

TABLE OF CONTENTS

TITLE PAGE.....	i
CERTIFICATE.....	iii
STATEMENT OF ORIGINALITY.....	iv
ACKNOWLEDGEMENTS.....	v
TABLE OF CONTENTS.....	vi
LIST OF TABLES.....	xvii
LIST OF FIGURES AND ILLUSTRATIONS.....	xxiv
ABSTRACT	xxviii

Chapter 1

STATEMENT OF THE PROBLEM.....	1
-------------------------------	---

Chapter 2

HISTORICAL REVIEW AND REVIEW OF THE LITERATURE.....	30
2.1. THE HISTORY OF IODINE DEFICIENCY DISORDERS.....	30
2.2. IDD IN THE 20 th AND 21 st CENTURY.....	37
2.3. DEFINITION OF IDD.....	47
2.4. AETIOLOGY OF IDD.....	48
2.4.1. IODINE DEFICIENCY.....	48
2.4.2. NATURAL DIETARY GOITROGENS.....	51
2.4.3. PROTEIN ENERGY MALNUTRITION (PEM).....	61
2.4.4. OTHER FACTORS.....	65
2.4.4.1. TRACE ELEMENTS DEFICIENCIES.....	65
SELENIUM DEFICIENCY.....	65
COBALT DEFICIENCY.....	66
IODINE AND ZINC DEFICIENCY.....	66

IRON DEFICIENCY.....	67
2.4.4.2. VITAMIN DEFICIENCY.....	67
VITAMIN A AND E AND IDD.....	67
2.5. CORRELATION BETWEEN IDD AND VARIOUS FACTORS.	69
EXCESS SILICONE AND IDD.....	69
SUFFICIENT IODINE AND GOITRE.....	69
GEOGRAPHICAL PLACEMENT AND IDD.....	70
SOCIOECONOMIC STATUS AND IDD.....	71
ETHNICITY AND IDD.....	71
GENETIC FACTORS AND IDD.....	71
THERAPEUTIC MEASURES AND IDD.....	72
PREGNANCY AND IDD.....	72
IODINE EXCESS AND THYROID STATUS.....	74
COGNITIVE PERFORMANCE AND IDD.....	76
LEARNING AND MOTIVATION AND IDD.....	76
THYROID SIZE AND URINARY IODINE.....	76
ELECTROENCEPHALOGRAM AND IDD.....	77
URINARY IODINE AND BREAST MILK IODINE.....	77
CARCINOMA AND IDD.....	77
CLASSIFICATION OF PALPATION 1960 VERSUS 1994 AND ULTRASONOGRAPHY.....	77
PALPATION INACCURATE.....	78
PREFERENCE OF ULTRASONOGRAPHY IN MILD IODINE DEFICIENCY.....	78
LOW IODINE IN WATER AND IDD.....	79
CIRCADIAN RHYTHM AND URINARY IODINE.....	80
2.6. URINARY IODINE ESTIMATION METHODS.....	80
SPECTROPHOTOMETRIC METHOD.....	80
AUTOANALYSER METHOD (AAII TECHNICON).....	80
ELECTROCHEMICAL METHOD.....	81
X-RAY FLUORESCENCE METHOD.....	81
ASHING OR DIGESION METHODS.....	81

CHLORIC ACID METHOD.....	81
AMMONIUM PERSULPHATE METHOD.....	82
MICROPLATE METHOD.....	82
INDUCTIVELY COUPLED PLASMA MASS	
SPECTROMETRY (ICPMS).....	83
ISOTOPE DILUTION ANALYSIS METHOD.....	83
PAIRED-ION REVERSED PHASE HPLC WITH	
ELECTROCHEMICAL DETECTION METHOD.....	83
PAIRED-ION REVERSED PHASE HPLC.....	84
RAPID URINARY IODINE TEST: METHOD J.....	84
FLOW-INJECTION ANALYSIS.....	85
AUTOMATED ULTRAVIOLET IRRADIATION ASSAY.....	85
METHOD K.....	85
2.7. THE SPECTRUM OF IODINE DEFICIENCY DISORDERS ...	86
2.8. IDD IN THE LIFE CYCLE.....	87
IODINE DEFICIENCY IN THE FETUS.....	87
IODINE DEFICIENCY IN THE NEONATE.....	87
IODINE DEFICIENCY IN THE CHILD.....	88
IODINE DEFICIENCY IN THE ADULT.....	89
2.9. REGIONAL DESCRIPTIONS OF IDD.....	90
DEVELOPED COUNTRIES.....	90
AMERICAS.....	90
IDD IN AUSTRALIA.....	90
DEVELOPING COUNTRIES.....	91
AFRICA.....	91
SOUTHEAST ASIA.....	92
BANGLADESH.....	92
BHUTAN, MYANMAR,	93
INDIA,.....	94
INDONESIA, NEPAL, SRILANKA	96
PAKISTAN, THAILAND.....	97
CHINA AND FAR EAST, CHINA	97

QINGHAI, MONGOLIA.....	98
LIBYA TUNISIA, JORDAN, SUDAN,	99
SYRIA, KUWAIT, LEBANON.....	100
MORROCCO, OMAN, PALESTINE	101
QATAR, SAUDI- ARABIA.....	102
UNITED ARAB EMIRATES, YEMEN	102
2.10. PRESENT STATUS OF IODISED SALT PROGRAMS.....	103
2.11. MANDATORY IODIZATION AND IDD.....	106
2.12. IODISED OIL.....	107
2.13. OTHER METHODS OF IODINE SUPPLEMENTATION.....	111
2.14. CLINICAL FEATURES OF GOITROGEN-INDUCED GOITRES.....	112
2.15. RELEVANCE OF GOITROGENS TO HUMAN GOITRE.....	112

CHAPTER 3

SUBJECTS, DIET AND GENERAL METHODS.....	114
3.1. PLACES OF STUDY	114
GUJARAT	117
BACKGROUND.....	117
BARODA.....	119
DANG.....	119
HIMACHAL PRADESH	120
TAMIL NADU AND CHENNAI.....	122
3.2. SUBJECTS.....	123
3.3. DIET.....	124
VEGETABLES, FRUITS, SPICES, SALT, GOITROGENS,	126-
FLAVONOIDS IN DIET, FLAVONOID CONTENT IN FOOD	30
3.4. GENERAL METHODS.....	130
3.4.1. ASSESSMENT OF IDD STATUS BY	
APPROPRIATE INDICATORS.....	130
3.4.1.1. CLINICAL INDICATORS.....	131

3.4.1.1.1. PALPATION.....	131
3.4.1.1.2. ULTRASONOGRAPHY	132
3.4.1.2. BIOCHEMICAL MARKERS.....	136
3.4.1.2.1. URINARY IODINE.....	136
3.4.1.2.2. BLOOD ASSAY TSH	144
3.4.2. DIETARY GOITROGEN ANALYSIS.....	149
3.4.3. ASSESSMENT OF PROTEIN ENERGY MALNUTRITION STATUS.....	149
3.4.3.1. WHO GROWTH INDICATORS	149
3.4.3.2. ADDITIONAL ANTHROPOMETRIC MEASUREMENTS.....	154
MUAC.....	154
THIGH CIRCUMFERENCE.....	155
TRICEPS SKIN FOLD THICKNESS...	155
DERIVED INDICES.....	155
ARM FAT AREA.....	155
ARM MUSCLE AREA.....	155
3.4.3.3. INDICATORS OF PEM THRESHOLD.....	156
WATERLOW CLASSIFICATION.....	156
3.5. SURVEILLANCE METHODS.....	158
3.5.1. ASSESSMENT OF IDD PREVALENCE.....	158
3.5.2. IDENTIFICATION OF HIGH PREVALENCE AREAS.....	160
3.5.3. CRITERIA FOR MONITORING PROGRESS	160
3.5.4. STATISTICAL METHODS.....	161

CHAPTER 4

BIOCHEMICAL ASSESSMENT OF IODINE DEFICIENCY DISORDERS IN BARODA AND DANG DISTRICTS OF GUJARAT AT FIELD CONDITIONS: A STUDY OF 1363 SCHOOLCHILDREN AND 959 ADULTS.....	162
--	------------

4.1. SUMMARY.....	162
-------------------	-----

4.2. INTRODUCTION.....	163
4.3. SUBJECTS AND METHODS.....	166
4.3.1. POPULATION STUDIED.....	166
4.3.2. URINARY IODINE.....	167
4.3.3. BLOOD SPOT TSH.....	167
4.3.4. ANTHROPOMETRY.....	167
4.4. RESULTS.....	167
4.4.1. URINARY IODINE LEVELS.....	167
4.4.2. BLOOD TSH LEVELS.....	182
4.4.3. VARIATION BY VILLAGE.....	189
4.5. DISCUSSION.....	199
4.6. CONCLUSIONS.....	201

CHAPTER 5

ASSESSMENT OF IODINE DEFICIENCY DISORDERS BY CLINICAL AND BIOCHEMICAL PREVALENCE INDICATORS IN RURAL/TRIBAL CHILDREN FROM GUJARAT..... 202

5.1. SUMMARY.....	202
5.2. INTRODUCTION.....	204
5.3. SUBJECTS AND METHODS.....	206
5.3.1. DIET.....	206
5.3.2. POPULATION STUDIED.....	207
5.3.3. THE IDD STATUS.....	207
5.3.3.1. THYROID SIZE.....	208
5.3.3.2. URINARY IODINE.....	208
5.3.3.3. BLOOD SPOT TSH.....	209
5.3.4. DIETARY GOITROGEN ANALYSIS.....	209
5.3.5. ANTHROPOMETRY.....	209
5.4. RESULTS.....	209
5.5. DISCUSSION.....	222

CHAPTER 6

ASSESSMENT OF IODINE DEFICIENCY DISORDERS BY CLINICAL AND BIOCHEMICAL INDICATORS IN ADULTS...	226
6.1. SUMMARY.....	226
6.2. INTRODUCTION.....	228
6.3. SUBJECTS.....	229
6.3.1. DIET.....	229
6.3.2. POPULATION STUDIED.....	230
6.4. METHODS.....	230
6.4.1. THYROID PALPATION.....	230
6.4.2. THYROID ULTRASONOGRAPHY.....	230
6.4.3. URINARY IODINE.....	231
6.4.4. TSH.....	231
6.5. RESULTS.....	231
6.5.1. GENERAL.....	231
6.5.2. BIOCHEMICAL STATUS.....	232
6.5.2.1. URINARY IODINE.....	232
6.5.2.2. BLOOD SPOT TSH.....	235
6.5.3. THYROID SIZE.....	237
6.5.3.1. PALPATION.....	237
6.5.3.2. ULTRASONOGRAPHY.....	237
6.5.4. RELATIONSHIPS.....	239
6.5.5. COMPARISONS.....	243
6.6. DISCUSSION.....	244

CHAPTER 7

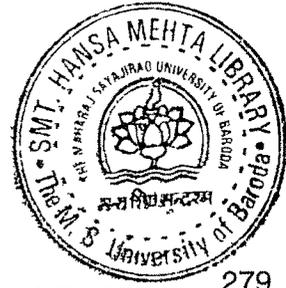
IMPACT OF PROTEIN ENERGY MALNUTRITION ON THYROID SIZE IN IODINE DEFICIENT POPULATION OF GUJARAT (INDIA): IS IT AN AETIOLOGICAL FACTOR FOR GOITRE?.....	247
---	------------

7.1. SUMMARY.....	247
7.2. INTRODUCTION.....	249
7.3. SUBJECTS AND METHODS.....	251
7.3.1. WHO CLASSIFICATION FOR PEM.....	252
7.3.2. WATERLOW CLASSIFICATION.....	252
7.3.3. THYROID VOLUMES.....	252
7.4. RESULTS.....	253
7.4.1. PREVALENCE OF PEM AND GOITRE.....	253
7.4.1.1. CHILDREN AGED 6-15 YEARS	253
7.4.1.2. ADULTS.....	260
7.4.2. REGRESSION ANALYSIS.....	263
7.4.2.1. CHILDREN.....	263
7.4.2.2. ADULTS.....	266
7.5. DISCUSSION.....	267
7.6. CONCLUSIONS.....	270

CHAPTER 8

IODINE DEFICIENCY DISORDERS ASSESSMENT IN URBAN AFFLUENT POPULATION (CHILDREN AND ADULTS) SHOWED INCREASED THYROID SIZE DESPITE SUFFICIENT IODINE AND NUTRITION INTAKE POINTING TO POSSIBLE AETIOLOGICAL ROLE OF DIETARY GOITROGENS.....	271
---	------------

8.1. SUMMARY.....	271
8.2. INTRODUCTION.....	274
8.3. SUBJECTS.....	275
8.4. DIET.....	278
8.5. METHODS.....	278
8.5.1. NUTRITION.....	278
8.5.1.1. WHO CLASSIFICATION FOR PEM..	279
8.5.1.2. WATERLOW CLASSIFICATION	279



8.5.2. IODINE INTAKE.....	279
8.5.2.1. URINARY IODINE.....	279
8.5.3. THYROID SIZE.....	280
8.5.3.1. PALPATION.....	280
8.5.3.2. THYROID VOLUME.....	280
8.6. RESULTS.....	280
8.6.1. NUTRITION.....	280
8.6.1.1. NUTRITIONAL STATUS.....	284
8.6.2. URINARY IODINE.....	295
8.6.3. THYROID SIZE.....	295
8.6.4. THYROID VOLUME COMPARISONS.....	301
8.6.5. REGRESSION ANALYSIS.....	309
8.7. DISCUSSION.....	315
8.8. CONCLUSIONS.....	318

CHAPTER 9

A SURVEY OF IDD IN HIMACHAL PRADESH PRESENTS NORMATIVE THYROID VOLUME REFERENCE DATA FOR SCHOOLCHILDREN:..... 319

9.1. SUMMARY.....	319
9.2. INTRODUCTION.....	321
9.3. BACKGROUND.....	322
9.4. SUBJECTS.....	323
9.5. DIET.....	324
9.6. RESULTS.....	324
9.6.1. WHO CLASSIFICATION.....	325
9.6.2. WATERLOW CLASSIFICATION SCHEME....	326
9.6.3. URINARY IODINE.....	328
9.6.4. THYROID SIZE.....	328
9.6.4.1. PALPATION.....	328
9.6.4.2. ULTRASONOGRAPHY.....	329

9.6.5. REGRESSION ANALYSIS.....	335
9.7. DISCUSSION.....	338
9.8. CONCLUSIONS.....	339

CHAPTER 10

IDD SURVEY IN TAMILNADU..... 340

10.1. SUMMARY.....	340
10.2. INTRODUCTION.....	342
10.3. SUBJECTS.....	343
10.4. DIET.....	344
10.5. METHODS.....	344
10.6. RESULTS.....	346
10.6.1. NUTRITIONAL STATUS.....	346
10.6.1.1. WHO CLASSIFICATION.....	346
10.6.2. IRON DEFICIENCY ANAEMIA.....	347
10.6.3. VITAMIN A DEFICIENCY.....	348
10.6.4. URINARY IODINE.....	348
10.6.5. THYROID SIZE.....	349
10.6.5.1. PALPATION.....	349
10.6.5.2. ULTRASONOGRAPHY.....	349
10.7. DISCUSSION.....	356
10.8. CONCLUSIONS.....	356

CHAPTER 11

DISCUSSION..... 357

CHAPTER 12

REFERENCES..... 376

.