Results and discussion

CHAPTER 5

RESULTS AND DISCUSSION

The results of the present study entitled "**Assessing the presence of Lactose Intolerance among Children, Adults and Elderly of Urban Vadodara and Evaluating the Impact of Supplementing Lactose Hydrolysed Milk on their Quality of Life and Nutritional Status"** are presented, explained and discussed in this chapter. The results are presented in four main phases according to the objectives of the study.

Phase I - Screening and identification of lactose intolerant (LI) subjects

Phase II – Impact of supplementing lactose hydrolysed milk (LHM) to lactose intolerant subjects

Phase III- Organoleptic evaluation of food products developed from standard and lactose hydrolysed milk

Phase IV- Development of IEC material

Phase I: Screening and identification of Lactose Intolerant (LI) subjects

5.1.1 General information of the respondents

5.1.2 Gastrointestinal symptoms experienced by respondents upon consumption of the various food groups and comparison among them.

5.1.3 Screening for LI among the subjects using Hydrogen Breath Analyser test (HBT)

5.1.4 Determining the severity of LI amongst the subjects.

5.1.5 HBT values of LI and non-lactose intolerant subjects.

5.1.6 Correlation between age and HBT reading.

5.1.7 Symptoms suffered by LI subjects during hydrogen breath analyser test (HBT) (N=90)

Phase II: Impact of supplementing Lactose hydrolysed milk (LHM) to lactose intolerant subjects.

5.2.1- Dietary intakes of the LI subjects before and after supplementation with LHM.

5.2.2- BMI of the LI subjects before and after supplementation with LHM.

5.2.3- Quality of life of the LI subjects before and supplementation with LHM.

5.2.4- Feedback of the subjects upon consumption of LHM post supplementation.

Phase III: Organoleptic evaluation of food products developed from standard and lactose hydrolysed milk

5.3.1 Organoleptic evaluation of beverages with lactose hydrolysed milk and standard dairy milk

5.3.2 Organoleptic qualities of white sauce pasta and veg au gratin with lactose hydrolysed milk and standard dairy milk.

5.3.4 Organoleptic qualities of *kheer* and *Sandesh* with and without lactose hydrolysed milk and standard dairy milk.

Phase IV: Development of IEC material

Phase I- Screening and Identification of Lactose Intolerant subjects

Milk and milk products are extremely nutritious because they are an outstanding source of calcium and protein. Indigestion of food leads to the occurrence of gastrointestinal symptoms as body is unable to absorb the nutrients. Several foods including milk and milk products can cause it. It is difficult to identify lactose intolerant subjects until and unless one is conscious and mindful of their eating. Secondly, it is difficult to comprehend that something as nutritious as milk can cause gastrointestinal symptoms and maximum people are unaware of lactose Intolerance. Thus, this phase of the research was designed to obtain data on several foods causing gastrointestinal symptoms and identify lactose intolerant subjects using HBT.

The results of this phase are divided into following sections:

5.1.1 General information of the respondents.

5.1.2 Gastrointestinal symptoms experienced by respondents upon consumption of the various food groups and comparison among them.

5.1.3 Screening for lactose intolerance among the subjects using Hydrogen Breath Analyser

5.1.4 Severity of Lactose intolerance amongst the subjects

5.1.5 Mean values of HBT readings of lactose intolerant and non-lactose intolerant subjects.

5.1.6 Correlation between age and HBT reading

Section 5.1.1 General information of the respondents

In this phase, semi-structured questionnaire was developed and 503 adults, 272 children and 219 elderlies responded to the questionnaire given to them. Most subjects belonged to the age group of 18 to 35 years followed by 13 to 17 years. Total female respondent was 55%. (Table 5.1.1) (Fig: 5.1.1, 5.1.1.2). The questionnaire revealed that total adult's respondents suffering from diabetes were 3.6% and total respondents suffering hypertension were 6.9% whereas total geriatric individuals suffering from diabetes and hypertension were 7.3% and 9.13% respectively. Around 42% respondents belonged to nuclear family and 15% belonged to joint family.

Table 5.1.1: General information of the respondents (N=994)

Parameters	Total subjects N(%)
Age	
10-12yrs	92 (9.25%)
13-17yrs	180 (18.1%)
18-35yrs	397 (39.93%)
36-50yrs	52 (5.23%)
51-60yrs	54 (5.43%)
61-80yrs	165 (16.59%)
81 and above	54 (5.43%)
Sex	
Female	550 (55.3%)
Male	444 (44.6%)
Types of family	
Nuclear family	421 (42.3%)
Extended family	394 (39.6%)
Joint family	159 (15.9%)
Respondents not mentioning type of family	25 (2.51%)

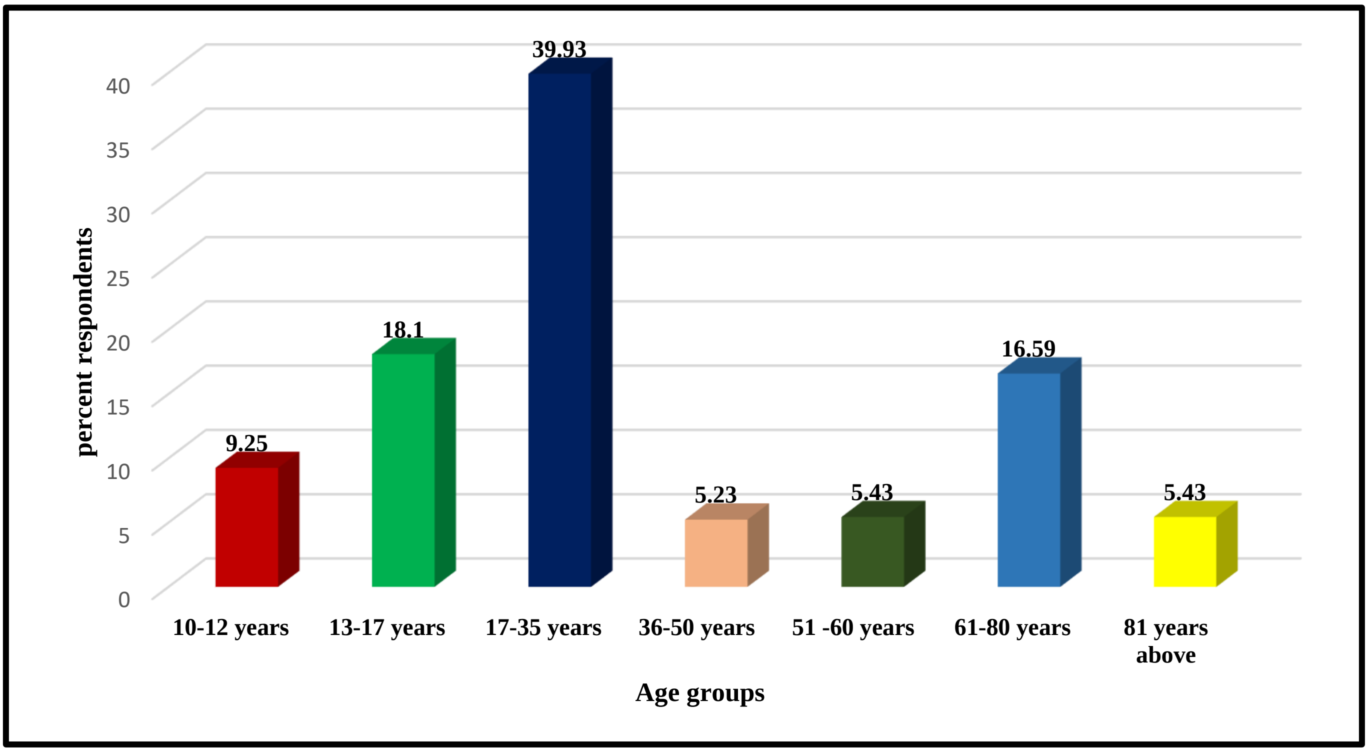

Figure-5.1.1- Age distribution of the population responding to questionnaire (N=994)

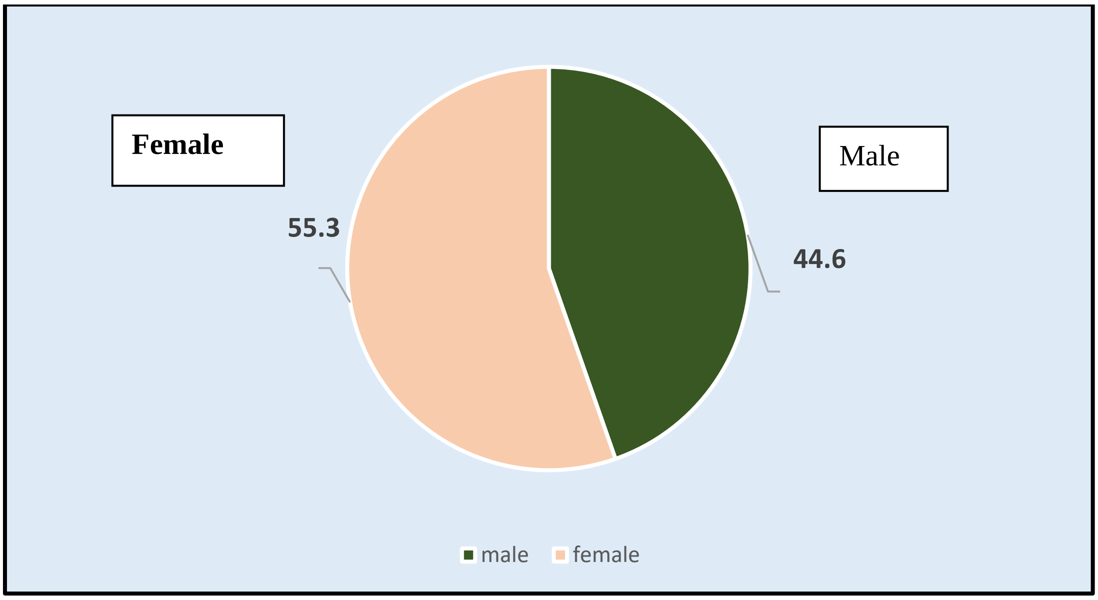

Figure -5.1.1.2- Gender wise distribution of the population responding to questionnaire (N=994)

Section 5.1.2 Gastrointestinal symptoms experienced by respondents upon consumption of the various food groups.

Gastrointestinal symptoms post consumption of food-groups such as milk and milk products, cereals, pulses, fermented foods, fruits and vegetables were assessed. It was observed that 27.5% of the subjects reported to have experienced gastrointestinal symptoms owing to the consumption of milk and milk-based products followed by vegetables (14.2%), pulses (5.8%), fermented foods (6.9%), fruits (8.8%) and cereal products (3.2%). Nearly one third of the respondents didn't experience any adverse gastrointestinal symptoms after consumption of various foods (Table 5.1.2).

Among children, gastrointestinal symptoms were observed post consumption of milk and milk products, vegetables, fruits, cereal products, fermented foods and pulses in 36.4%, 18.3%, 15.4%, 5.8%, 4.04% and 1.01% of subjects respectively. Among adults, gastrointestinal symptoms were observed post consumption of milk and milk products, vegetables, pulses, fermented foods, fruits and cereal products in 18.4%, 13.5%, 7.7%, 6.2%, 5.2% and 2.9% of subjects respectively. Among elderlies, gastrointestinal symptoms were observed post consumption of milk and milk products, vegetables, fermented foods, fruits, pulses and cereal products in 37.4%, 10.95%, 10.04%, 9.1%, 7.3% and 2.7% of subjects respectively.

With respect to milk and milk products, maximum children (17.7%) reported gastrointestinal symptoms were observed post consumption of cheese whereas maximum adults (61.3%) and elderlies (65%) suffered from gastrointestinal symptoms post milk consumption.

Table 5.1.2- Number of adults, children and elderly suffering from gastrointestinal symptoms experienced upon consumption of various food (N=994)

Various food groups	Adult (n=503)	Children(n=272)	Elderly(n=219)	Total (N=994)
Milk and milk products	93 **(18.4%)**	99 **(36.4 %)**	82 **(37.4%)**	274 **(27.5%)**
Vegetables	68 **(13.5%)**	50 **(18.3%)**	24 **(10.95%)**	142 **(14.2%)**
Pulses	39 **(7.7 %)**	3 **(1.01%)**	16 **(7.30%)**	58 **(5.8%)**
Cereal products	15 **(2.9%)**	11 **(4.04%)**	6 **(2.73%)**	32 **(3.2%)**
Fermented foods	31 **(6.16%)**	16 **(5.88%)**	22 **(10.04%)**	69 **(6.9%)**
Fruits	26 **(5.16%)**	42 **(15.4%)**	20 **(9.13%)**	88 **(8.8 %)**

Table 5.1.2.1 Number of adults, children and elderly suffering from gastrointestinal symptoms experienced upon consumption of various milk and milk products food (N=994)

Milk and milk products	Adult (n=93)	Children (n=99)	Elderly (n=82)	Total -274 (N)
Milk	57 **(61.3%)**	15 **(15.15%)**	53 **(64.6%)**	125 **(45.6%)**
Lassi	6 **(6.45%)**	5 **(5.05%)**	2 **(2.43%)**	13 **(4.74%)**
Kadhi	7 **(7.52%)**	9 **(9.09%)**	4 **(4.87%)**	20 **(7.29%)**
Milk powder	5 **(5.37%)**	8 **(8.08%)**	0 **(0%)**	13 **(4.74%)**
Chaach	4 **(4.30%)**	8 **(8.08%)**	3 **(3.65%)**	15 **(5.47%)**
Milk sweets	2 **(2.15%)**	9 **(9.09%)**	2 **(2.43%)**	13 **(4.74%)**
Milk chocolates	0 **(0%)**	0 **(0%)**	0 **(0%)**	0 **(0%)**
Ice cream	3 **(3.2%)**	12 **(12.12%)**	1 **(1.21%)**	16 **(5.83%)**
Cheese	4 **(4.3%)**	17 **(17.17%)**	7 **(8.53%)**	28 **(10.21%)**
Fruit custard	2 **(2.15%)**	4 **(4.04%)**	6 **(7.31%)**	12 **(4.37%)**
Yogurt	3 **(3.22%)**	6 **(6.06%)**	4 **(4.87%)**	13 **(4.74%)**
Condensed milk	0 **(0%)**	6 **(6.06%)**	0 **(0%)**	6 **(2.18%)**

Section 5.1.3 Screening for lactose intolerance among the subjects using Hydrogen Breath Analyser.

Respondents (N=220) who reported adverse gastrointestinal symptoms post consumption of milk and milk-based products were enrolled and hydrogen breath analyser test was performed on the subjects (N=181) who consented for HBT. In this test, an oral dose of 25 gm of lactose powder dissolved in 250 ml of water was orally administered to the subjects and after 30 mins they had to blow out air through their mouth into the device for six times (with 30 mins break between each breath out) which calculates the hydrogen emitted by the human gut post consumption of lactose powder. Test was conducted till we achieve 30 lactose-intolerant subjects.

5.1.3.1 Presence of lactose intolerance (N=181)

A total of 62 children, 65 adults and 54 elderlies were screened using hydrogen breath analyser test and the results showed that 49.72% of them were lactose intolerant. (Table 5.1.3)

Table 5.1.3- Presence of lactose intolerance detected post HBT (N=181)

Presence of lactose intolerance	Adult (n=62)	Children (n=65)	Elderly (n=54)	Total N (%) (N=181)
Lactose intolerant	30 (48.3%)	30 (46.15%)	30 (55.5%)	90 (49.72%)
Non- lactose intolerant	32 (51.6%)	35 (53.84%)	24 (44.4%)	91 (50.27%)

Section 5.1.4 Severity of Lactose Intolerance amongst the subjects.

The subjects with lactose intolerance were further divided into mild, moderate and severe categories depending on the severity of lactose intolerance. Majority of the subjects (80%) fell in the mild malabsorption category (Table 5.1.4). There was no significant difference among children, adult and elderly population.

Table 5.1.4- Severity of lactose intolerance amongst the subjects (N=90)

Category	**Adult (n=30)**	**Children (n=30)**	**Elderly (n=30)**	**Total N (%) (N=90)**	**X^2 value**
Mild malabsorption (>21 ppm)	26 (86.6%)	28 (93.3%)	26 (86.6%)	**80 (88.8%)**	**0.59 NS** **(p>0.05)**
Moderate malabsorption (>60ppm)	3 (10%)	2 (6.6%)	4 (13.3%)	**9 (9.4%)**	
Severe malabsorption (>80 ppm)	1 (3.3%)	0 (0%)	0 (0%)	**1 (1.1%)**	

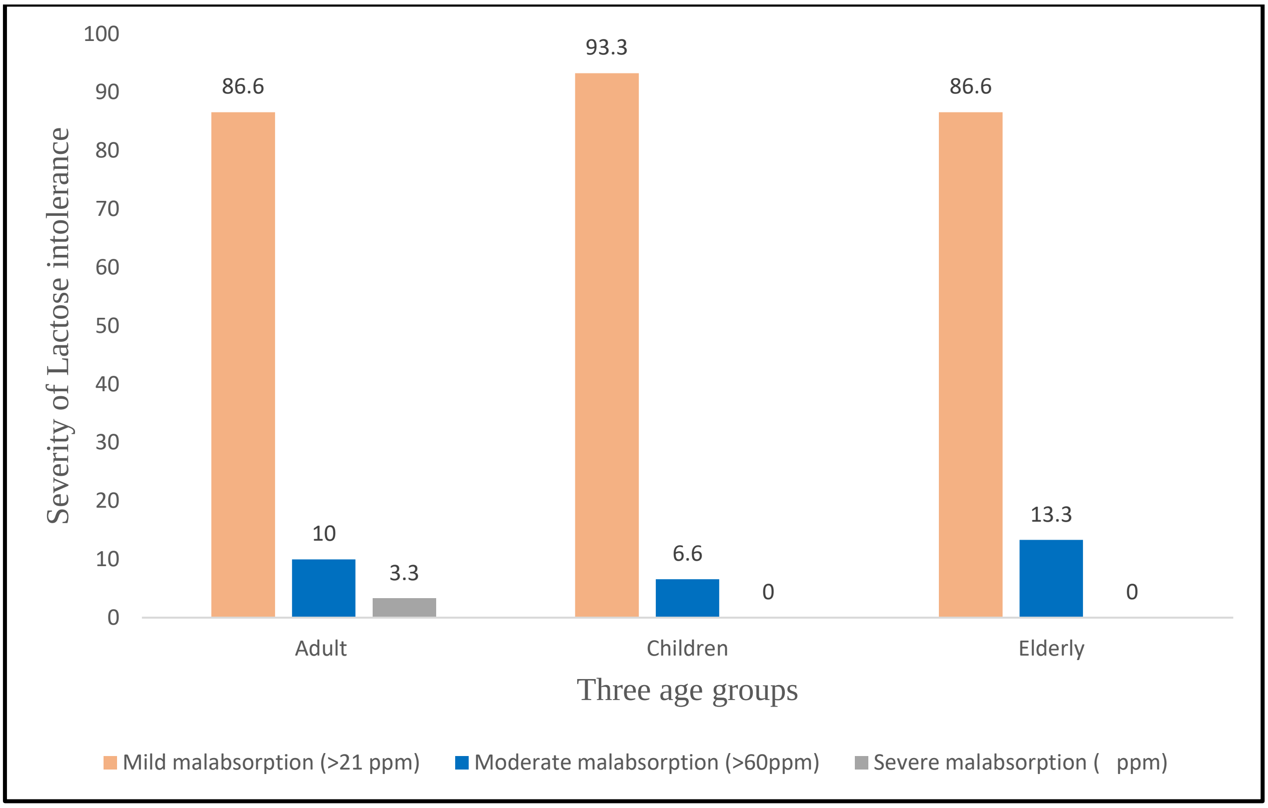

Figure 5.1.4 Severity of lactose intolerance amongst the subjects (N=90)

Section 5.1.5 Mean values of HBT readings of lactose intolerant and non-lactose intolerant Subjects.

Among children, mean HBT baseline readings amongst lactose intolerant subjects was higher than the mean baseline readings amongst non-lactose intolerant subject (8.3±6.0 v/s 6.9±7.2). Mean HBT readings amongst lactose intolerant subject kept increasing rapidly from baseline to the final reading (8.3±6.0 v/s 35.1±9.8) whereas, mean readings amongst non-lactose intolerant showed insignificant progress from baseline and ranged between 6.9 to7.5. At the end of the test, mean of the last HBT reading of lactose intolerant subject was observed to be significantly higher compared to the mean of the last reading amongst the non-lactose intolerant (35.1±9.8 v/s 7.5±5.15) (Table 5.1.5) (fig 5.1.5).

Among adults, mean HBT baseline readings amongst lactose intolerant subjects was higher than the mean baseline HBT readings amongst non-lactose intolerant subject (12.4±11.06 v/s 9.28±8.15). Mean HBT readings amongst lactose intolerant subject kept increasing rapidly from baseline to the final reading (12.4±11 v/s 43.3±19.3) whereas, mean readings amongst non-lactose intolerant showed insignificant progress from baseline and ranged between 9 to 10.28. At the end of the test, mean of the last HBT reading f lactose intolerant subject was observed to be significantly higher compared to the mean of the last reading amongst the non-lactose intolerant (43.3 ±19.3 v/s 10.12 ± 9.24) (Table 5.1.5.1) (fig 5.1.5.1).

Among elderly, mean HBT baseline readings amongst lactose intolerant subjects was higher than the mean baseline HBT readings amongst non-lactose intolerant subject (14.17± 7.58 ppm v/s 11.79± 6.98 ppm). Mean HBT readings amongst lactose intolerant subject kept increasing rapidly from baseline to the final reading (14.17± 7.58 ppm v/s40.83±11.02 ppm) whereas, mean HBT readings amongst non-lactose intolerant showed insignificant progress from baseline and ranged between ppm to ppm. At the end of the test, mean HBT of the last reading of lactose intolerant subject was observed to be significantly higher compared to the mean of the last HBT reading amongst the non-lactose intolerant (40.83±11.02ppm v/s 15.29±10.46 ppm) (Table 5.1.5.2) (fig 5.1.5.2).

Table 5.1.5.- Mean values of HBT readings of lactose intolerant and non-lactose intolerant subjects (children) (N=65)

Readings	LI (lactose intolerant) Mean ± SD (N=30) (ppm)	NLI (non-lactose intolerant) Mean ± SD (N=35) (ppm)	t-value
Baseline reading (before giving lactose dose)	8.3±6.0	6.9±7.3	0.042^{NS}
Reading 1 (30 minutes after consumption of lactose)	12.3±6.5	7.2±5.4	1.18^{NS}
Reading 2 (30 minutes after reading 1)	21.1±7.7	7.6±4.9	2.84**
Reading 3 (30 minutes after reading 2)	30.8±8.1	7.5±5.1	3.15**
Reading 4 (30 minutes after reading 3)	35.1±9.8	7.3±5.3	3.14***

*** - significant at 0.001, **- significant at 0.01, NS- non significant

Table 5.1.5.1- Mean values of HBT readings of lactose intolerant and non-lactose intolerant subjects (adults) (N=62)

Readings	**LI (lactose intolerant) Mean + SD (N=30) (ppm)**	**NLI (non-lactose intolerant) Mean + SD (N=32) (ppm)**	**t-value**
Baseline reading (before giving lactose dose)	12.47+ 11.06	9.00 + 8.10	1.41^{NS}
Reading 1 (30 minutes after consumption of lactose)	15.63 + 9.21	9.28 +7.84	3.05**
Reading 2 (30 minutes after reading 1)	26.5 + 9.40	9.47 + 7.73	7.81***
Reading 3 (30 minutes after reading 2)	37.6 + 14.39	9.25 + 7.50	9.79***
Reading 4 (30 minutes after reading 3)	43.33 +19.29	9.03 + 7.19	9.38^{***-}

*** - significant at 0.001, **- significant at 0.01, NS- non significant

Table 5.1.5.2- Mean values of HBT readings of lactose intolerant and non-lactose intolerant subjects elderly (N=62)

Readings	**LI (lactose intolerant) Mean + SD (N=30) (ppm)**	**NLI (non-lactose intolerant) Mean + SD (N=32) (ppm)**	**t-value**
Baseline reading (before giving lactose dose)	14.17+ 7.58	11.79+ 6.98	1.04^{9NS}
Reading 1 (30 minutes after consumption of lactose)	18.42+7.6	12.92+ 6.97	2.601**
Reading 2 (30 minutes after reading 1)	26.75+6.68	14.04+ 8.23	6.59***
Reading 3 (30 minutes after reading 2)	34.75+9.92	14.96+8.86	11.11***
Reading 4 (30 minutes after reading 3)	40.83+11.02	15.29+10.46	11.51 ***

*** - significant at 0.001, **- significant at 0.01, NS- non significant

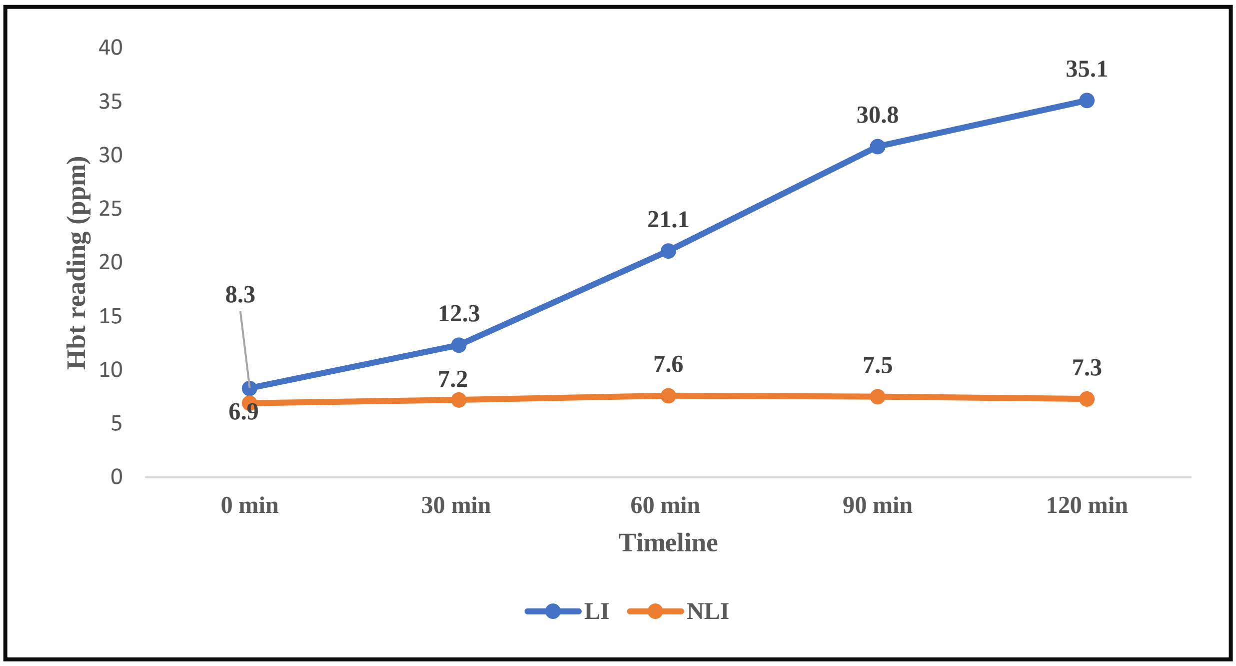

Figure 5.1.5 - Hydrogen Breath Analyzer readings for Lactose Intolerant and Non-Lactose Intolerant subjects among children (N=65)

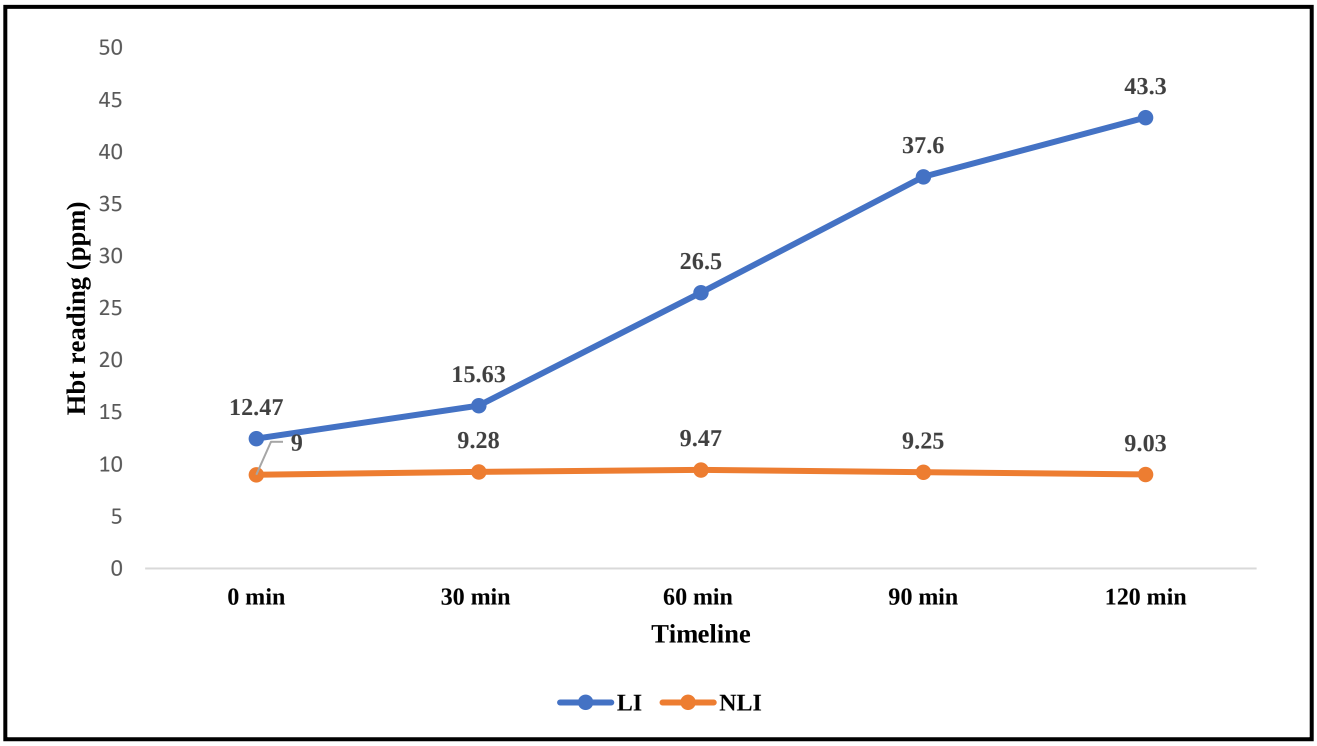

Figure 5.1.5.1 - Hydrogen Breath Analyzer readings for Lactose Intolerant and Non-Lactose Intolerant subjects among adult subjects (N=62)

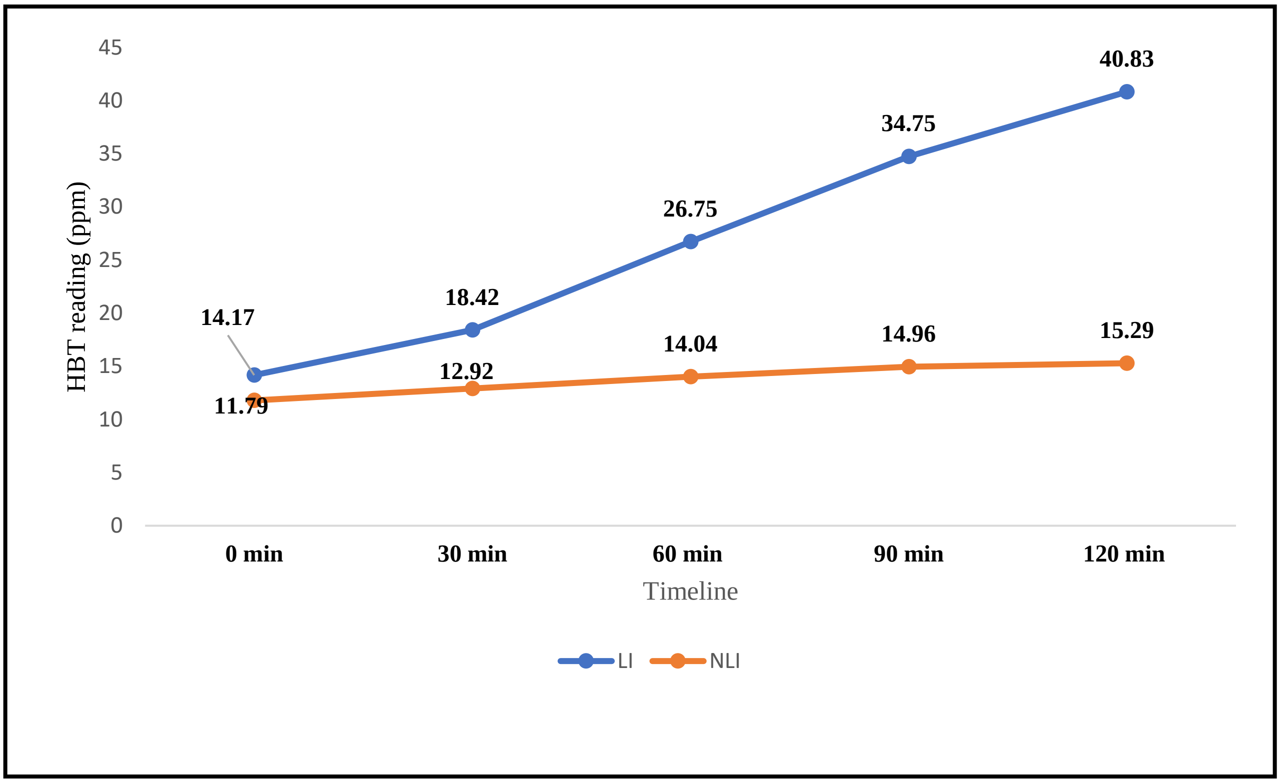

Figure 5.1.5.2 - Hydrogen Breath Analyzer readings for Lactose Intolerant and Non-Lactose Intolerant subjects among elderly subjects (N=54)

Section 5.1.6 Correlation between Age and HBT reading (N=90)

Pearson correlation revealed a coefficient of 0.384. This shows that there is high significant correlation between increase in age and HBT reading (table 5.1.6).

Table 5.1.6- Pearson's correlation between age and HBT reading (N=90)

Age (years)	Mean HBT value (ppm)	Pearson Correlation coefficient value
10-20	22.51	0.384**
21-30	24.62	
31-40	24.73	
41-50	26	
51-60	28.6	
61 and above	28.68	

Note: **= <0.01

Section 5.1.7. Age and gastrointestinal symptoms upon consumption of various food products among lactose intolerant subjects (N=90)

There is a significant positive correlation between increase in age and gastrointestinal symptoms suffered from vegetables, fermented foods and cereals consumption. However, no significant correlation between increase in age and gastrointestinal symptoms suffered from pulses and fruits consumption.

Table 5.1.7- Pearson's correlation between age and gastrointestinal symptoms upon consumption of various food (N=90)

Age (years)	Cereal (Mean score)	Pulses (Mean score)	Fruits (Mean score)	Vegetables (Mean score)	Fermented foods (Mean score)
10-20	0.25	0.48	0.45	0.64	0.25
21-30	0.13	0.39	0.26	0.34	0.26
31-40	0	1	0	1	0.33
41-50	0.5	0.5	0.5	0.5	0
51-60	0.28	0.57	0.42	0.85	0.68
61 and above	0.52	0.58	0.52	0.88	0.58
Pearson Correlation coefficient	0.248*	0.106^{NS}	0.083^{NS}	0.294**	0.395**

Note: NS= non-significant; *=<0.05, **=<0.001

Section 5.1.8- Symptoms suffered by lactose intolerant subjects during hydrogen breath analyser test (HBT) (N=90)

Lactose intolerant subjects experienced symptoms such as flatulence, cramps, diarrhoea and other non-gastrointestinal symptoms like headache. Maximum children, adult and elderly experienced vomiting, diarrhoea and flatulence respectively. Where, adult and geriatric individuals suffered from diarrhoea whereas children suffered mostly from flatulence (fig 5.1.7)

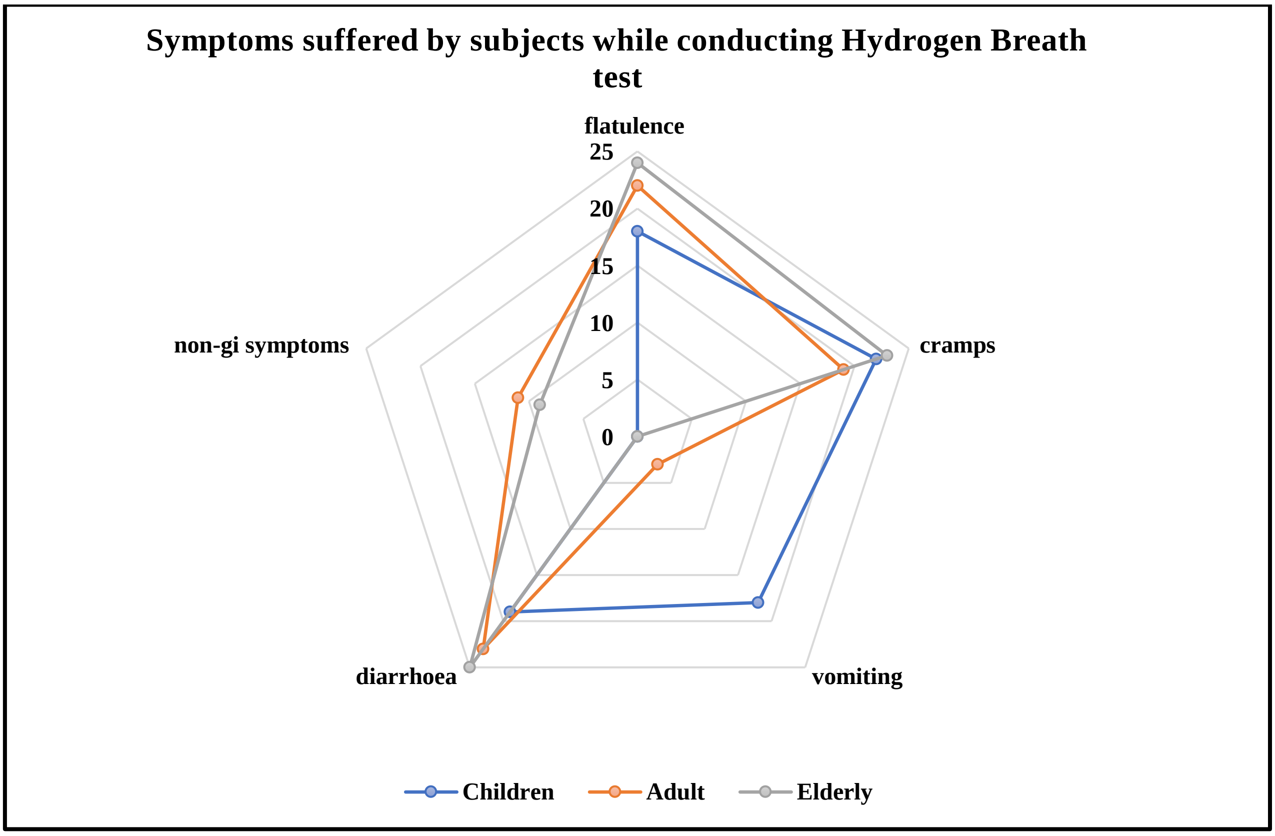

Fig 5.1.8- Gastrointestinal symptoms suffered by lactose subjects during hydrogen breath analyser test (HBT)

PHASE I Highlights

- ✓ **A semi-structured questionnaire was developed and 503 adults, 272 children and 219 elderlies responded to the questionnaire given to them. Most subjects belonged to the age group of 18 to 35 years (40%) followed by 13 to 17 years (18%). Majority (55%) of the respondents were female.**
- ✓ **It was observed that 22% subjects suffered from gastrointestinal symptoms after consumption of milk and milk products followed by vegetables and fermented products.**
- ✓ **Among children, 36.4% of them suffered gastrointestinal symptoms post consumption of milk and milk products followed by vegetables, fruits, cereal products, fermented foods and pulses.**
- ✓ **Among adults, 18.4% suffered gastrointestinal symptoms post consumption of milk and milk products vegetables, pulses, fermented foods, fruits and cereal products.**
- ✓ **Among geriatric population, 37.4% of them suffered from gastrointestinal symptoms after consuming milk and milk products followed by vegetables, fermented foods, fruits, pulses and cereal products.**
- ✓ **With respect to milk and milk products, maximum children (17.7%) reported gastrointestinal symptoms were observed post consumption of cheese whereas whereas maximum adults (61.3%) and elderlies (65%) suffered from gastrointestinal symptoms post milk consumption.**
- ✓ **Post conducting hydrogen breath analyser test-46% children; 48% adult and 56% elderlies are lactose intolerant. It was divided into three category- mild, moderate and severe. Majority fall in the mild category.**

Phase II - Supplementation of Lactose intolerant subjects with Lactose hydrolysed milk and its effect on their Dietary intakes, BMI and Quality of life.

In this phase 250 ml lactose hydrolysed milk (LHM) per day was supplemented for a period of 6 weeks to all the lactose intolerant subjects (children, adults and elderly) after obtaining their consent and the subjects were assessed for dietary intakes, BMI and Quality of life before and after supplementation. Feedback of the subjects after consumption of LHM was taken post supplementation.

The results of this phase are presented under the following heads:

Section 5.2.1- Dietary intakes of the LI subjects before and after supplementation with LHM.

Section 5.2.2- BMI of the LI subjects before and after supplementation with LHM.

Section 5.2.3- Quality of life of the LI subjects before and after supplementation with LHM.

Section 5.2.4- Feedback of the subjects upon consumption of LHM post supplementation.

Section 5.2.1-Dietary intake of the lactose intolerant subjects before and after supplementation with LHM

Macronutrients such as carbohydrate, protein, fats and micronutrients- calcium and carotenoid were measured before and after supplementation with LHM. As seen in table 5.2.1, energy and protein consumption of the adults were less than 75% of RDA whereas fat was 233.31% higher than RDA. Among children, energy consumption was around 60% whereas fat intakes were 137.5% which was higher than RDA. Calcium was estimated to be less than 49%. Protein consumption of the elderly population was 84.85% whereas fat intake was 240.22% which was very high than RDA. Calcium was estimated to be 55% at the baseline. Protein consumed by children was high compared to adult and elderly, fat consumption was higher among elderly compared to adult and children (Table 5.2.1).

Energy intake was maximum post lactose hydrolysed milk supplementation among elderly (96% of RDA). Among children protein consumption increased by 7% post supplementation. Calcium increased considerably by 17.6% among children post supplementation. The mean energy consumption of adult was found to be 1148.65 $\pm$ 256.61 before supplementation, after supplementation it was 1207.93$\pm$256.55. Mean energy consumption of children was 1561.99$\pm$271.48 at baseline whereas it was 1622.23 $\pm$ 271.25 post supplementation. Micronutrients like calcium, carotenoid were also estimated. There was a significant increase in energy, protein, calcium intake post supplementation. (Table 5.2.1.1**).** Among children, protein, carbohydrate, fat, calcium and carotenoid post LHM supplementation increased by 4%, 7%, 3%, 6%, 35%, 0.61% respectively. Among adults, protein, carbohydrate, fat, calcium and carotenoid increased by 8%, 4%, 7%, 59%, 2% respectively**.** Among elderly population, protein, carbohydrate, fat, calcium and carotenoid post LHM supplementation increases – 3%, 7%, 4%, 7%, 44%, 4% respectively (Fig 5.2.1).

Table 5.2.1- Percent nutrient intake of RDA by adults, children and elderly population before and after supplementation of LHM (N=90)

Nutrients	**%RDA (adult) (n=30)**		**%RDA (children) (n=30)**		**%RDA (Elderly) (n=30)**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Energy (kcal/day)	59.7%	62.9%	59.9%	62.3%	92%	96.0%
Protein (gm/day)	65.0%	70.7%	88.8%	95.2%	79%	84.8%
Carbohydrate (gm/day)	12.3%	12.3%	24.3%	24.0%	23.6%	24.1%
Fats (gm/day)	233.3%	249.6%	137.6%	145.6%	224%	240.2%
Calcium (mg/day)	41.1%	65.8%	49.0%	66.6%	55.5%	79.7%
Carotenoid	88.3%	91.0%	95.0%	99.0%	71.6%	73.1%

Table 5.2.1.1- Mean value of nutrient intake of the lactose intolerant subjects before and after supplementation (N=30)

	Energy (kcal)	Protein (gm)	Carbohydrate (gm)	Fat (gm)	Calcium (mg)	Carotenoids (mcg)
Adult	Pre- 1148.65±256.61 Post- 1207.93± 256.55 Paired t test- 589.52*** %diff- 5.16 ↑	Pre- 35.50± 11.18 Post- 38.5 ± 11.04 Paired t test- 22.03*** %diff- 8.45 ↑	Pre- 142.07±41.80 Post- 147.42±41.73 Paired t test- 32.08*** %diff- 3.76 ↑	Pre- 46.95±9.40 Post- 50.36±9.41 Paired t test- 34.05*** %diff- 7.26 ↑	Pre- 246.40 ± 113.13 Post- 391.60 ± 113.01 Paired t test- 1723.13*** %diff- 58.9 ↑	Pre- 4317.91±2047.10 Post- 4393.01± 2047.15 Paired t test- 1528.58*** %diff- 1.73 ↑
Children	Pre- 1561.99±271.4 Post- 1622.23±271.25 Paired t test- 373.35*** %diff- 3.85 ↑	Pre- 46.73± 9.59 Post- 50.04±9.51 Paired t test- 43.51*** %diff- 7.08 ↑	Pre- 209.19+41.98 Post- 214.92+41.91 Paired t test- 34.50*** %diff- 2.73 ↑	Pre- 59.50+12.81 Post- 62.93+12.6 Paired t test- 31.94*** %diff- 5.76 ↑	Pre- 396.01+94.93 Post- 536.53+97.3 Paired t test- 28.99*** %diff- 35.48 ↑	Pre- 12293.43+41603.05 Post- 12368.65+41604.5 Paired t test- 247.36*** %diff- 0.61 ↑
Elderly	Pre- 1788.85+272.40 Post- 1847.93+273.3 Paired t test- 83.7*** %diff- 3.30 ↑	Pre- 45.06+6.19 Post- 48.01+5.16 Paired t test- 5.3*** %diff- 6.54 ↑	Pre- 225.69+75.84 Post- 235.16+77.99 Paired t test- 2.21* %diff- 4.19 ↑	Pre- 48.35+8.41 Post- 51.90+8.22 Paired t test- 42.63*** %diff- 7.34 ↑	Pre- 333.35+118.05 Post- 478.77+117.19 Paired t test- 244.25*** %diff- 43.62 ↑	Pre- 3437.8+584.78 Post- 3583.08+584.62 Paired t test- 1025.19*** %diff- 4.22 ↑

*** - significant at 0.001, **- significant at 0.01, NS- non significant

Section 5.2.2-BMI of the lactose intolerant subjects before and after LHM supplementation

Anthropometry was determined in terms of height, weight and Z score for BMI was calculated for children using WHO anthroplus software and subjects were categorised into thin, normal, overweight and obese. At baseline it was observed that 20% children belonged to normal category and 50%, 27% and 1% belonged to mild overweight, moderately overweight and obese category respectively. Post supplementation with LHM there was a decrease in mild overweight category by 3% and moderate overweight category increased by 3% (Fig 5.2.2.1).

Based on the BMI score, adult subjects were categorised into underweight, normal, overweight and obese. At baseline it was observed that 6.9%, 48.3%, 31% and 13.3% belonged to underweight, normal, overweight, obese categories respectively. Post supplementation with LHM It was observed there was a decrease in underweight category by 4% eventually improving percent under normal category by 4%. However, there were no changes in the overweight and obese categories (Fig 5.2.2.2).

Among elderly subjects, at baseline it was observed that 6.9%, 48.3%, 31% 13.3% belonged to underweight, normal, overweight and obese categories respectively. Post supplementation underweight decreased by 4% and normal category increased by 4%. Obesity and overweight category remained the same (Fig 5.2.4.2).

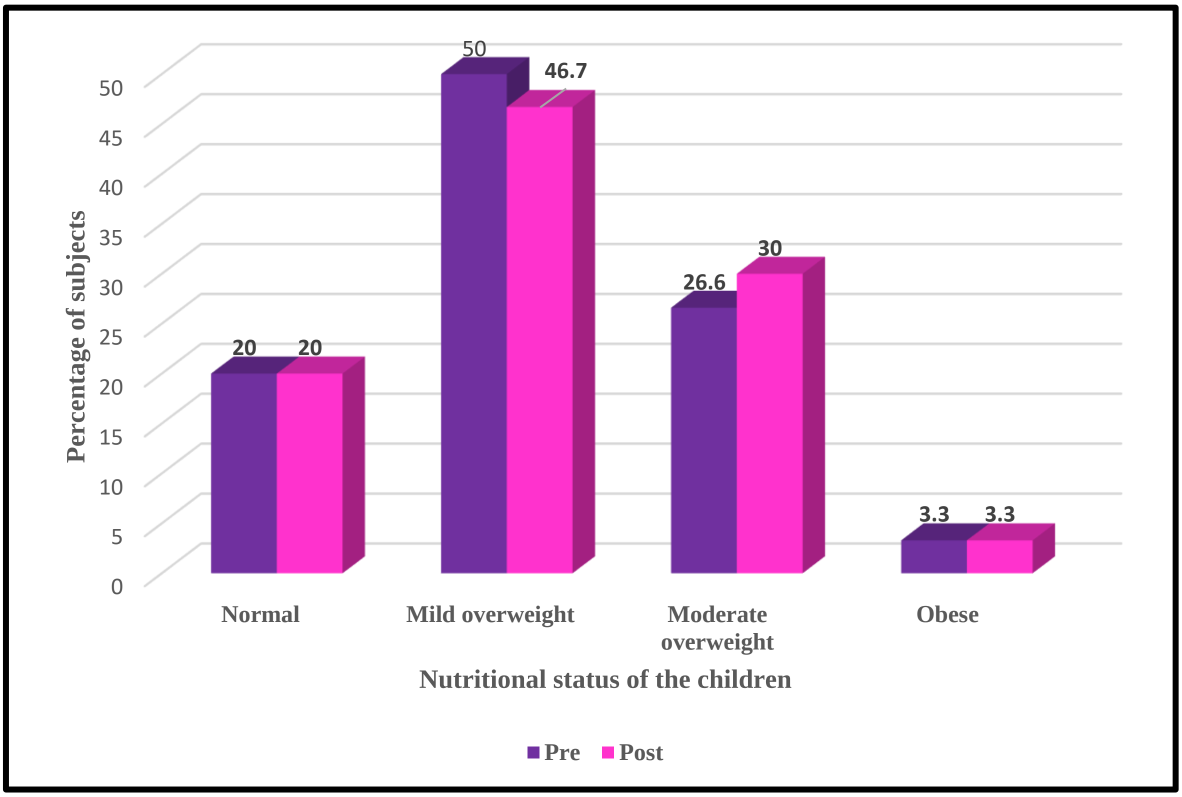

Figure 5.2.2.1 Impact of LHM supplementation on Nutritional status of LI children (N=30)

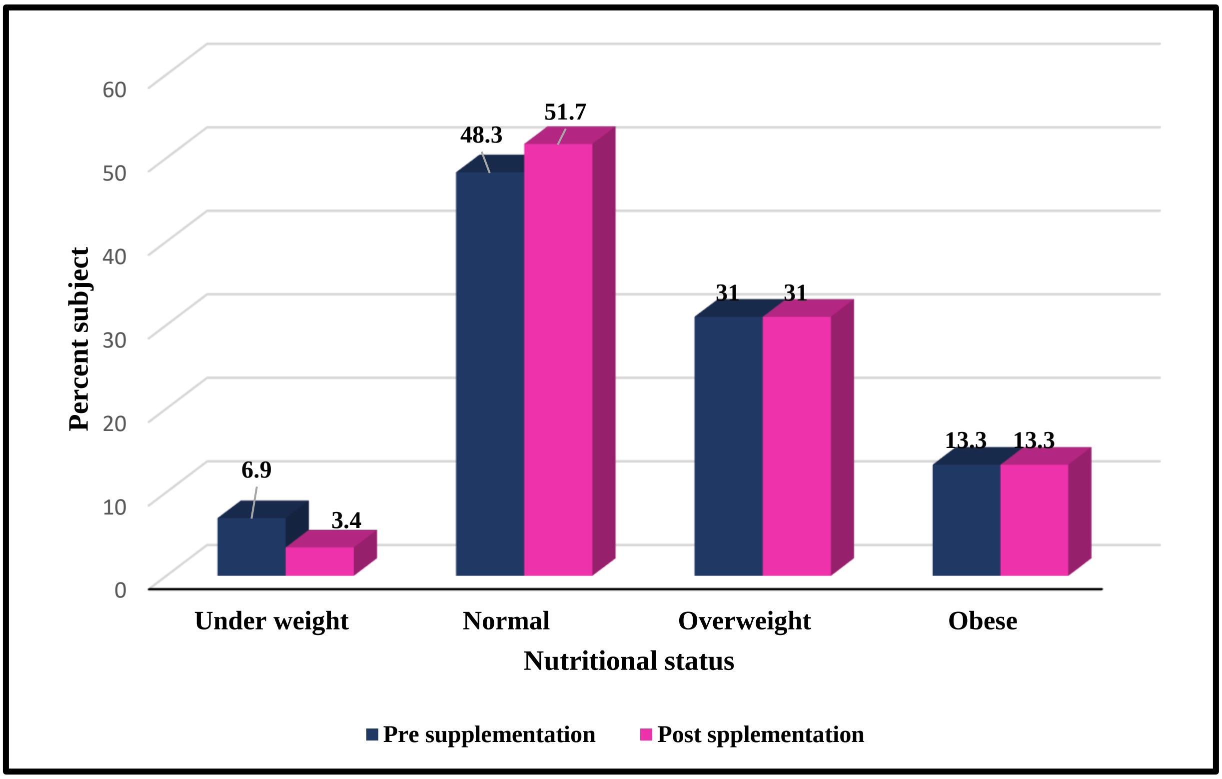

Figure 5.2.2.2 Impact of LHM supplementation on BMI of LI adults (N=30)

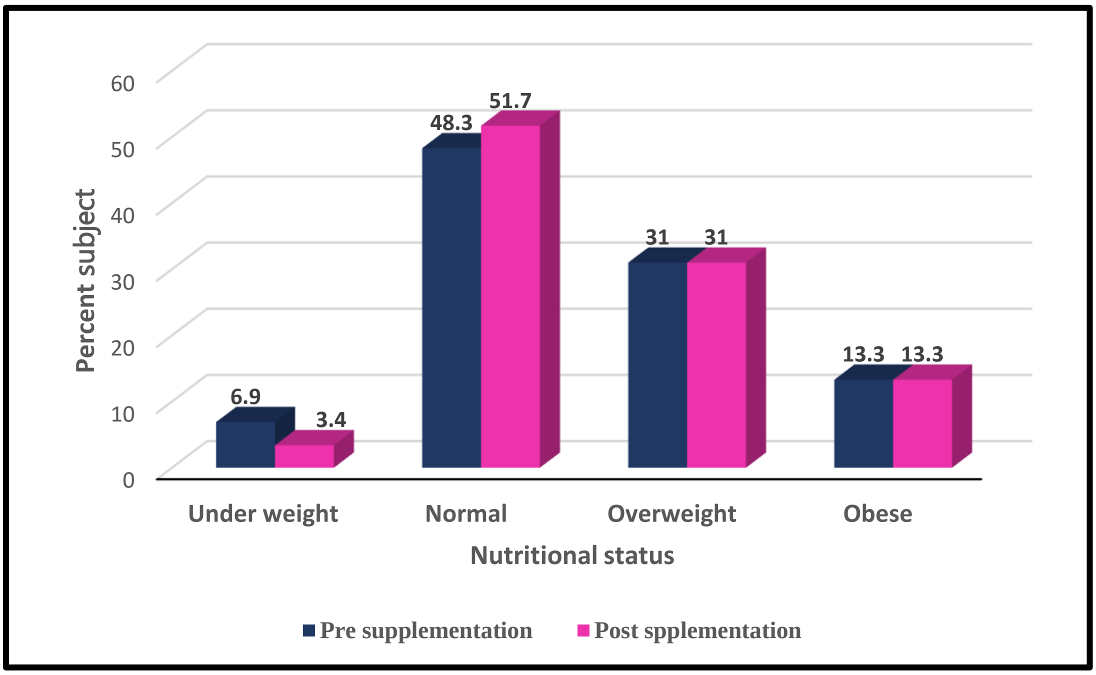

Figure 5.2.2.3 Impact of LHM supplementation on BMI elderlies (N=30)

Section 5.2.3 Quality of life of the LI subjects before and after supplementation with LHM

A semi-structured modified questionnaire comprising of ten questions was used to assess the quality of life of the lactose intolerant subjects. Depending upon the severity of lactose intolerance, the subject's quality of life might get affected. Majority of children (93.3%) had good quality of life before supplementation with LHM. However, post supplementation 100% of children had good quality of life.

Among adults, 86.6% had good quality of life before LHM supplementation and 100% had good quality of life post supplementation.

However, among elderlies, maximum (70%) had average quality of life and only 13.3% belonged to good quality of life before supplementation. Post supplementation, there was an increase in average category of quality life by 6% where as good quality of life increased by 10% (Fig 5.2.3.1) (Fig 5.2.3.2).

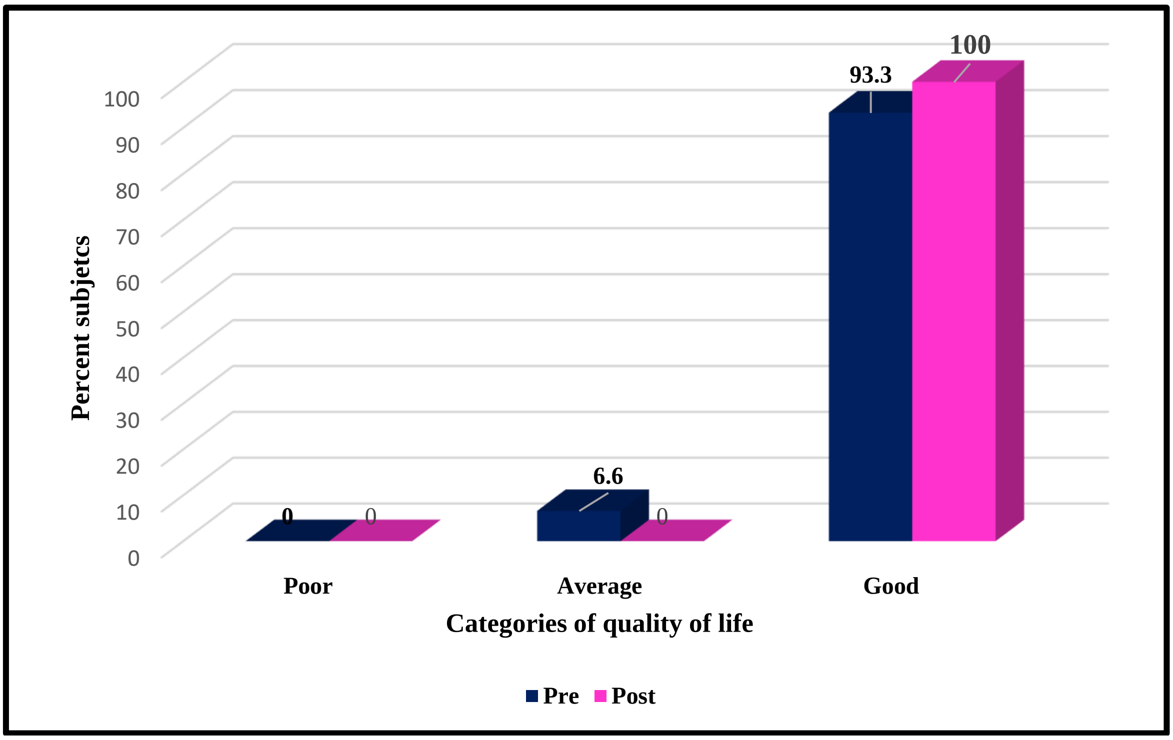

Figure 5.2.3.1- Impact of LHM supplementation on Quality of life of LI children (N=30)

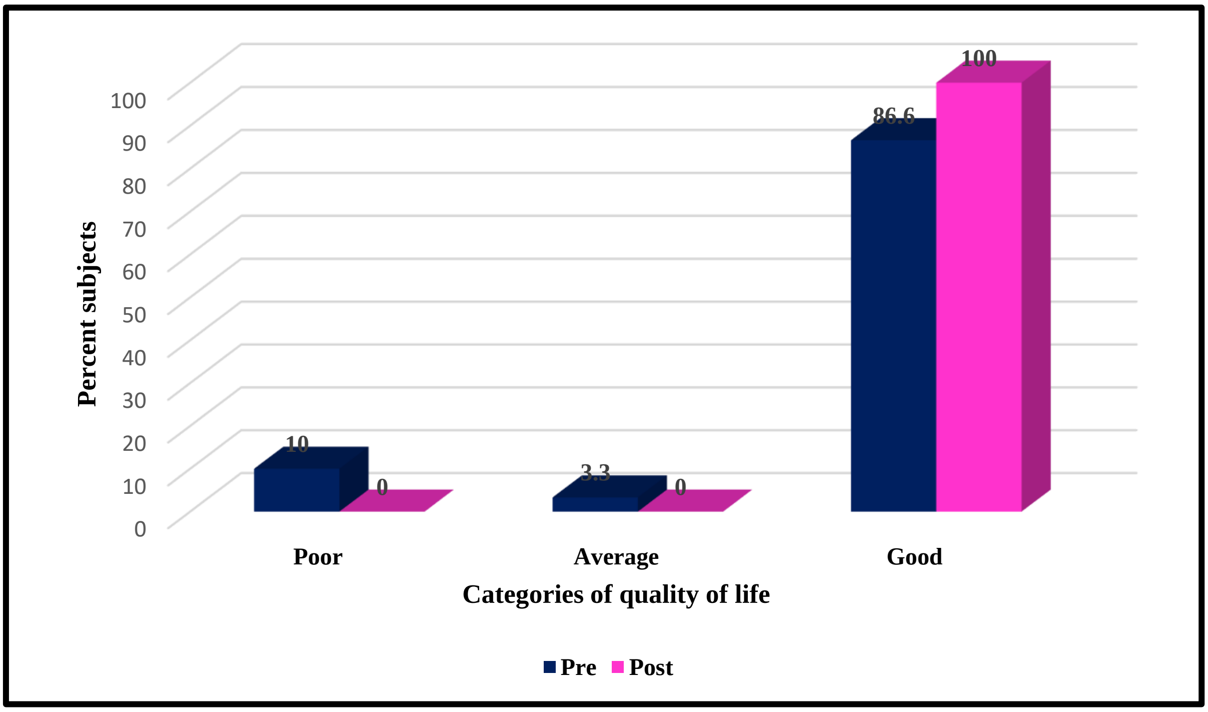

Figure 5.2.3.2- Impact of LHM supplementation on Quality of life of LI adults (N=30)

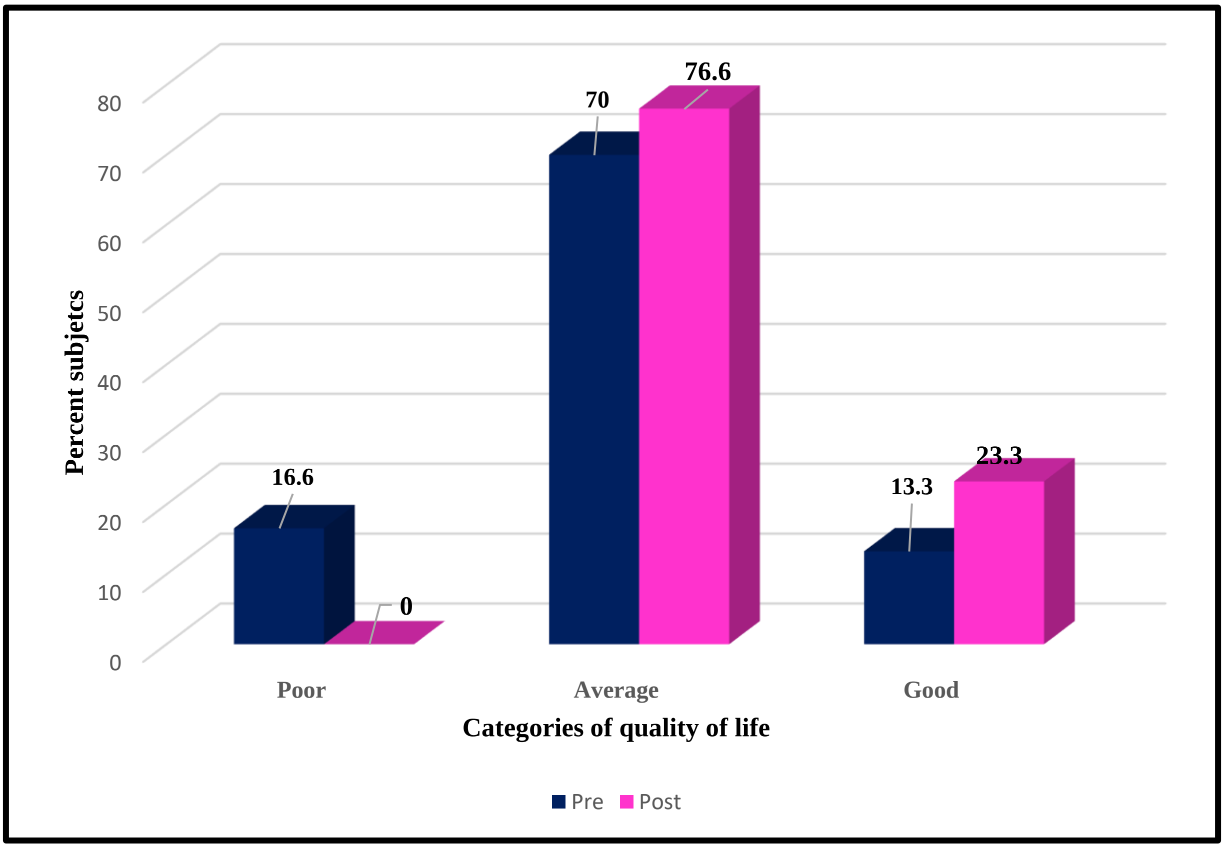

Figure 5.2.3.3- Impact of LHM supplementation on Quality of life of LI elderly (N=30)

Section 5.2.4- Feedback from LI subjects regarding LHM

Acceptance of the product was determined in terms of human senses- such as sight, smell, taste, texture by the lactose intolerant subjects and lastly their desire to purchase the product commercially (Table 5.2.4). With respect to smell, 100% of adult and elderly subjects liked the snell of lactose hydrolysed milk. 20% of children disliked the smell of the milk.

With respect to sight, taste and texture, 100% of children, adult and elderly subjects liked it unanimously. With respect to desire to purchase; 100% of children's parents exhibited desire to purchase it. 100% of elderly expressed desire to purchase LHM. However, 67% of adults expressed desire to purchase as 33% of adults felt it to be costly compared to standard dairy milk.

Table 5.2.4 Feedback upon acceptability of LHM (N=30)

Parameters	Children N (%) (n=30)	Adult N (%) (n=30)	Elderly N (%) (n=30)
Smell – desirable	24 **(80%)**	30 **(100%)**	30 **(100%)**
Undesirable	6 **(20%)**	0 **(0%)**	0 **(0%)**
Sight	30 **(100%)**	30 **(100%)**	30 **(100 %)**
Taste	30 **(100%)**	30 **(100%)**	30 **(100 %)**
Texture	30 **(100%)**	30 **(100%)**	30 **(100 %)**
Desire to purchase	30 **(100%)**	20 **(66.6%)**	30 **(100 %)**

PHASE II Highlights

- ✓ **Among children, post supplementation mild overweight category decreased by 3% thereby increasing moderately overweight category by 3%. With respect to BMI, among adults, there was a decrease in underweight category by 4% and normal category increased by 7%. Among elderly underweight category decreased and normally category increased by 7%.**
- ✓ **With respective to the nutrient intake among children; post supplementation with LHM- protein, carbohydrate, fat, calcium and carotenoid increased by 4%, 7%, 3%, 6%, 35%, 0.61% respectively.**
- ✓ **Among adults; post supplementation- protein, carbohydrate, fat, calcium and carotenoid increased by 8%, 4%, 7%, 59%, 2% respectively.**
- ✓ **Among elderly population; post supplementation- protein, carbohydrate, fat, calcium and carotenoid post LHM supplementation increased – 3%, 7%, 4%, 7%, 44%, 4% respectively.**
- ✓ **With respect to feedback upon acceptability of LHM; among children – 20% didn't liked the smell. Adult and elderly population liked the smell.**
- ✓ **Sight, taste and texture were accepted by children, adults and elderly population.**
- ✓ **With respect to desire to purchase 100% of children's parents and elderlies expressed desire to purchase LHM. Among adults, 67% expressed their desire to purchase LHM.**

Phase III- Food Product development from Lactose hydrolysed milk and Standard dairy milk

In this phase of the study, standard methods were used to develop six food products namely *cold cocoa, rose milk, white sauce pasta, vegetable au gratin, kheer and Sandesh* using standard dairy milk and LHM. Organoleptic evaluation was performed in duplicates using nine-point hedonic scale by 25 semi-trained panel members who qualified the threshold test.

The results of this phase are divided into following sections:

5.3.1 Organoleptic evaluation of beverages with LHM and standard dairy milk

5.3.2 Organoleptic qualities of white sauce pasta and veg au gratin with LHM and standard dairy milk

5.3.4 Organoleptic qualities of *kheer* and *Sandesh* with and LHM and standard dairy milk

5.3.1 Organoleptic evaluation of beverages with lactose hydrolysed milk and standard dairy milk

Among beverages, Cold cocoa and rose milk was developed from standard dairy milk and LHM (plate 6, plate 7 and plate 8). In cold cocoa, no significant difference was seen in organoleptic properties developed from standard dairy and LHM. In rose milk, t-test revealed statistically significant decrease in after taste and taste by 3.8% and 5.1% respectively developed. (Fig 5.3.1) (Fig 5.3.1.1).

Table 5.3.1 Organoleptic evaluation of beverages made out of standard milk and lactose hydrolysed milk

Beverages	Organoleptic properties	Mean ± S.D (Standard milk)	Mean ± S.D (LHM)	t value	P value	% diff
Cold cocoa	Colour and appearance	7.48 ± 0.974	7.56 ± 0.884	0.496	0.622^{NS}	1.06 ↑
	Aroma	7.44± 0.951	7.48 ± 0.909	0.265	0.792 ^{NS}	0.53 ↑
	Texture	7.36 ± 0.964	7.4 ± 1.01	0.260	0.796 ^{NS}	0.54 ↑
	After taste	7.52 ± 1.182	7.42 ± 0.95	0.532	0.597 ^{NS}	1.32 ↓
	Taste	7.52 ± 1.126	7.66 ± 0.96	0.312	0.757 ^{NS}	1.86 ↑
	Mouth feel	7.6 ± 0.969	7.42 ± 1.032	1.055	0.297 ^{NS}	2.36 ↓
	Over all acceptability	7.58 ± 0.992	7.58 ± 0.81	0.000	1.000 ^{NS}	0
Rose milk	Colour and appearance	7.82 ± 1.119	7.5 ± 1.093	1.719	0.092^{NS}	4.09 ↓
	Aroma	7.58 ± 1.108	7.26 ± 1.084	1.908	0.062^{NS}	4.22 ↓
	Texture	7.72 ± 0.991	7.48 ± 1.092	1.288	0.204^{NS}	3.10 ↓
	After taste	7.74 ± 0.986	7.44 ± 0.951	1.976	0.054*	3.87 ↓
	Taste	7.82 ± 0.919	7.42 ± 0.928	2.694	0.010**	5.11 ↓
	Mouth feel	7.72 ± 1.011	7.44 ± 0.951	1.705	0.095^{NS}	3.62 ↓
	Over all acceptability	7.8 ± 0.969	7.56 ± 0.884	1.731	0.090^{NS}	3.07 ↓

Note: NS=non-significant; *= <0.05, **= <0.01

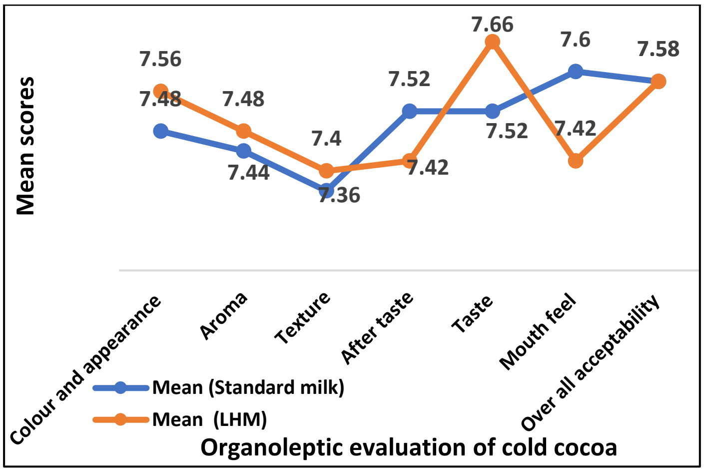

Figure 5.3.1 Organoleptic evaluation of cold cocoa prepared from standard dairy milk and lactose hydrolysed milk.

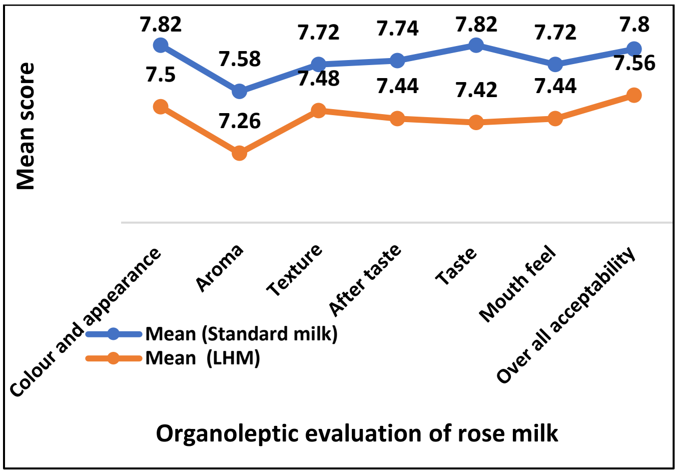

Figure 5.3.1.1 Organoleptic evaluation of rose milk prepared from standard dairy milk and lactose hydrolysed milk.

A (Standard dairy milk) B (LHM)

Plate 6- Cold cocoa made from standard dairy and LHM

A (Standard dairy milk B (LHM)

Plate 7- Rose milk made from standard dairy and LHM

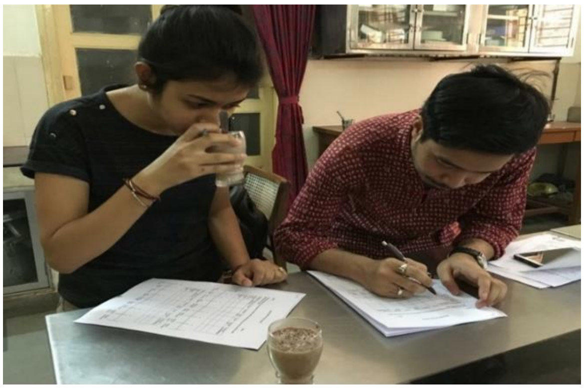

Plate 8- Organoleptic evaluation being conducted on cold cocoa

5.3.2 Organoleptic qualities of white sauce pasta and veg au gratin with lactose hydrolyzed milk and standard dairy milk

Among main courses, white sauce pasta and veg au gratin was developed from standard dairy milk (A) and LHM (B) (Plate 9 and Plate 10). No significant difference was observed in the organoleptic qualities between both the milk products. Mouth feels and overall acceptability of white sauce pasta prepared from LHM increased significantly by 6.8% and 4.12% respectively. No significant difference was observed in the organoleptic qualities between veg au gratin made from standard dairy milk and LHM (Table no. 5.3.2) (Fig 5.3.2) (Fig 5.3.2.1).

Table 5.3.2: Organoleptic evaluation of white sauce pasta and veg au gratin made out of standard milk and LHM.

Main course		Mean ± S.D (Standard milk)	Mean ± S.D (LHM)	t value	P value	%diff
White sauce pasta	Colour and appearance	6.98 ± 1.204	6.78 ±1.016	1.167	0.249^{NS}	2.86 ↓
	Aroma	6.68 ± 1.115	6.78±1.093	0.573	0.569^{NS}	1.49 ↑
	Texture	6.98 ± 1.04	7.08±1.007	0.598	0.553^{NS}	1.43 ↑
	After taste	6.72 ± 1.196	6.96± 1.009	1.205	0.234^{NS}	2.98 ↑
	Taste	6.7 ± 1.074	6.9 ± 0.995	0.953	0.345^{NS}	2.98 ↑
	Mouth feel	6.76 ± 1.17	7.22 ± 0.996	2.837	0.007**	6.80 ↑
	Over all acceptability	6.78 ± 1.055	7.06 ± 0.998	1.705	0.095*	4.12 ↑
Vegetable au gratin	Colour and appearance	7.46 ±1.147	7.28 ±1.179	1.219	0.229^{NS}	2.40 ↓
	Aroma	7.28 ±1.246	7.5 ± 1.111	1.355	0.182^{NS}	3.02 ↑
	Texture	7.42 ± 1.162	7.52 ± 1.015	0.626	0.534^{NS}	1.34 ↑
	After taste	7.42 ± 1.197	7.52 ± 1.035	0.670	0.506^{NS}	1.34 ↑
	Taste	7.4 ±1.143	7.5 ± 1.035	0.590	0.558^{NS}	1.35 ↑
	Mouth feel	7.38 ±1.93	7.42 ± 1.052	0.252	0.802^{NS}	0.54 ↑
	Over all acceptability	7.48 ±1.216	7.54 ± 1.054	0.387	0.700^{NS}	0.80 ↑

Note: NS=non-significant; *= <0.05, **= <0.01

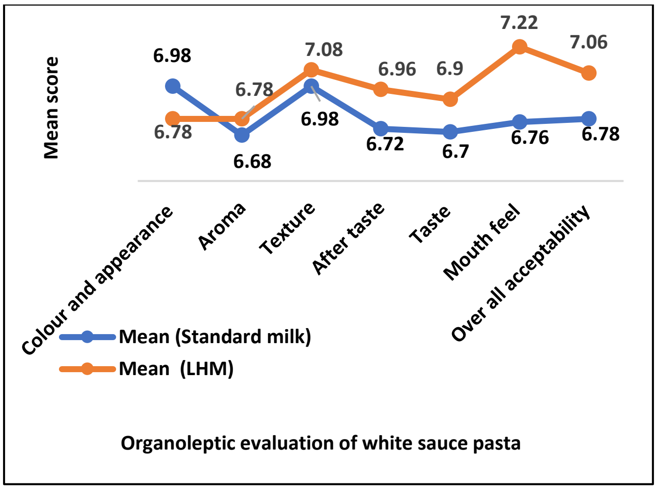

Figure 5.3.2 Organoleptic evaluation of white sauce pasta prepared from standard dairy milk and lactose hydrolysed milk

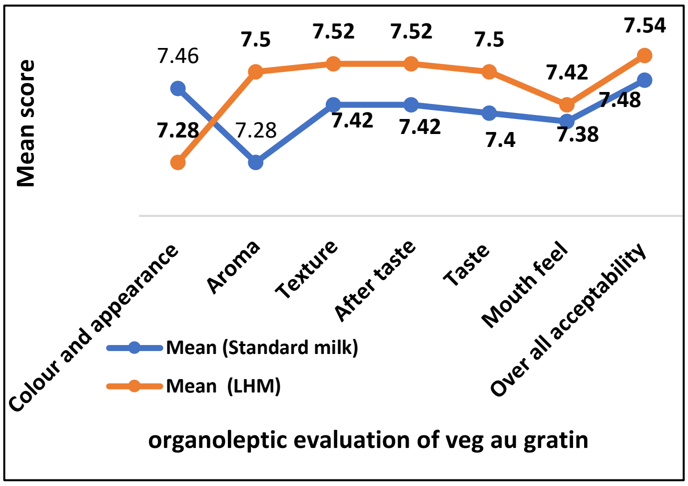

Figure 5.3.2.1 Organoleptic evaluation of vegetable au gratin prepared from standard dairy milk and lactose hydrolysed milk

A (Standard dairy milk) B (LHM)

Plate 9- Veg au gratin made from standard dairy and LHM

A (Standard dairy milk) B (LHM)

Plate 10- White sauce pasta made from standard dairy and LHM

5.3.3 Organoleptic qualities of *kheer* and *Sandesh* with lactose hydrolysed milk and standard dairy milk

Among desserts, Sandesh and kheer were developed from standard dairy milk (A) and LHM (B) (plate 11 and plate 12). No significant difference was observed in the organoleptic qualities between desserts prepared from both standard milk and LHM. However, panellist mentioned, dessert made from LHM was sweeter compared to dessert prepared from standard dairy milk (Table 5.3.3, Fig 5.3.3.1, Fig 5.3.3.2).

Table 5.3.3: Organoleptic evaluation of desserts (*kheer* and *Sandesh)* made out of standard milk and Lactose hydrolysed milk

Desserts		Mean ± S.D (Standard milk)	Mean ± S.D (LHM)	t value	p value	%diff
Kheer	Colour and appearance	7.9 ± 0.909	7.76 ± 0.894	0.943	0.35 NS	1.77 ↓
	Aroma	7.8 ± 0.99	7.68 ± 1.039	0.759	0.452 NS	1.53 ↓
	Texture	7.8 ± 0.756	7.9 ± 0.863	0.670	0.506 NS	1.28 ↑
	After taste	7.84 ± 0.912	7.76 ± 1.001	0.496	0.622 NS	1.02 ↓
	Taste	7.96 ± 0.781	7.9 ± 0.931	0.417	0.679 NS	0.75 ↓
	Mouth feel	7.8 ± 0.782	7.92 ± 0.877	0.759	0.452 NS	1.53 ↑
	Over all acceptability	8.02 ± 0.685	7.92 ± 0.752	0.962	0.341 NS	1.24 ↓
Sandesh	Colour and appearance	7.64 ± 1.174	7.62 ± 0.987	0.110	0.913 NS	0.261 ↓
	Aroma	7.62 ± 1.008	7.52 ± 0.931	0.538	0.593 NS	1.31 ↓
	Texture	7.5 ± 1.055	7.62 ± 0.945	0.651	0.518 NS	1.6 ↑
	After taste	7.58 ± 1.247	7.64 ± 0.875	0.335	0.739 NS	0.79 ↑
	Taste	7.54 ± 1.216	7.64± 0.985	0.509	0.613 NS	1.32 ↑
	Mouth feel	7.44 ± 1.198	7.66± 0.798	1.244	0.219 NS	2.95 ↑
	Over all acceptability	7.56 ± 1.181	7.74 ± 0.853	1.055	0.297 NS	2.38 ↑

Note: NS=non-significant

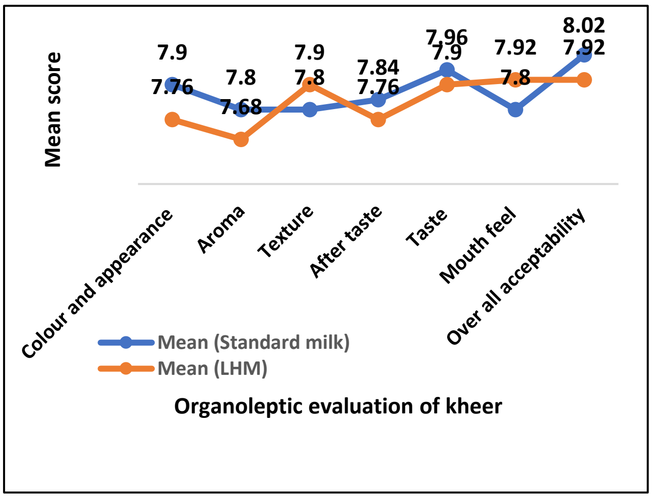

Figure 5.3.3.1 Organoleptic evaluation of kheer prepared from standard dairy milk and lactose hydrolysed milk

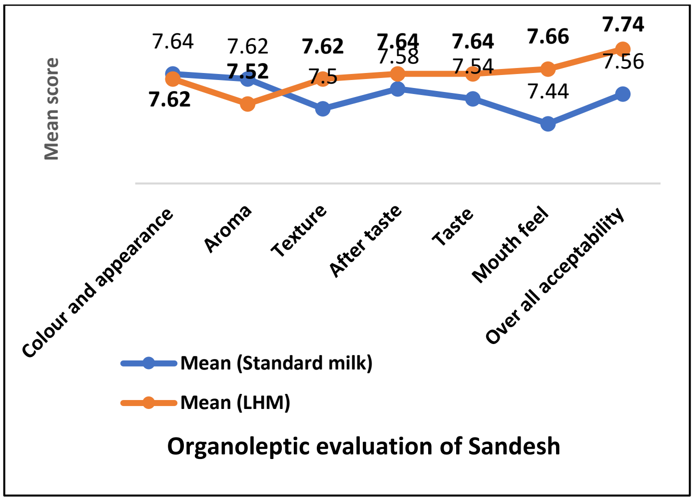

Fig 5.3.3.2 Organoleptic evaluation of sandesh prepared from standard dairy milk and lactose hydrolysed milk

A (Standard dairy milk) B (LHM)

Plate 11- Kheer made from standard dairy and LHM

A (Standard dairy milk) B (LHM)

Plate 12- Sandesh made from standard dairy and LHM

PHASE III Highlights

- ✓ Among beverages, Cold cocoa and rose milk was developed from standard dairy milk and LHM. In cold cocoa, no significant difference was seen in organoleptic properties developed from standard dairy and LHM. In rose milk, t-test revealed statistically significant decrease in after taste and taste by 3.8% and 5.1% respectively developed.
- ✓ Among main courses, white sauce pasta and veg au gratin was developed from standard dairy milk and LHM. No significant difference was observed in the organoleptic qualities between both the milk products. Mouth feels and overall acceptability of white sauce pasta prepared from LHM increased significantly by 6.8% and 4.12% respectively. No significant difference was observed in the organoleptic qualities between veg au gratin made from standard dairy milk and LHM.
- ✓ Among desserts, Sandesh and kheer was developed from standard dairy milk and LHM. No significant difference was observed in the organoleptic qualities between desserts prepared from both standard milk and LHM. However, panellist mentioned, dessert made from LHM was sweeter compared to dessert prepared from standard dairy milk.

In the view of the results of all the three phases, the following null hypothesis formulated at the beginning of the study are rejected:

- Hydrogen breath analyser test cannot detect lactose intolerant subjects.
- LHM supplementation for a period of 6 weeks to LI subjects will not cause improvement in BMI, QOL and nutrient intake.
- Recipes prepared from Lactose hydrolysed milk will not be accepted by the panellists for most of the organoleptic attributes.

The following alternative hypothesis are accepted:

- Hydrogen breath analyser test can detect lactose intolerant subjects.
- LHM supplementation for a period of 6 weeks to LI subjects will bring about improvement in BMI, QOL and nutrient intake.
- Recipes prepared from lactose hydrolysed milk was accepted by the panellists for most of the organoleptic attributes.

Phase IV- Development of IEC material

IEC material comprised of a booklet to spread awareness about lactose intolerance, types and its treatment options. It also mentioned recipes developed from lactose hydrolysed milk. Below the cover page of developed booklet is illustrated.

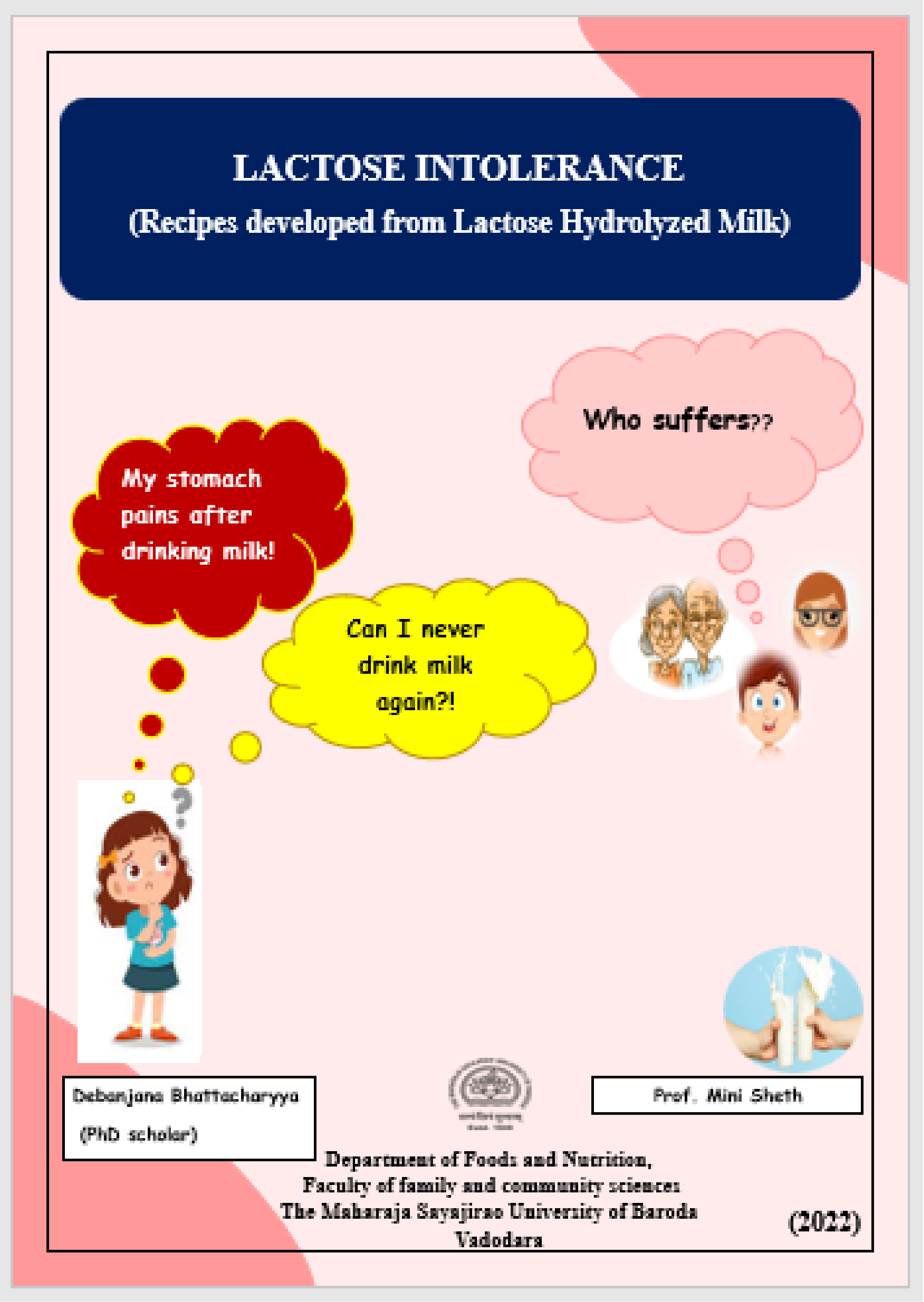

Figure 5.4 Cover page of IEC material

DISCUSSION

In the present study lactose intolerance was detected among three age groups- children, adults and elderlies. Lactose intolerant subjects were supplemented with lactose hydrolysed milk for a period of 6 weeks and impact of supplementation of LHM on BMI, dietary intake and quality of life was assessed. Organoleptic evaluation of food products developed from standard milk and lactose hydrolysed milk was conducted. The results of the present study are discussed in this chapter as per the stated objectives.

In this study Gastrointestinal symptoms were assessed post consumption of various food products such as- cereals, pulses, fruits, vegetables, fermented foods, milk and milk products. Food intolerances are opposing reaction to foods, the immune system do not play a role in this. (Turnbull JL et al 2005). Among children, 24% of them suffered gastrointestinal symptoms post consumption of milk and milk products followed by vegetables, fruits and fermented foods. Among adults, 41% suffered gastrointestinal symptoms post consumption of pulses followed by fermented, fruits and milk and milk products. Among geriatric population, 28% of them suffered from gastrointestinal symptoms after consuming milk and milk products followed by vegetables, fermented and fruits.

Fermentable carbohydrates are naturally occurring and present in a wide variety of foods, these foods are termed ‘FODMAPs’ (denoting fermentable oligo- di- mono-saccharides and polyols). This group of carbohydrates has been identified to trigger symptoms in patients with functional GI symptoms such as in irritable bowel syndrome (IBS) (Tuck CJ et al 2019; Halmos EP et al 2014). The low FODMAP diet reduces intake of carbohydrate subgroups including (i) excess fructose present in foods such as honey, apples and mangoes, (ii) lactose present in milk and yoghurt (in the presence of lactase deficiency), (iii) polyols (largely comprised of sorbitol and mannitol) present in avocado and pears, iv) fructans present in wheat, onion and garlic, and (v) galacto-oligosaccharides present in legumes and nuts. gluten is associated with GI symptoms including abdominal pain, bloating and bowel habit abnormalities, so-called ‘non-coeliac gluten/wheat sensitivity’ (NCG/WS). In addition to the GI response, there are various systemic manifestations reported to be associated with wheat intake, including disorders of the neuropsychiatric area such as “foggy mind”, headache, fatigue and dermatological and musculoskeletal symptoms (such as- leg or arm numbness) (Catassi C et al 2015).

There is a perception that pluses cause flatulence and contribute to gastrointestinal symptoms. A study conducted by Veenstra JM et al in the year 2010 revealed increased in flatulence and abdominal discomfort. Lentil and chickpea increased flatulence significantly high. No major changes were observed in overall gastrointestinal function. Another study conducted by Zimmerman SA et al 1986 conducted among elderlies revealed cooked vegetables are tolerated better than raw vegetables. However, brassica genus vegetables were not tolerated well.

In the present study, HBT revealed lactose intolerance among 46.15% of children. Similarly, Hydrogen breath analyser test was used to detected lactose intolerance among children (aged 21/2 months to 13 years suffering from chronic diarrhoea and 6 patients without diarrhoea). Out of 23, 12 patients with diarrhoea had HBT readings greater than 24ppm. This study establishes HBT as a non-invasive, effective diagnostic tool to detect lactose intolerance (Maffei HVL et al 1977).

In this study, 48.3% of adults had lactose intolerance post conducting HBT. In another study, HBT revealed lactose intolerance among 78.9% and 57.1% adults in southern Indians and northern Indians respectively (Babu J et al 2009). HBT revealed 55.5% of elderlies had lactose intolerance in this study. HBT conducted showed prevalence of lactose intolerance among 50.5% of the studied elderly population (Casellas F et al 2013). In another study conducted in Indonesia, HBT revealed prevalence of lactose intolerance among 66% of the total population, 54% among dairy users and 73% among non-dairy users. This study also revealed low mean intake of protein, calcium, vitamin D and vitamin B12 among elderlies (Dewiasty E et al 2021).

In the present study, among children, post supplementation mild overweight category decreased by 3% thereby increasing moderately overweight category by 3%. In another study conducted among children aged 6-18 years revealed milk and milk consumption lead to increase in lean mass and consequently decrease in percent body weight (Kang Kai et al 2019). However, another study conducted in the year 1928 revealed increase of 20% in height and weight for Scottish children (5-14 years) who consumed milk in addition to their normal diet for 7 months (Herber C et al 2020).

With respect to BMI, among adults, there was a decrease in underweight category by 4% and normal category increased by 7%. Among elderly underweight category decreased and normally category increased by 7%. Similarly, another study conducted upon 204 individuals (55 – 85 years) revealed increase in body weight by 0.6kg (Barr IS et al 2000).

With respect to nutrient intake, post supplementation with LHM among children- protein, carbohydrate, fat, calcium and carotenoid increased by 4%, 7%, 3%, 6%, 35%, 0.61% respectively. Kim HS in the year 2005 mentioned in their study, consumption of partially lactose digested and low-fat milk for a period of 4 months lead to the increase in calcium, protein, fat, phosphorus, riboflavin etc.

Among adults; post supplementation- protein, carbohydrate, fat, calcium and carotenoid increased by 8%, 4%, 7%, 59%, 2% respectively. Among elderly population; post supplementation- protein, carbohydrate, fat, calcium and carotenoid post LHM supplementation increased – 3%, 7%, 4%, 7%, 44%, 4% respectively. Barr IS et al 2000 reported milk intake in diet significantly increased energy, protein, calcium, magnesium and potassium intakes. Similarly, in another study, there was increase in total energy, saturated fat, total protein and lactose with increase in servings of dairy products consumed. Intake of calcium, folate, riboflavin, vitamins (B-6, B-12, A, D, E) also increased with increase in dairy products servings (Ranganathan R et al 2005).

Majority of children (93.3%) had good quality of life before supplementation with LHM. However, post supplementation 100% of children had good quality of life. Among adults, 86.6% had good quality of life before LHM supplementation and 100% had good quality of life post supplementation.

The WHO defines the concept of quality of life (QOL) as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns. The health-related quality of life (HRQOL) is a patient-focused concept, referring to an impairment of functional status (physical or mental) and the sense of well-being.

Carlson MJ in the year 2014 mentioned in their study, Children reported that food-induced symptoms interfered with school performance, sports, and social activities. despite use of several coping strategies, food-induced symptoms can adversely impact children's QOL in several important areas. Gastrointestinal-specific anxiety seems to be an important factor for GI symptom severity and QOL in patients with IBS (Jerndal P et al 2010). In this study 100% of children supplemented with lactose hydrolysed milk had good quality of life. Majority (87%) of the lactose intolerant adults reported to have good quality of life as most of them had stopped completely consumption of milk completely. Since there was no consumption of milk. Therefore, lactose intolerance did not affect their quality of life that explains the reason for them having good scores for quality of life.

The health-related quality of life was significantly impaired in subjects with GERD, un investigated dyspepsia and IBS in this community (Jeong JJ et al 2008). In one of the studies, it was revealed that approximately 25% of the respondents reported conditions such as hypertension, asthma or diabetes, and a mean of 46.4% reported at least one GI symptom. The most frequent symptoms were heartburn, diarrhoea and postprandial fullness. Approximately 10-20% of the respondents reporting individual symptoms experienced these several times a week. Symptoms were considered as severe or interfering 'quite a lot' with daily activities by at least 7.3% and 4.8% of respondents, respectively. demonstrate on a large scale the importance of GI symptoms in daily life and their influence on QoL (Flokstra-de Blok BM et al 1999). Self-perception of intolerance was associated with lower HRQOL scores (Casellas F et al 2016).

Correlation between Health-related quality of life (HRQOL) and Health-promoting lifestyle (HPL) were studied in China revealing Role-emotional domain score was far below average, vitality domain was a little below average, social functioning and general health domains were a little above average, and other domains were far above average. This established a positive correlation between HPL and HRQL.

HRQOL could be improved through promoting HPL (such as health responsibility and physical activity) (Li, J., Yu, J et al 2018).

With increase in elderly population there is an increase in health demands and other social requirement. Studies have shown that physical deterioration, psychological trauma, and mental weakness are associated with aging.

In the present study, the sensory panellist accepted all the six food products prepared from LHM based upon organoleptic qualities. Thus, these food products prepared from LHM can be recommended to lactose intolerant individuals for their conception.

In a study conducted in India, sensory evaluation of low lactose khoa prepared from hydrolysed buffalo milk was performed on the basis of 100-point composite card. Statistical analysis revealed no significant change ($p>0.05$) in flavour and body and texture in Khoa prepared from lactose hydrolysed milk compared with fresh milk Khoa samples until the 21st day of storage but a significant change ($p<0.05$) was observed on the 28th day. However, the flavour scores of Khoa prepared from fresh milk had slightly higher scores than Khoa prepared from lactose hydrolysed milk. The variation can be attributed to the development of a sweet flavour owing to the release of monosaccharides i.e., glucose and galactose released upon lactose hydrolysis in milk used for the preparation of Khoa. Lactose hydrolysed milk can be used in making fermented dairy products such as cheese, yoghurt, dahi and heat desiccated products such as Khoa. Lactose hydrolysis in milk produces better digestibility and sweet taste, thereby leading to the recent rise in the demand for lactose hydrolysed dairy products (Aggarwal A et al 2019).

Similarly, results were obtained where higher sweetness in lactose hydrolysed gulabjamun (a deep-fried Khoa Indian dessert) compared with control was observed (Harini G and Rao H 2011). In the present study also we see, Sandesh prepared from lactose hydrolysed milk had higher sweetness compared to Sandesh prepared from standard dairy milk. While heating, during Sandesh preparation a slight brown colour appeared due to mailard reaction in lactose hydrolysed milk compared to Sandesh prepared from standard dairy milk.

In one of the study, organoleptic properties of yogurt made up of lactose hydrolysed milk and standard revealed no significant changes between control and the test samples upon evaluation by triangle test, however the addition of fruit and sugars increased sweetness when detected by triangle test. (Ismail A et al 1983). In another study, the use of low lactose milk with varying degree of hydrolysis of lactose may have an impact on the textural properties of yogurt. In a study, yogurt prepared using 50%, 70% and 90% hydrolysed lactose revealed significantly higher scores for body and texture, flavour and overall acceptability than control ($P<0.05$) whereas lower scores were observed for 90% hydrolysis (Nagaraj M et al 2009).

From the above studies we can say that a wide variety of food products can be developed from lactose hydrolysed milk without compromising on its organoleptic properties at both household and commercial level.