher counts of *Lactic acid bacteria* compared to severely undernourished ones (p=0.000).
- ❖ Serum IgA levels showed an increasing trend with decreasing status of nutrition, indicating higher rates of infection in undernourished children.
- ❖ Quartile analysis showed that higher ranges of serum IgA had a significantly positive correlation with colonization of *E. coli* (r= 0.463).
- ❖ Gut microflora especially *Bifidobacteria (β= 0.543- 0.645)* came out to be significant positive regressors for BMI in all the quartiles of serum IgA.
- ❖ Analysis of variance indicated significant differences in the counts of pathogenic bacteria (p<0.01) and incidence of diarrhea (p<0.00) across the quartiles of serum IgA levels (56-273 mg/dl).

❖ Intake of energy (34.22%), carbohydrate (31.94%), protein (36%), fat (36%), dietary fibre (55.55%), iron (37.86%), calcium (43.26%), zinc (33.50%), and vitamin C (51.05%) were significantly higher (p=0.000) in the nourished children compared to undernourished children.

❖ *Bifidobacteria* counts showed significant positive correlation with energy, carbohydrate, protein, fat, iron, calcium and zinc intakes.

❖ Low consumption of total dietary fibre and zinc impacted higher log counts of *E. coli*.

Hence the undernourished children had poorer gut health as indicated by significantly higher colonization of pathogenic bacteria *(E. coli)* and significantly lower colonization of favorable bacteria (*Lactic acid bacteria* and *Bifidobacteria*). Undernourished children also had higher episodes of common colds and severely undernourished children experienced higher episodes of diarrhea according to their past month morbidity profile. Serum IgA levels were positively correlated with higher colonization of *E. coli*. Gut health was significantly affected by lower consumption of zinc and dietary fibre.

6.3. In the **phase III,** an experimental comparative study was undertaken wherein a randomized placebo control trial was used to determine the impact of FOS (10g) or placebo (sucrose) incorporated ice cream (manufactured by Gujarat co-operative Milk Marketing Federation) on the gut microflora,

serum IgA, morbidity profile, and nutritional status of randomly stratified 60 undernourished children. Previously mentioned methods were employed for biochemical, microbial estimations and statistical analysis along with Paired 't' test.

Result highlights of Phase III were:

❖ 30 days of FOS supplementation over a period of 45 days beneficially impacted the undernourished children by:

  ✓ Increase in 28.6% *Bifidobacteria* (p=0.000) and 2.56% of *Lactic acid bacteria* colonization (p<0.00).

  ✓ Decrease in colonization of *E. coli* by 2.38% (p<0.00).

  ✓ Reduction in diarrheal episodes by 79.6% (p<0.00) and in common colds episodes by 82% (p=0.000).

After considering the reduction in common colds episodes of placebo group (57.86%), the net impact of FOS supplementation on common colds was came out to be 24.52% and hence the prebiotic effect of FOS played an important role in reducing common colds and diarrhea.

❖ Exclusive impact of FOS incorporated ice cream did not reveal a significant improvement in the nutritional status of undernourished children as both the groups reported gain in weight.

This randomized clinical trial therefore concludes that FOS incorporated in the diets of undernourished children can significantly improve their morbidity profile via the mechanism of improving gut health.

6.4. Phase IV: In this phase of the study, a compilation of recipes incorporated with prebiotic *viz.* inulin and FOS, in a form of bilingual booklet entitled "Prebiotics: Our Gut Guardians" was undertaken, in order to bring out a ready reckoner of prebiotic rich foods. These recipes were standardized and developed by the various researchers working in the field of prebiotics at the department of Foods and Nutrition, Faculty of Family and Community Sciences, The Maharaja Sayajirao University of Baroda. The recipes were computed for an appropriate portion size considering the maximum allowance of prebiotic that would result in most acceptable products.

Hence, phase IV of the study helped in bringing out a recipe book in a daily dose of prebiotic in a form of one's favorite food. This booklet believed to be helpful for nutritionists, dieticians, and other people directly or indirectly associated with health sector.